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Measuring the Security and Privacy of IP Cameras on Shodan

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List of Abbreviations

CCTV	Closed-circuit Television
CNN	Convolutional Neural Network
DDoS	Distributed Denial-of-Service
HLS	HTTP Live Streaming
HTTP	Hypertext Transfer Protocol
ICS	Industrial Control System
IoT	Internet of Things
IP	Internet Protocol
JSON	JavaScript Object Notation
MPEG-DASH	Dynamic Adaptive Streaming over HTTP
NIST	National Institute of Standards and Technology
ONVIF	Open Network Video Interface Forum
PII	Personal Identifiable Information
PLC	Programmable Logic Controller
QoE	Quality of User Experience
RAM	Random-Access Memory
RTMP	Real-Time Messaging Protocol
RTSP	Real-Time Streaming Protocol
SCADA	Supervisory Control And Data Acquisition
SSH	Secure Shell
TCP	Transmission Control Protocol
UART	Universal Asynchronous Receiver / Transmitter
URL	Uniform Resource Locator

USB	Universal Serial Bus
WebRTC	Web Real-Time Communication

1 Introduction

1.1 Background

Online Security has become a widely discussed topic nowadays, with the main reason being the contribution of cyber-attacks and ransomware. The public's concerns about security are rising, and this can be evidenced by the increased number of surveillance camera throughout the years. Research from Clarion Security Systems indicates that from 2012 to 2022, there was a 238.16% increase in the number of CCTV cameras in London Boroughs, with an estimated total of over 7 million CCTV cameras in the UK [1]. This research takes into account the rise of home CCTV cameras, doorbell cameras, council investment in CCTV systems, and more commercial CCTV systems being installed.

The use of surveillance cameras has evolved from eyes to IPs, from analog camera to IP camera. IP cameras have become a popular option in residential spaces, especially for family members, pet owners, and others who wish to monitor their home from afar, providing both security and peace of mind. The ease of use, the ability to stream real-time data and the affordable price make them an attractive choice not just in homes, but also in commercial environment.

However, just like any other IoT devices, any misconfiguration during the manufacturing or deployment process can result in an insecure device. According to the National Cybersecurity Alliance (NCA, 2016), "You can have security without privacy, but you can't have privacy without security." [2]. There is no "one-size-fits-all" security and privacy answer, it is important for the manufacturer to accurately identify their users' daily usage of the IP camera and apply appropriate security measures [2]. It is also crucial for end-users to be aware of the security settings of IP cameras, which they can adjust to enhance the security of the device, and to further protect themselves. The purpose of this research is to analyse the implications of publicly available IP camera data and provide guidance on how to protect privacy and improve security in the rapidly growing IoT environment.

1.2 Motivation

As the technology and popularity of IoT devices rise, their security concerns become an inevitable topic. Within the categories of IoT, the security of IP cameras is the most crucial, not only because IP cameras are IoT devices and massive distributed denial-of-service (DDoS) attacks like Mirai [3] are powerful, but also because of the substantial amount of sensitive information

they provide and the severe consequences if compromised. It is noteworthy to see that the general public becomes more used to the presence of IoT devices, there appears to be a trend of general opinion that the conveniences of IoT devices come with the price of insecurity and the leakage of information, which is erroneous. The security awareness of both users and manufacturers should be improved to correct this view. Standards and regulations should also be adjusted to improve the security of IoT devices, specifically IP cameras.

1.3 Aims and Objectives

This project investigates how publicly accessible data of IP cameras on Shodan, an online search engine that scans for devices connected to the Internet and collects information about them, affects the device owners and the general public. The objective of this project is to gain a comprehensive understanding of the privacy and security challenges in the IoT era, with a focus on the impact of Shodan on IP cameras. By integrating insight from multiple disciplines, this project aims to propose a holistic strategy for responsible security practices across the IoT lifecycle – manufacturing, deployment, usage and regulation.

1.4 Project Outline and Structure

To achieve the aims and objectives discussed in section 1.3, this research is broken down into smaller objectives:

- Literature Review: This project will begin by reviewing existing literature, related to IoT devices, IP cameras, and existing research related to Shodan.
- Review standards, policies, and regulations: The standards, policies and regulations related to IoT will be reviewed in this section.
- Data collection: This project will focus on the publicly accessible footages of IP cameras on Shodan. These images will be collected using commands.
- Data Analysis: The publicly accessible data of IP cameras found on Shodan will then be analysed and examined. This analysis will focus on two key areas:
 - The extent to which this data exposure intrudes on individuals’ privacy.
 - How malicious actors could exploit this data.
- Evaluation: Using the results of the data analysis, this project will then evaluate the effectiveness of the standards, policies, and regulations reviewed in the literature review section.

- Recommendations: Based on the findings, the project will conclude with proposing recommendations to improve responsible and secure practices throughout all stages of IoT lifecycle.

1.5 Research Questions

This research aims to answer the following questions:

- *RQ #1: To what extent does publicly accessible data from IP cameras listed on Shodan expose individuals' privacy, even if the data itself is not personally identifiable?*

The footage of IP cameras available on Shodan will be analysed in the Data Analysis section. Even the data is not PII, the footage might reveal information about a user's daily activities or the layout of their properties. This kind of information can be combined with other data like IP/street view to identify individuals.

- *RQ #2: How does the discoverability of IP cameras on Shodan impact the attack surface for malicious actors?*

Shodan allows attackers to identify cameras with no authentication using a simple filter "has_screenshot:true AND RTSP/1.0". by analysing the metadata of the vulnerable cameras, attackers can easily identify specific types of IP cameras, their locations and potentially their configuration. Shodan can also reveal vulnerabilities like outdated firmware, or unpatched system. Based on the literature review of Shodan, this will be discussed in the Evaluation section.

- *RQ#3: How can industry standards, policies and regulatory frameworks for IoT device help in mitigating the risks associated with publicly accessible IP camera data on platforms like Shodan? What are the changes required to ensure responsible practices across the entire IoT lifecycle?*

Based on the review of existing standards, policies, and regulations and the result of evaluation related to IoT devices will be used to identify the gap between existing regulations and real-world IoT security challenges.

- *RQ #4: What mitigation strategies can be applied to address the identified challenges?*

A holistic approach will be proposed, including how regulatory bodies, manufacturers, and users can collaboratively contribute to mitigating the risks associated with publicly accessible IP camera data.

2 Literature Review

In recent years, the adoption of IoT devices has grown significantly. According to research report by IoT Analytics [4], there were 14.4 billion connected IoT devices in 2022 and is estimated to reach 29.7 billion by 2027. The rise of IoT devices has transformed household appliances into a network of interconnected smart devices, bringing various benefits in all areas of life. Among these devices, IP cameras have become increasingly popular and ubiquitous, providing not only homeowners but also business owners with surveillance and security. However, the availability of search engines like Shodan, which index network-connected devices, has raised concerns about potential vulnerabilities and privacy issues with these IoT devices. In order to discuss the privacy, security, and socio-technical issues associated with the use of Shodan in the context of IP cameras, this section focuses on existing literature on IoT devices, IP cameras, and Shodan.

2.1 Internet of Things Infrastructure

Before diving deep into IP camera, which is a type of IoT device, it is important to explore the fundamentals of IoTs. This section examines the IoT landscape with a focus on surveillance devices and the importance of security for IoT devices.

NIST defines internet of things (IoT) as the network of interconnected ecosystem of devices equipped with hardware, software, firmware and actuators that connect, interact and exchange data [5]. The IoT ecosystem mainly includes two types of devices: sensors that collect data and actuators that control the physical devices. GPS and ECGs device are examples of IoT sensors, which read and collect the data from the surrounding. On the other hand, a motor in a valve of an air conditioner is an example of IoT actuator, which transforms the signal and energy into motion.

A large-scale empirical analysis of IoT devices on home networks worldwide was conducted by Kumar et al. [6] in 2019. The researchers collaborated with Avast Software and used data from one of their IoT-focused software called WiFi Inspector, leveraging internal network scans of 83 million IoT devices in 16 million homes worldwide. The dataset was analysed and broken down into 14 types of devices, 11 of which were considered IoT devices. Surveillance devices (e.g., IP cameras) were among the IoT device types included in this research. The origin countries of the dataset were also broken down into 11 regions, defined by the ISO 3166-2 standard. Table 2.1 illustrates part of the results presented by Kumar et al. [6].

Table 2.1 shows that North America had the highest density of IoT devices of any region,

Table 2.1: Percentage of surveillance devices in homes with at least one IoT device [6]

Region	% of homes that have at least one IoT device	Surveillance devices	
		% of homes	% of devices
North America	71.00%	3.90%	3.70%
South America	34.40%	4.60%	13.30%
Eastern Europe	25.70%	2.50%	14.00%
Western Europe	57.20%	3.80%	5.60%
East Asia	30.80%	2.20%	9.10%
Central Asia	17.30%	2.40%	30.30%
Southeast Asia	21.70%	7.80%	37.00%
South Asia	8.70%	4.10%	54.50%
N. Africa, M. East	19.10%	5.20%	28.50%
Oceania	49.20%	3.00%	5.30%
Sub-Saharan Africa	19.70%	2.80%	18.00%

with 71% of homes having at least one IoT device, compared to the global median of 40.2%. In contrast, South Asia had the lowest density at 8.7%. Despite North America having the highest density of IoT devices, only 3.7% of North American IoT devices were surveillance devices. This research also suggests that there were significantly more surveillance devices in Eastern Europe than Western Europe (14% versus 5.6% of IoT devices in homes). However, surveillance devices accounted for 54.5%, 37%, and 30.3% of devices in South, Southeast, and Central Asia, respectively, which were significantly higher than North America, Eastern Europe and Western Europe.

A bibliometric study of IoT literature from 2000 to 2019 was performed by Wang et al. [7]. They concluded that security, management and privacy are dominant themes and are becoming increasingly important. This is also supported by Farhan et al. [8], who concluded that security, privacy and trust are critical factors for IoT applications. Farhan et al. also suggest that security measurements should be taken when packets are routed through different devices and links on the internet so that the confidentiality and integrity of the data is not compromised [8]. Elgazzar et al. [9] suggested that with the rising trends in sensor data analytics, access control, transparency of data collection, security, user and data privacy pose grand challenges in IoT devices.

2.2 The Security of IP Cameras

There are many studies focused on the security of IP cameras that echo the same idea: stronger security features should be implemented by the device manufacturer. For example, Abdalla et al. [10] investigated the security weaknesses of a specific brand of wireless IP cameras (Intelligent Onvif YY HD) and showed that the device has various flaws and weaknesses, including default credentials and lack of encryption. In this section, the related work on the security of IP cameras is discussed.

Seralathan et al. [11] analysed the existing security features and weaknesses of IP cameras. The brand name and model of the IP camera are not mentioned in the research. They used Nmap and Wireshark to collect and analyse data. They found that the IP camera used unencrypted communication, resulting in sensitive data being transferred in plaintext. The default credentials were attached to the device surface and after adding the device to the mobile application, the credentials were stored in plaintext within the application and could be retrieved when traffic was captured using tools like Wireshark. The RTSP URL used to stream data was predictable and there was no authentication required. Exploiting these vulnerabilities could result in unauthorised access to data, and potentially allowing attackers to use the device as a botnet. Some security recommendations were made, including the use of encryption protocol, applying authentication to the RTSP protocol, and the use of encryption to store credentials.

Alharbi and Aspinall [12] analysed and compared the security measures of five different smart cameras from various perspectives, including communication methods, smart camera devices, web interface settings, and Android applications. They also developed a systematic analysis framework for assessing domestic smart cameras. Their analysis revealed a wide range of vulnerabilities across all components, such as non-encrypted video stream, default password, lack of password policy and account lockout mechanisms, and over-privileged Android application with unnecessary permissions. They pointed out that these vulnerabilities indicated that security was not a priority for vendors. Furthermore, the security measures of the devices did not match the advertisements, which gave an impression of high security and privacy oriented.

More recently, Herodotou and Hao [13] analysed the security of IP-based hidden cameras, and presented a systematic analysis of a generic IP camera module. Using reverse engineering techniques, they discovered that the JSON command system used by the Android application to communicate with the camera was highly vulnerable. By exploiting these vulnerabilities, they were able to bypass authentication and gain unauthorised access, which allow them to read configuration values, access live streaming, download arbitrary file and shadow file. They also discovered that a chain of bash scripts were executed during the start-up procedure of the camera, which contains vulnerable code and can be exploited to perform remote code execution

on the camera with superuser privileges. The researchers demonstrated proof-of-concept attacks to eavesdrop on the audio and video streams, retrieve videos stored on the camera, retrieve the Wi-Fi passwords of the user's home network, and run a reverse shell script on the camera device which could potentially turn the device into part of a botnet.

While the research mentioned above focused on the software and the communication between Android applications and IP cameras, Almazrouei et al. [14] focused on the hardware layer of an IP camera (VAVA Outdoor Camera). They examined the circuit board and were able to identify the communication protocol as UART because the manufacturer kept the labelling on the circuit board. They were then able to interact with the system using a USB-to-UART serial cable and start the device in safe mode. After entering safe mode, they modified system boot-up scripts and gained root access. With root access, they were able to modify the authorised SSH keys file and establish a SSH connection to the device from the internal network.

Many reports [15], [16], [17] have expressed the public concerns about the insecurity of IP cameras. Xu et al. [18] showed that despite the public concerns regarding IP cameras having weak security and the possibility of infringing user privacy, there was an incredible number of IP cameras found to have empty or null passwords. They analysed data from *insecam.org*, a website listing insecure IP cameras all over the world. The data was collected from September 25, 2017 to October 12, 2017. Their research showed that there were about 20,000 to 25,000 active cameras shown on *insecam* each day. As of this writing (March 23, 2024), there are 4640 live cameras listed on *insecam*, with footage and IP addresses available, which can be seen as an indicator of improved security for IP cameras.

2.3 RTSP and its Security

The Real-Time Streaming Protocol (RTSP) is an application level protocol for controlling the delivery of real-time data, such as audio and video [19]. There are many other protocols for IP cameras, for example, HTTP, ONVIF, WebRTC, RTMP. This section discusses why RTSP is widely used and what strengths make it irreplaceable and ubiquitous in IP cameras.

The Open Network Video Interface Forum (ONVIF) Streaming Specification stated that any devices providing real-time streaming of video, audio and metadata, shall support media transfer using RTSP [20]. Moreover, most systems, even if they do not use RTSP as the primary streaming protocol, support RTSP as a fallback or secondary streaming protocol [21].

A comparative study of HTTP and RTSP for streaming services was conducted by Firman-syah et al. [22]. Their results are summarised as shown in Table ??.

Another comparative study between RTSP and WebRTC was conducted by González et al. [23]. With a focus on the communication establishment of each protocol, RTSP shows slower

Table 2.2: Results of the comparative study of HTTP and RTSP [22]

	RTSP	HTTP
Delay	Lower	Higher
Throughput	Higher	Lower
Packet loss	Higher	Lower
Memory Usage	Higher	Lower
Power Usage	No difference	

performance for connection establishment than WebRTC.

Nuñez and Toasa [24] compared the performance of RTMP, RTSP and HLS protocols on mobile network. In their research, HLS showed the best stability in performance but was resource consuming. RTSP had the lowest RAM and battery consumption, however, the performance was unstable. RTMP had a better performance than RTSP but was the worst in terms of resource consumption.

Aloman et al. [25] compared the performance of MPEG-DASH, RTSP and RTMP. They concluded that RTSP had the lowest latency but suffers in Quality of User Experience (QoE) due to packet loss. MPEG-DASH and RTMP had a lower packet loss rate. MPEG-DASH delivered higher QoE than RTSP, but lower than RTMP.

The studies above explain why RTSP is still widely used despite the existence of better options. This is because the most important security property for an IP camera is availability. An IP camera should always be able to show the video and audio data in “real-time” or with the lowest possible latency. Additionally, long battery life ensures the availability of the IP camera's data [22], [24]. With the focus on availability as the top priority, packet loss and user experience quality become secondary concerns [23], [25]. This is also why most of the IP cameras keep RTSP as a fallback solution – to guarantee availability. As RTSP is almost a must-have feature in IP cameras, the remainder of this section focuses on the security of RTSP.

A commonality among all existing literature that focused on security analysis of IP cameras, including the one discussed in Section 2.2, is the discoverability and predictability of the RTSP URLs, which can be used to retrieve live videos from the devices. TCP port 554 is frequently found open without proper security measures [10], [11], [12]. A large scale empirical investigation of IP cameras with no password protection was carried out by Xu et al. [18] also suggested that TCP port 554 (used by the RTSP service) is commonly opened and could be easily exploited by attackers as a pivot point to the internal network.

This vulnerability allows attackers to use a simple Nmap brute-force attack to find the RTSP URL of an IP camera. If the default password remains unchanged and no security measures are

Table 2.3: List of RTSP URLs of some of the most popular IP camera brands.

Brand	RTSP URL
AXIS Communications	rtsp://<ip>/axis-media/media.amp
BOSCH	rtsp://<ip>/rtsp_tunnel
Dahua	rtsp://<username>:<password>@<ip>:<port>/cam/realmonitor? channel=<channelNo>&subtype=<typeNo>
Hanwha Vision	rtsp://<ip>:<port>/LiveChannel/Channel/media.smp
Hikvision	rtsp://<ip>:<port>/Streaming/Channels/<id>
Intellinet	rtsp://<ip>/video.mp4
Panasonic	rtsp://<ip>/nphMpeg4/<id>
Samsung	rtsp://<ip>:<port>/LiveChannel/0/media.smp
Siemens	rtsp://<ip>/img/video.asf

applied, the attacker will be able to gain unauthorised access to the live video stream using a password brute-force attack. Table 3.3 below shows the list of RTSP URLs for some of the most popular IP camera brands [26], [27].

Whilst RTSP is a commonly used protocol in IP cameras, its security concerns are often overlooked by manufacturers and users. Section 2.4 explores how online search engines like Shodan can be leveraged to identify and potentially exploit these vulnerabilities.

2.4 Shodan

Shodan, an online search engine that scans for devices connected to the Internet and collects information about them, has slowly become the researchers' favourite toolkit when conducting large-scale analysis because of its convenience, especially for researches related to the industrial control systems (ICS) and IoT because of their discoverability and criticality. Similar to insecam, Shodan also has the ability to discover vulnerable IP cameras, using the same technique of detecting non-password-protected devices [28], [29]. The remainder of this section will focus on the applications, advantages and disadvantages of Shodan.

Genge and Enăchescu [30] developed a Shodan-based passive vulnerability assessment tool for Internet-facing services, ShoVAT. The experiment was performed on 1501 services in 12 different institutions and 3922 known vulnerabilities were able to be discovered. Phan et al. [31] developed an immersive visualisation tool, ShodanVR to visualise text records from Shodan's database. Ercolani et al. [32] used Gephi, a network graphs visualising and analysing tool, to visualise data collected using Shodan and proposed a methodology to identify SCADA devices.

Rae et al. [33] assessed the effectiveness of device hardening using Shodan and tools like

ShoVAT. They concluded that ShoVAT is a powerful and thorough tool for vulnerability scanning and assessment within the IoT landscape. Shodan API has integrated with existing security systems which makes it easier to manage and address vulnerabilities. In contrast, this integration also makes life easier for less experienced hackers to compromised devices.

Shodan claims that they crawl the entire Internet at least once a week and an on-demand scan can be performed immediately using the API [34]. Bodenheim et al. [35] evaluated the ability of the Shodan search engine in 2014. They deployed four internet-facing programmable logic controllers (PLCs) and showed that all four PLCs were initially scanned by Shodan in less than four days and Shodan was able to index all four PLCs within 19 days. They expressed concerns regarding the easy discoverability of ICS systems on Shodan and proposed mitigating strategies like service banner manipulation [35].

Chen et al. [36] evaluated Shodan scans through a honeypot analysis. They concluded that Shodan scans the entire Internet at least every 66 hours and focuses on scanning common ports below 10000, only some specific service related ports that are over 10000 were scanned. They observed a significant increase in traffic on honeypots after they were indexed by Shodan, they suggested that it could be due to attackers exploiting Shodan to capture ICS information. For mitigation, they suggested that blacklisting Shodan scanner IPs and deploying an Intrusion Detection System (IDS) to identify and block Shodan scan traffic would help.

Das and Tuna [37] suggested that Shodan can be used alongside with IP-based location identifier tools and web mapping services to obtain location information. They suggested that there is a high potential that personal information which should be kept private may be captured and used for illegal purposes.

2.5 Conclusion

In conclusion, the review of various literature highlights the importance of recognising the security threats associated with IP cameras and their discoverabilities on search engines like Shodan. The studies [10], [11], [12], [13] have extensively explored the vulnerabilities and risks associated with IP cameras, for example, default passwords, unencrypted protocols, and the discoverability of RTSP URLs. These studies support the urgent need for security awareness among manufacturers and users, encryption protocols along with password policies and authentication methods should be mandatory.

Research [33], [35], [36] shows that vulnerabilities of certain ICSs and IoT devices can be detected using Shodan, which raises concerns about the exposure of sensitive systems. In order to mitigate these risks, several strategies have been proposed, such as service banner modification, blacklisting Shodan scanner IPs, or implementing IDS.

Besides, the use of Shodan alongside with geolocating tools and services also raises privacy concerns because any person's personal data can be disclosed and used for malicious purposes [37]. As a result, security measures, including the proactive steps taken from users and manufacturers to restrict access to private IP cameras, as well as implementation or revision of relevant standards and regulations are required.

However, the contribution of Shodan as an online search engine should not be disregarded. It helps researchers to understand the security landscape and assists with detecting, tracking, and exposing vulnerable devices around the world. Moreover, its comprehensive database enables researchers to gain insight into the security posture and potential risks of some specific devices and systems, including IP cameras, IoT devices and industrial control systems.

Shodan also helps in vulnerability management and risk management. Security professionals are able to detect vulnerable devices and their vulnerabilities within their networks using the on-demand scanning function of Shodan. Researchers are able to identify trends, vulnerabilities and potential threats, and take proactive action to secure their systems and networks.

Shodan's capabilities and ease to use are a double-edged sword. While researchers and security professionals leverage Shodan to identify vulnerabilities and assess risk, it also provide valuable information for attackers to locate and exploit vulnerabilities. Responsible use of platform like Shodan and continuous improvement of security practices in the IoT industry are crucial for mitigating the risks associated with interconnected devices.

3 Review of Standards and Legislation

3.1 Standards

This section discusses two of the industrial standards specifically designed for IoT devices manufacturing: ISO/IEC 27402:2023 [38] and NIST IR 8259 [39]. ISO/IEC 27402:2023 focuses on securing the hardware and software aspects of IoT devices, whereas NIST IR 8259 focuses on activities such as planning, defining use cases in the pre-market phase, and communicating with customer in the post-market phase.

3.1.1 ISO/IEC 27402:2023 — IoT security and privacy — Device baseline requirements

ISO/IEC 27402:2023 [38] provides comprehensive baseline ICT requirements for IoT devices to ensure they support security and privacy controls. The standard contains two parts: documentation and configuration requirements.

For documentation requirements, ISO/IEC 27402:2023 specifies that a set of thorough policies and documentations should be established, including risk management, vulnerability disclosure and handling processes.

For configuration requirements, ISO/IEC 27402:2023 specifies a list of features that the devices shall provide to support controls for security and privacy, and these features should be clearly listed and made publicly available. Clause 5.2.2.1.1 specifies that only authorised entities shall be able to modify the configuration settings of IoT devices. Clause 5.2.4 states that if IoT devices stores user data, a deleting function should be provided to remove user data stored in any type of memory, restricted to authorised entities only. Clause 5.2.5.1.1 specifies that data at rest and in transit should be protected from unauthorised access, modification and disclosure. Clause 5.2.5.1.4 specifies that cryptography shall be used to protect data. For IoT devices that support software updates, clause 5.2.7.1.1 states that update shall be performed using a secure procedure and initiated by authorised entities.

3.1.2 NIST IR 8259 — Foundation Cybersecurity Activities for IoT Device Manufacturers

NIST IR 8259 [39] describes activities that manufacturer should consider performing both before and after IoT devices are sold to customers.

In the pre-market phase, NIST IR 8259 suggests that manufacturers should identify target customers and clearly defined expected use cases, including understanding the interaction of IoT devices with the physical world and how will they be managed and accessed. Furthermore, NIST IR 8259 recommends that manufacturers address customers' needs and goals and plan for adequate support both in hardware and software.

In the post-market phase, NIST IR 8259 suggests that manufacturers should communicate with customer. This involves identifying the information customers require and establishing an adequate way to deliver that information. Additionally, NIST IR 8259 recommends that manufacturers should define processes and procedures for customer support, end-of-life management, and define expectation for IoT device lifespan.

3.2 Legislation

In this section, the laws and regulations related to IoT devices, specifically IP cameras, are reviewed and discussed. Table 3.1 summarises the results.

Table 3.1: List of regulations in EU, U.K. and California related to IP cameras and data.

Law	Enforcement year	Country / State	Summary	Related to this project?
General Data Protection Regulation (GDPR)	2018	EU, United Kingdom	• Applies to businesses handling personal data of individuals within the EEA. • Restricts how companies use collected personal data. • Enhances data subject's rights. • Defines responsibilities of data controller and data processor. • Requires explicit consent from individuals before collecting and processing their personal data. • Mandates data breach notification. • Restricts international transfers of personal data.	Yes
EU Cybersecurity Act	2019	EU	Establishes a unified cybersecurity certification framework.	No
NIS 2 Directive	2023	EU	• Mandates companies that are either essential or important to comply. • Establishes new requirements for protecting IT and OT systems.	No
The Cyber Resilience Act (CRA)	Late 2024 or 2025	EU	Introduces mandatory cybersecurity requirements for hardware and software products, throughout their whole lifecycle.	Yes
The California Consumer Privacy Act (CCPA)	2018	California	• Applies to businesses that collect personal information of California residents. • Emphasises data subject's rights related to data access, deletion, and opting out of data sales. • Requires businesses to disclose data collection practices and purposes to consumers. • Requires explicit consent from data subject.	Yes
The California Privacy Rights Act (CPRA)	2023	California	• Amends the CCPA. • Expands right to know and right to opt-out.	Yes
The California IoT Security Law	2020	California	• Applies to IoT device manufacturers that sell IoT devices in California. • Requires IoT devices to have reasonable security features.	Yes

3.2.1 General Data Protection Regulation

After Brexit, the EU GDPR no longer applies to the United Kingdom. The United Kingdom has incorporated the EU GDPR into United Kingdom law as the UK GDPR. In practice, there is little change to the core principles, rights and obligation [40].

In the GDPR, personal data is defined as: “information that relates to an identified or identifiable individual.” [41]. Biometric data is classified within the special categories of personal data, which are subject to a higher level of protection. Household IP cameras are often placed in residential areas, which implies a high likelihood of capturing biometric data, such as faces and fingerprints.

As a result, IP cameras manufacturers who designed the OS and determined overall functionality, are data controllers under GDPR. Also, mobile application providers that provide apps for users to access and view the footages of the IP cameras, are data processors under GDPR.

3.2.2 EU Cybersecurity Act

The EU Cybersecurity Act [42] established an EU cybersecurity certification framework for products and services that all certification schemes must adhere to. However, the requirements and methodologies suggested in the Act are often ambiguous. Phrases such as ‘meet the corresponding security requirements’, ‘evaluated at a level intended to minimise the risk of state-of-the-art cyber attack’ are frequently used without specifying the baseline criteria.

3.2.3 NIS 2 Directive

In 2023, the EU adopted a new version of the Network and Information Security Directive, also known as NIS2 [43]. The aim of this directive is to strengthen cybersecurity capabilities at a national level, with a focus on critical infrastructures. While IoT devices are implemented in different critical infrastructures, often called Industrial IoT or IIoT, e.g. temperature or water level sensors, and are crucial to monitor and control entire industrial processes, they do not fall within the scope of this project, which focuses on residential IP cameras.

3.2.4 The Cyber Resilience Act

In March 2024, the Cyber Resilience Act (CRA) [44] was approved by the European Parliament. This act mandates cybersecurity requirements for manufacturers and developers of products with digital elements, including both hardware and software. Once the proposal is formally adopted and enters into force, economic operators and Member States will have 36 months to adapt to the new requirements.

One significant impact of the CRA is that it mandates any products with digital elements, such as laptops, smartphones, sensors and cameras, routers, ICS, OS, firmware, apps, games, software libraries and CPUs, to be compliant. This means that IP cameras and their mobile applications fall into this category, and it is the obligations of manufacturers, importers and distributors to ensure compliance with the CRA.

The Act specifies essential cybersecurity requirements relating to the properties of products and vulnerability handling. Products shall ensure protection from unauthorised access by appropriate control mechanisms. The product shall also be designed, developed and produced to limit attack surfaces. Manufacturers shall identify and document vulnerabilities and components contained in the product, address and remediate vulnerabilities without delay, including by providing security updates.

The Act also specifies the information and instructions that should be made public to the user, including the point of contact where information about cybersecurity vulnerabilities of the product can be reported and received, the intended use, the security environment provided by the manufacturer, the product's essential functionalities and information about the security properties.

Non compliance can be subject to fines of up to 15 million EUR or 2.5% of the total world wide annual turnover, whichever is higher. It is a less severe penalty compared to GDPR, which results in fines of up to 20 million EUR or 4% of the total world wide annual turnover, whichever is higher.

3.2.5 The California Consumer Privacy Act

The California Consumer Privacy Act (CCPA) [45] applies to any for-profit business that does business in California and either have a gross annual revenue of over \$25 million USD; buys, sells, or shares the personal information of 100,000 or more California residents or households; or derives 50% or more of their annual revenue from selling California residents' personal information.

The Act gives California residents the right to know what personal data is being collected, the right to delete, and the right to opt-out of sale. The Act also specifies the responsibilities of businesses, including responding to consumer requests to exercise these rights and giving consumers certain notices explaining their privacy practices.

However, California residents cannot sue businesses for CCPA violations. A business can only be sue under CCPA if there is a data breach under certain circumstances, for example, personal information was stolen in a data breach as a result of the business's failure to maintain reasonable security procedures and practices to protect it.

3.2.6 The California Privacy Rights Act

The California Privacy Rights Act (CPRA) [45] is an amendment to the CCPA. It adds new consumer rights, such as, the right to correct inaccurate personal information that a business has about the consumer, and the right to limit the user of collected personal information.

3.2.7 The California IoT security Law (SB-327)

The California IoT security Law [46] applies to IoT device manufacturers that sell in California. The Law mandates manufacturers of connected devices to ensure that the devices are implemented with reasonable security features appropriate to the nature and function of the device, and to the information it may collect, contain, or transmit. Connected device means any device that is capable of connecting to the Internet, directly or indirectly. Such device must be assigned a unique preprogrammed password or require new users to create a new password before first-time access to the connected device.

4 Threat Modeling

In this chapter, qualitative methods are used to identify threats and define related mitigation strategies as shown in Figure 4.1. First, the use cases are defined. The system components and threat targets are then derived based on the use cases. Following this, a data flow diagram of the use cases is created. Then, the STRIDE security threat modelling framework is used for security threat analysis and the LINDDUN privacy threat modelling frameworks is used for privacy threat analysis on IP cameras and their exposure on Shodan. Finally, potential mitigation strategies are defined to address the identified threats.

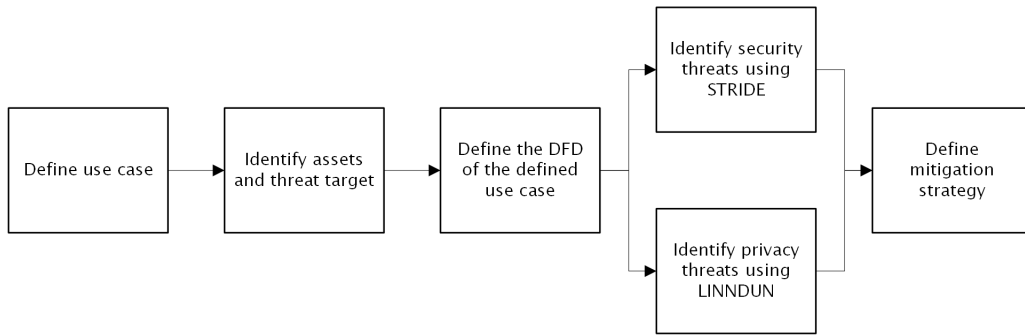


Figure 4.1: Threat Modeling Methodology

4.1 Related Work

Many researchers surveyed the security and privacy requirements for IoT and IIoT systems and offered various solutions to address the security requirements.

Asif et al. [47] analysed the security threats of IoT-enabled Precision Agriculture Systems using STRIDE method and identified fifty-eight security threats which need to be controlled.

Khan et al. [48] presented a comprehensive STRIDE-based threat modelling for cyber physical systems. They highlighted the significance of securing the system at the component level based on the STRIDE-per-element analysis.

AbuEmera et al. [49] identified threats in smart manufacturing systems using STRIDE approach and concluded that 79% of the identified threats was critical and high.

LINDDUN threat modelling approach was also used by Nweke et al. [50] to identify privacy threats of National Identification Systems with the consideration of standards and regulations.

Robles-González et al. [51] conducted a LINDDUN-Based privacy threat analysis of identification and authentication processes. They proposed a more precise modelling of the identification

and authentication processes which allows analysing more specific privacy threats.

4.2 Use Cases

The use case involves a user viewing IP camera footage via a website. First, the user opens the website on their device and enters login credentials. The website then verifies the credentials with the IP camera. Access is granted upon successful authentication, and connection is established with the IP camera, allowing user to view live or recorded footage stored on the IP camera. Once the user finishes viewing the footage, they either log out or close the session. Following assumptions are made for the use case:

- The IP camera is accessible over the internet.
- The IP camera has no authentication enabled.
- The IP camera has no access controls implemented.
- The footage is stored on the IP camera.

Based on the use case and assumptions above, a separate use case can be deduced, which involves Shodan indexing and storing information of publicly accessible IP, allowing its user to view the information. First, the Shodan scan engine scans and accesses the IP camera. Because the IP camera has no authentication and access control mechanisms in place, Shodan scan engine is able to capture the footage from the IP camera, index and store the footage in Shodan database alongside with the IP of the IP camera. A Shodan user then queries Shodan database and the results are returned to the user. If the Shodan user search the IP of the IP camera, they will be able to view the footage and learn that this is a publicly accessible IP camera. Following assumptions are made for this use case:

- Shodan does not require its user to login in order to query.
- Shodan scans the internet once a week.

4.3 Assets / Threat Targets Identification

Based on the defined use case describes in Section 4.2, threat targets are identified as shown in Table 4.1.

Table 4.1: Assets/Threat Targets

DFD Elements	Threat Targets	Description
Entity	IP Camera User	Uses an mobile app or website to access the footages of IP camera. Usually, there is only one user per IP camera.
	Shodan User	Uses Shodan to query results. With the correct query, the user is able to access the footage of the IP camera.
	IP Camera	Records and stores footages.
	Shodan Scan Engine	Scans the internet regularly.
Process	Login	Contains information such as IP camera's identity and user's identity.
	Store Data	IP camera stores the recorded footages to the IP camera DB
	Search Footage	User can view real-time footage or search recorded footages.
	Watch Footage	User views footage on mobile app or website.
	Shodan Index and Store Data	Shodan Scan Engine indexes and stores data of the IPs it scanned and found alive.
	Search IP on Shodan	Shodan user queries Shodan DB.
	Watch Footage on Shodan	Shodan user views indexed footage of a certain IP camera through Shodan.
Data Store	IP Camera DB	Stores recorded footages.
	Shodan DB	Stored indexed data.
Data Flow	Login data stream	Login credentials used during the login process
	IP Camera DB data stream	Data transmitted from IP camera to IP camera DB during Store Data process
	Shodan DB data stream	Data indexed by Shodan is stored in Shodan DB during Shodan Index and Store Data process

4.4 Data Flow Diagram

Figure 4.2 represents the data flow diagram of the use case describes in Section 4.2. Below is the detailed description of each step:

- Step 1: A legitimate user of the IP camera attempts to log in to the IP camera. The login details, i.e., username and password, are sent to the IP camera using the Login process.
- Step 2: The Login process verifies the login details.
- Step 3: The IP camera returns the result of the verification. If correct, the user is authenticated and authorized to access the IP camera.
- Step 4: The IP camera captures real-time footage and sends the captured footage to the Store Data process.
- Step 5: The Store Data process sends the footage to the IP camera database.

- Step 6: After logging in, the user sends search queries to the Search Footage process.
- Step 7: The Search Footage process sends the queries to the IP camera database.
- Step 8: The Search Footage process selects the footage selected by the user.
- Step 9: The IP camera database returns the result to the Watch Footage process.
- Step 10: The Watch Footage process sends the selected footage to the IP camera user.
- Step 11: The Shodan Scan Engine scans the IP camera and attempts to log in to the IP camera.
- Step 12: If successful, the footage is returned to the Shodan Scan Engine.
- Step 13: After receiving the footage, the Shodan Scan Engine sends the footage to the Index and Store Data process.
- Step 14: After indexing and storing the data, the footage is stored in the Shodan database.
- Step 15: A Shodan user sends search queries to the Search IP process.
- Step 16: The Search IP process sends the queries to the Shodan database.
- Step 17: The Shodan database returns the footage data to the Watch Footage process.
- Step 18: The Watch Footage process returns the footage to the Shodan user.

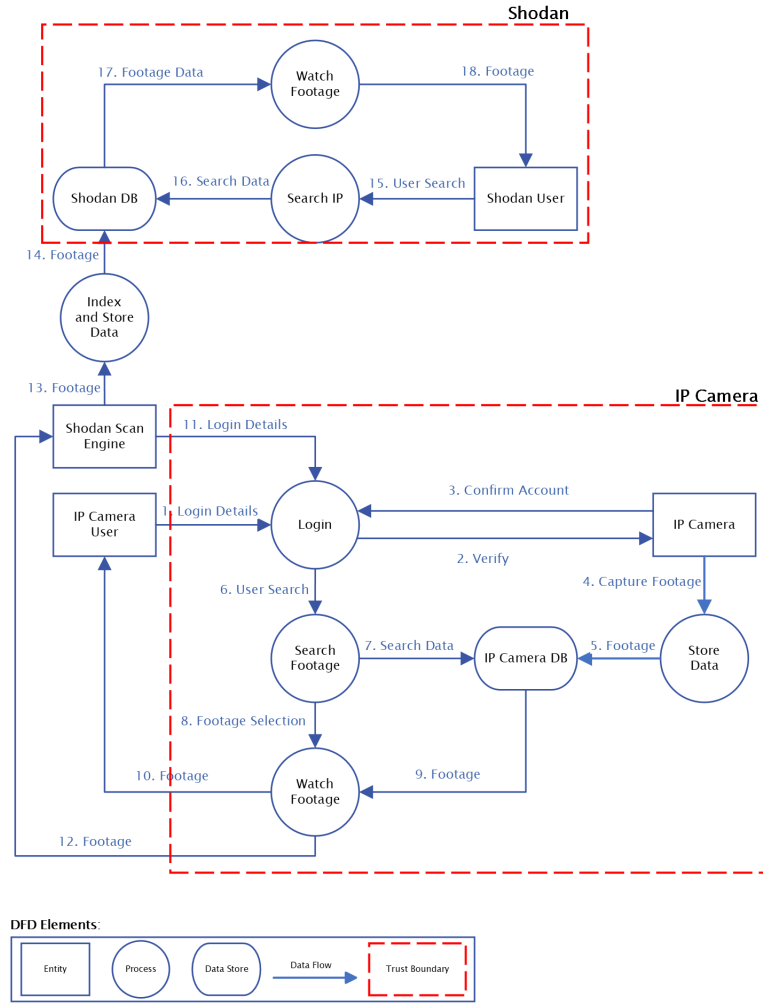


Figure 4.2: Data Flow Diagram for IP Camera Use Case

4.5 STRIDE Threat Modelling

The STRIDE threat model is used to identify security threats. It is a systematic method that analyse security threats against system components and represents the threat categorisation, i.e., Spoofing, Tampering, Repudiation, Information Disclosure, Denial of Service, and Elevation of Privilege [52].

4.5.1 Security Threats Mapping

For the use case describes in Section 4.2, Table 4.2 shows the threats-DFD elements mapping based on STRIDE approach. The “X” in the table indicates a potential threat to the system.

4.5.2 Security Threats, Consequences and Mitigation Strategies

Fifteen security threats are identified based on the mapping in Table 4.2. Table 4.3 shows the identified threats, the corresponding consequences and proposes mitigation for each threat.

Table 4.2: Security Threats Mapping Based on STRIDE Mapping Template

	DFD Elements	Spoofing	Tampering	Repudiation	Information Disclosure	Denial of Service	Elevation of Privilege
Entity	IP Camera User	X		X			
	Shodan User	X		X			
	IP Camera		X	X	X	X	
	Shodan Scan Engine		X	X	X	X	
Process	Login	X	X	X	X	X	X
	Search Footage	X	X	X	X	X	X
	Watch Footage On App	X	X	X	X	X	X
	Store Data	X	X	X	X	X	X
	Search IP on Shodan	X	X	X	X	X	X
	Watch Footage on Shodan	X	X	X	X	X	X
Data Store	IP Camera DB		X		X	X	
	Shodan DB		X		X	X	
Data Flow	Login data stream		X		X	X	
	IP Camera DB data stream		X		X	X	
	Shodan DB data stream		X		X	X	

Table 4.3: Identified Security Threats, Consequences and Mitigations

	Threat	Consequences	Mitigation
Spoofing	T01- Identity spoofing of IP camera user	Threat actor gains access to the IP camera, potentially viewing footage or manipulation the camera settings.	- Implement strong authentication mechanism, such as multifactor authentication. - Use secure, unique passwords and change regularly. - Audit activity logs regularly.
	T02- Identity spoofing of Shodan user	Threat actor gains more information about the user, leading to potential misuse of data.	
	T03- Network spoofing during process	Threat actor intercepts and potentially alters communication, leading to unauthorised access, or disruption of services.	Use encrypted communication protocols, e.g. TLS/SSL
Tampering	T04- Tampering device data	Compromised device data can lead to faulty device and false records.	- Implement data integrity checks and validation mechanisms, such as HMAC, CMAC. - Monitor data changes. - HMAC of TLS
	T05- Tampering message during transmission	Altered message can lead to system failure, data breach.	
	T06- Tampering storage data	Altered message can lead to data loss.	- Implement strong encryption AES-256, AES-512, RSA-4096. - Implement hashing mechanisms such as HMAC, CMAC to check data integrity. - Backup regularly. - Restrict access
Repudiation	T07 - Activity hiding	Threat actor's malicious activities can be hidden, making it difficult to investigate incidents, detect unauthorised activities.	Enforce appropriate auditing and logging.
Information disclosure	T08- User's identity disclosure	Threat actors gains more information about the user, potentially lead to privacy breach, identity theft and targeted attacks against users.	- Implement strong encryption mechanisms such as AES-256, AES-512, RSA-4096. - Implement strict access controls.
	T09- Transmission data disclosure	Threat actor gains access to the user's login information and can spoof the user. Threat actor can also gain access to the footage. Leading to data breach and potential misuse of data.	
	T10- Storage data disclosure	Threat actor gains unauthorised access to stored data, leading to loss of confidentiality and exposure of sensitive information.	- Implement strong encryption mechanisms such as AES-256, AES-512, RSA-4096. - Implement strict access controls.
	T11- Eavesdropping	Threat actor can listen to the communication channel proactively, gaining knowledge to information, data flow, and potentially leading to data breaches.	
Denial of Service	T12- IP camera Denial of Service	IP camera becomes inaccessible, leaving areas unmonitored.	- Implement rate limiting and traffic filtering. - Implement redundancy mechanisms and load balancing.
	T13- Shodan scan engine Denial of Service	Shodan scan engine unable to index and store data, potentially impacting the overall functionality of Shodan's services	
	T14- Distributed denial of service	Multiple services become unavailable, leading to system outage.	
Elevation of privilege	T15- Unauthorised access of IP camera	Threat actor can access and control the IP camera, leading to privacy breaches.	Implement strong authentication and authorisation mechanisms.

4.6 LINDDUN Threat Modelling

The LINDDUN privacy framework is used to conduct privacy threat modelling for the use case described in Section 4.2. LINDDUN is used to systematically analyse privacy threats in a system. LINDDUN stands for the different categories of privacy threats: Linking, Identifying, Non-Repudiation, Detecting, Data Disclosure, Unawareness and Unintervenability, and Non-Compliance [53].

4.6.1 Privacy Threats Mapping

Table 4.4 shows the threats-DFD elements mapping based on LINDDUN approach. The “X” in the table indicates a potential threat to the system.

Table 4.4: Privacy Threats Mapping Based on LINDDUN Mapping Template

	DFD Elements	Linking	Identifying	Non-Repudiation	Detecting	Data Disclosure	Unawareness & Unintervenability	Non-Compliance
Entity	IP Camera User	X	X				X	
	Shodan User	X	X				X	
	IP Camera	X	X	X	X	X		X
	Shodan Scan Engine		X	X	X	X		X
Process	Login	X	X	X	X	X		X
	Search Footage	X	X	X	X	X		X
	Watch Footage On App	X	X	X	X	X		X
	Store Data	X	X	X	X	X		X
	Search IP on Shodan	X	X	X	X	X		X
	Watch Footage on Shodan	X	X	X	X	X		X
Data Store	IP Camera DB	X	X	X	X	X		X
	Shodan DB	X	X	X	X	X		X
Data Flow	Login data stream	X	X	X	X	X		X
	IP Camera DB data stream	X	X	X	X	X		X
	Shodan DB data stream	X	X	X	X	X		X

4.6.2 Privacy Threats, Consequences and Mitigation Strategies

Sixteen privacy threats are identified based on the mapping in Table 4.4. Table 4.5 shows the identified privacy threats, the corresponding consequences and proposes mitigation for each threat.

Table 4.5: Identified Privacy Threats, Consequences and Mitigations

	Threat	Consequences	Mitigations
Linking	T16- Profiling Users	Threat actor gains access to the user's personal data which may be used to create detailed user profiles, potentially leading to target attack and discrimination.	• Implement pseudonymisation techniques to protect personal data. • Only collect minimum and necessary information.
	T17- Linking biographic data to biometrics data	Leads to privacy breaches, misuse of sensitive data, and potential identity theft.	Implement strong encryption AES-256, AES-512, RSA-4096.
Identifying	T18- Identifying a person from biographic data and/or biometrics data from footage	Leads to loss of anonymity, privacy invasions, and misuse of personal information.	Implement anonymisation techniques and strict access control.
Non-Repudiation	T19- Identity spoofing of user	Threat actor able to impersonate user, results in unauthorised access to data and services.	• Implement strong authentication mechanism, such as multifactor authentication. • Use secure, unique passwords and change regularly. • Audit activity logs regularly.
	T20- Data flow spoofing	Threat actor able to alter data flows and messages, leading to data manipulation, data breaches.	Use encrypted communication protocols, e.g. TLS/SSL
Detecting	T21- Data flow detectability	Detectable data flow can expose the presence and movement of information, allowing threat actor to intercept data.	Implement obfuscation techniques to hide data flows.
	T22- Data storage detectability	Detectable data storage location can lead to targeted attacks on stored data, increasing the risk of data breaches.	• Implement strong encryption AES-256, AES-512, RSA-4096. • Implement data masking techniques to hide storage locations.
Data Disclosure	T23- Disclosure of login credentials	Leads to unauthorised access and potential identity theft.	• Use secure, unique passwords and change regularly. • Implement strong encryption mechanism for storing and transmitting login credentials.
	T24- User's identity disclosure	Leads to privacy violations, identity theft and targeted attacks.	Implement anonymisation techniques and strict access control.
	T25- Transmission data disclosure	Unauthorised access to data during transmission can lead to data breaches.	• Use encrypted communication protocols • Monitor network traffic for abnormal activities.
	T26- Storage data disclosure	Unauthorised access to Stored data during transmission can lead to data breaches.	• Implement strong encryption mechanisms such as AES-256, AES-512, RSA-4096. • Implement strict access controls.
Unawareness & Unintervenability	T27- User unawareness	Users who are unaware of privacy risks may not take necessary preventive activities, increasing the risk of privacy breaches.	• Provide clear privacy information to users. • Obtain consent from users for data collection, processing and storage.
	T28- Non-compliance devices	Non-compliance devices can lead to data breaches, privacy violations, and legal consequences.	
Non-Compliance	T29- Non-compliance data collection process	Non-compliance data collection process can lead to privacy violations, and legal consequences.	
	T30- Non-compliance data processing process	Non-compliance data processing process can lead to unauthorised access, use, and disclosure of data, resulting in privacy breaches and legal consequences.	• Ensure all devices comply with relevant standards and regulations. • Regularly review and audit practices for compliance.
	T31- Non-compliance data storage	Non-compliance devices can lead to data breaches and legal consequences.	

5 Preliminary Testing

5.1 Purposes and Approach

The purpose of conducting a preliminary test prior to the main research is to identify the best methods for this project. This initial experiment was conducted to evaluate the feasibility of analyzing the level of privacy leakage when using pre-trained Convolutional Neural Network (CNN) models to analyze images.

Places365 [54], a pre-trained CNN model with a training set of 1.8 million images, is used to conduct the preliminary test. The model is downloaded and run locally, and 10 images were collected randomly on Shodan. These images were used in the analysis based on their characteristics of being Indoor or Outdoor, Commercial or Residential, and Daytime or Nighttime.

5.2 Results and Analysis

Even though Places365 has a training set of 1.8 million images, it seems like the accuracy and confident level of the results are not high. Table 5.1 shows the results of 4 selected daytime images out of the 10 test images.

Place365 suggests that example 1 is an image of a restaurant patio with a confidence level of 10.4%, while it actually is a fast-food restaurant.

For example 4, Place365 suggests that there is a 42.3% of chance that it is a outdoor kennel, a 4.9% chance that it is a driveway, and a 3.8% chance that it is a loading dock.

Compared to daytime images analysis, nighttime images were also selected for analysis. Table 5.2 represents the results of 4 selected nighttime images out of the 10 test images. The overall confident level of nighttime images are generally higher than daytime images. However, the accuracy of the results seem to be lower.

Places365 suggests that example 5 is an image of a pharmacy with a confidence level of 19.2%, while it is actually a convenience store given that there are 2 refrigerators shown in the image.

Places365 also suggests that example 7 is an image of a closet with a confidence level of 77.2%. The images shows an indoor hallway with coats hanging and personal items. There is a wooden door in the image but it is uncertain whether it is a closet or not.

Table 5.1: Preliminary Testing Daytime Results

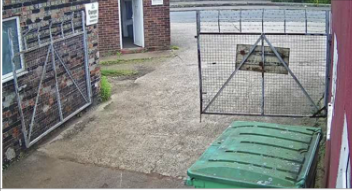
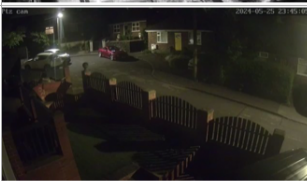
Example	Catergory	Image	Result
1	Indoor/ Commercial		0.104 -> restaurant_patio 0.094 -> patio 0.086 -> assembly_line 0.073 -> coffee_shop 0.038 -> ice_cream_parlor
2	Indoor/ Residential		0.501 -> living_room 0.404 -> television_room 0.021 -> home_theater 0.016 -> waiting_room 0.013 -> recreation_room
3	Outdoor/ Residenial		0.268 -> yard 0.175 -> kennel/outdoor 0.111 -> lawn 0.093 -> patio 0.058 -> stadium/baseball
4	Outdoor/ Commercial		0.423 -> kennel/outdoor 0.101 -> roof_garden 0.049 -> driveway 0.046 -> patio 0.038 -> loading_dock

Table 5.2: Preliminary Testing Nighttime Results

Example	Catergory	Image	Result
5	Indoor/Commercial		0.192 -> pharmacy 0.147 -> hardware_store 0.141 -> drugstore 0.125 -> bookstore 0.067 -> department_store
6	Outdoor/Residenial		0.092 -> patio 0.056 -> alley 0.053 -> coffee_shop 0.051 -> yard 0.043 -> porch
7	Indoor/Residenial		0.772 -> closet 0.085 -> locker_room 0.036 -> shower 0.027 -> utility_room 0.018 -> elevator/door
8	Outdoor/Residenial		0.306 -> elevator_shaft 0.087 -> staircase 0.077 -> basement 0.053 -> barndoor 0.050 -> construction_site

5.3 Impact on Research Design

The results of the test images do not meet the expectations as they are non-descriptive and low accuracy. The Place365 model works by identifying items in the images to determine the scene. The output is the determined scene only, without description, making it difficult to understand what is in the image just by reading the output. The accuracy is generally low, possibly due to the quality of the images. The test images are IP camera footage from Shodan, it is possible that images are being compressed during the process which reduces the quality of the images, leading to low accuracy.

ChatGPT-4o is considered due to its ability its ability to analyze images and output descriptions. ChatGPT-4o is able to take an image as input, analyse the image, and provide a description of the uploaded image. ChatGPT-4o is also more accessible than Place365, which requires knowledge of coding, while ChatGPT-4o is accessible through a browser and does not require any coding knowledge.

Example 1 and 5 are used to compare the results of Place365 and ChatGPT-4o. Table 5.3 shows the results. ChatGPT-4o describes the setting, layout, items and equipment, lighting and quality, environment of the images very clearly. It allows reader to understand what the images contain without looking at them.

Table 5.3: Places365 vs. ChatGPT-4o

Example	Category	Image	Place365 Result	ChatGPT Result
1	Indoor/ Commercial/ Daytime		0.104 -> restaurant_patio 0.094 -> patio 0.086 -> assembly_line 0.073 -> coffee_shop 0.038 -> ice_cream_parlor	Setting: The image depicts the interior of a Subway restaurant. Layout: - The dining area consists of several round tables with chairs. Some tables have two chairs, while others have four. - The counter area is equipped with a display case containing various food items. - There is a visible food preparation area behind the counter. Items and Equipment: - On the left side of the image, there are several refrigerators or coolers, likely containing beverages. - The counter area has a variety of items, including a soda fountain machine and what appears to be a cash register. - There are displays for chips and snacks near the counter. People: There is a single person seated at one of the tables towards the back of the restaurant. Environment: The floor is tiled, and the overall setup is typical of a fast-food restaurant.
5	Indoor/ Commercial/ Nighttime		0.192 -> pharmacy 0.147 -> hardware_store 0.141 -> drugstore 0.125 -> bookstore 0.067 -> department_store	Setting: The image shows the interior of a convenience store. Layout: - There are multiple aisles with shelves stocked with various products. - The central focus is on the main aisle with a display shelf in the middle. Items and Equipment: - The shelves are filled with an assortment of items, including snacks, canned goods, and other convenience store products. - Towards the bottom of the image, there are refrigerators or freezers with glass doors displaying refrigerated items. Lighting and Quality: - The image is in black and white, indicating it was likely taken with a night vision camera. - The timestamp on the image suggests it was taken early in the morning. Environment: The store is well-organized, and the aisles are clean and clear of any obstructions.

6 Research Methodology

6.1 Research Design and Approach

The research design and approach aim to focus on the technical weaknesses of IP camera, specifically focusing on what information a third party can obtain merely by accessing the footage available online. The results are used to help answer RQ#1 and RQ#2:

- *RQ #1: To what extent does publicly accessible data from IP cameras listed on Shodan expose individuals' privacy, even if the data itself is not personally identifiable?*
- *RQ #2: How does the discoverability of IP cameras on Shodan impact the attack surface for malicious actors, and what specific vulnerabilities are most readily exploited?*

The research uses a combination of quantitative and qualitative approaches. First, quantitative approach and descriptive statistics are used for data collection, data analysis, summarise data, and describe the main features of the dataset. Then, qualitative approach is used to verify the accuracy of the results and perform further analysis of the content in the images. The methodology is described in Figure 6.1.

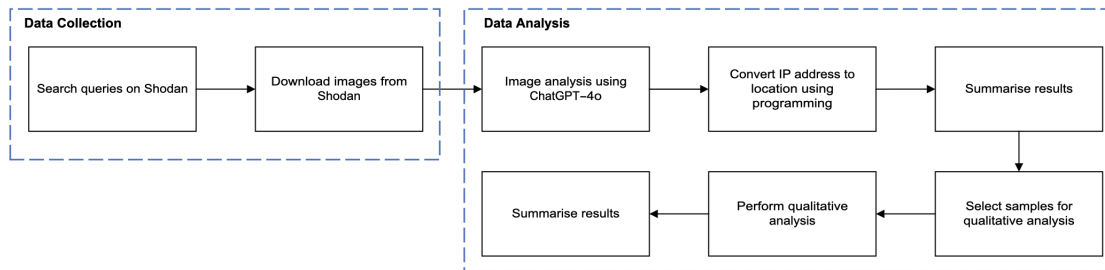


Figure 6.1: Research Methodology

First, data is collected from Shodan using command line. Next, ChatGPT-4o is trained with appropriate instructions and the collected data is sent for analysis. The IP addresses of the IP cameras are converted into location in the format [city, region, country] using Python. The results are then summarised into a table. For qualitative analysis, a few images are selected based on their categories for further analysis. The results are then summarised and reviewed.

6.2 Implementation

This section provides an overview of the data collection and analysis methodologies used in this research, including the specific techniques and tools used for data collection, and the methods

used to interpret and analyse the data.

6.2.1 Data Collection

Shodan provides a command-line interface (CLI) [55] and Python library that allow users to execute commands with their API key. Since it is only possible to download search results using either the CLI or the official Python library for Shodan, and a free user account does not support the use of CLI and Python library, an academic membership account is used in this research.

This research focuses on the IP cameras within the United Kingdom. In order to find vulnerable IP cameras, below search query is used:

```
rtsp/1.0 has_screenshot:true country:gb
```

The query 'rtsp/1.0' searches for devices with RTSP version 1.0 enabled. Since RTSP is commonly used in IP cameras, it is expected that the query will return a list of IP cameras. The query 'has_screenshot:true' searches for devices that have a screenshot available in the Shodan database, this could include footage from IP cameras, desktop screenshots, or lock screens from computers or servers. The query 'country:gb' searches for devices with IP addresses located in the United Kingdom. Combining these queries, the full query returns a list of UK-based IP cameras with RTSP 1.0 enabled, for which Shodan has a screenshot of the device available in its database.

At the time of conducting the research, there were a total of 622 results. The following CLI command was used to download and output the results into a file 'results.json.gz':

```
$ shodan download results rtsp/1.0 has_screenshot:true country:gb
```

The file 'results.json.gz' was then parsed and converted to images using the following commands:

```
$ shodan parse results.json.gz
$ shodan convert results.json.gz images
```

6.2.2 Data Cleansing

It was notable that when reviewing the data, there was a significantly large number of duplicate results, such as footage from the same camera taken in different times of the day, as well as outdated footage that was over a year old.

Shodan claims that it crawls the internet once a week [34]. To ensure the accuracy and relevance of this research, it was decided that only footage taken within a week of the research date would be included and analysed. This method ensures that all IP cameras are operational and active at the time of conducting research. Additionally, it allows for an assessment of what

information a third party might obtain if given access to IP camera footage that is no more than a week old. By analysing recent footage, this research can evaluate the potential risk and privacy implications associated with IP camera footage more effectively.

Data was cleaned based on the timestamp on the image and the last online date of the device on Shodan. During the data cleansing process, it was observed that some footage appeared to be taken from the same camera but had different IP addresses, with the last online date of one being more recent than the other. Therefore, because most of the residential IP addresses are allocated dynamically, it is deduced that Shodan may cache the images captured from the same device under old IP address, and only update or clean the cache within a certain time interval, which could potentially allow a third party to gain more information about a specific area.

After the data cleansing process, the total number of results was reduced from 622 to 281. This significant reduction suggests that Shodan stores a substantial amount of screenshots from devices that are either no longer alive, or have changed IP addresses. This information could potentially allow a malicious actor to profile a specific IP camera.

6.2.3 Data Analysis

ChatGPT-4o was used to analyse the cleaned data. Due to the limitation of a ChatGPT free account, which restricts the number of attachments a user can upload and the number of requests a user can make using ChatGPT-4o within a specific time frame, a ChatGPT Plus account was necessary for handling the analysis accurately and efficiently.

The model is trained with instructions before starting the analysis. Below instructions were used to ensure the accuracy and relevance of the results.

Analyse attached images and export the results into a CSV file. The CSV should contain below columns:

1. Residential or commercial. You should specify whether the image is from a residential property (e.g., a house) or a commercial property (e.g., a supermarket).
2. Reason. You should provide the reason why the image is residential or commercial.
3. Indoor or outdoor. You should tell whether the image was taken indoor or outdoor. Put unknown if you are uncertain.
4. People present in the photo. You should also tell whether or not there are people in the photo.
5. Detailed description. This should include the full content of your analysis.

ChatGPT-4o was also tested for converting IP addresses into locations. However, the accuracy and the responding time were slow. Therefore, a Python script was used instead to convert IP addresses to locations.

This was feasible because the format of the downloaded image filename is 'ip-port.jpg'. The Python script was used to create a list of IP addresses from the collected data, send HTTP request to 'http://ip-api.com/', parse the responses, return a string that includes the city, region, and country, and append the results into a text file. To ensure that the rate limit of the API is not exceeded, the script sends 2 requests per second using the Python 'time.sleep' function. Below is a snippet of the code that takes an IP address as input, sends HTTP request to 'http://ip-api.com/', parse the response, and returns a string that includes the corresponding city, region, and country of the IP address.

```
def get_location_by_ip(ip):  
    try:  
        response = requests.get(f'http://ip-api.com/json/{ip}')  
        data = response.json()  
        if data['status'] == 'success':  
            return f"{data['city']},{data['regionName']},{data['country']}"  
        else:  
            return "Location_not_found"  
    except Exception as e:  
        return str(e)
```

The results of converting IP addresses into locations are then integrated with the image analysis results for further analysis. The results of the analysis are described in Chapter 7.

6.3 Ethical Considerations

This research was conducted with adherence to the professional standards outlined in the code of conduct established by the British Computer Society, The Chartered Institute for IT [56]. Below are some of the key excerpts taken from the document that are directly relevant to the conduct of this research.

- "have due regard for public health, privacy, security and wellbeing of others and the environment."

- "have due regard for the legitimate rights of Third Parties."
- "only undertake to do work or provide a service that is within your professional competence."
- "carry out your professional responsibilities with due care and diligence in accordance with the Relevant Authority's requirements whilst exercising your professional judgement at all times."
- "NOT disclose or authorise to be disclosed, or use for personal gain, or to benefit a third party, confidential information except with the permission of your Relevant Authority, or as required by Legislation."
- "NOT misrepresent or withhold information on the performance of products, systems or services (unless lawfully bound by a duty of confidentiality not to disclose such information), or take advantage of the lack of relevant knowledge or inexperience of others."
- "accept your personal duty to uphold the reputation of the profession and not take any action which could bring the profession into disrepute."

6.3.1 Confidentiality and Privacy

Data were stored in an encrypted hard disk securely that is accessible only to the research team. This research does not include any analysis of personal identifiers to protect individual privacy.

6.3.2 Exploitation

The software and services used for conducting the research on IP cameras do not attempt to:

- Connect to the IP camera.
- Login to the IP camera.
- Exploit vulnerabilities of the camera.
- Access hidden URLs of the IP camera.

6.3.3 Information Disclosure

Since this research uses publicly available information from the internet and does not reveal of exploit vulnerabilities of any IP cameras, there is no risk of exposing information that could disclose vulnerabilities.

6.4 Limitations of the Methodology

While this methodology provides insights into the security and privacy issues of IP camera footage on Shodan, it is important to acknowledge that there are limitations exist in this research methodology. Understanding these limitations are crucial as they could affect the interpretation of the results and impact the accuracy of assessing the validity and reliability of the findings.

6.4.1 Data Accuracy and Completeness

The data downloaded from Shodan may not be accurate or complete. Some IP addresses could be outdated or have incorrect information, which affects the accuracy and reliability of the location data. By analysing only footage taken within a week of the research date helps to improve the data accuracy and completeness to some extent, but does not eliminate the limitation completely.

6.4.2 Image Quality

The image quality also affects the accuracy of the analysis. For example, some footage has low resolution and some was taken during nighttime, which makes it difficult to analyse the image accurately due to lack of details. This limitation is mitigated by training ChatGPT-4o to return ‘Unknown’ for any images that it cannot analyse due to resolution and clarity issues. The approach ensures that for uncertain image, ChatGPT-4o returns ‘Unknown’ rather than providing inaccurate results.

6.4.3 Dynamic Assignment of IP addresses

The dynamic nature of residential IP addresses means that their allocation changes frequently. This suggests that there may be a mismatch between the IP address location at the time the data was collected and analysed, and the actual location at the time the footage was captured by Shodan.

6.4.4 API Limitations

The accuracy of the locations relies on the IP geolocation API from ‘<http://ip-api.com/>’. The geolocation data may not be accurate and there could be request rate limits. While some level of geolocation data inaccuracy is inevitable, the rate limits restraint was managed by employing the Python ‘time.sleep’ function to ensure that only 2 requests per second were sent.

6.4.5 Data Coverage

This research focuses on IP cameras located in the United Kingdom, which means the collected sample may not fully represent of the global IP camera landscape. This limitation implies that the findings of this research only reflect the security and privacy issues unique to the United Kingdom, rather than providing a comprehensive view of IP cameras worldwide. Therefore, the results should be interpreted with the understanding that they may not apply to other regions with different user behaviours, security and privacy awareness levels, standards, and regulations.

7 Results

In this chapter, 281 images downloaded from Shodan are analysed and summarised into a table using ChatGPT-4o. The full results are shown in Appendix A.

7.1 Top 10 Cities With The Most Occurrence

Out of the 281 analysed images, the top 10 cities with the most occurrence are shown in Table 7.1. It appears that London had the most insecure cameras at the time of data collection. Considering that London is the largest city in the United Kingdom with over 8.9 million people living there [57], London may have a higher density of IP cameras and, therefore, a higher density of insecure IP cameras. The concentration of insecure cameras in specific cities like London suggests the possibilities of targeted attacks against these areas. Specific security measures and awareness campaigns targeted in these locations may help to mitigate security and privacy risks.

Table 7.1: Top 10 Cities With The Most Occurrence

City	Occurence
London	21
Nottingham	5
Birmingham	5
Leicester	4
Crewe	4
Wolverhampton	4
Greenwich	4
Manchester	4
Fulham	3
Norwich	3

7.2 Distribution of IP Camera

This section discusses the distribution of IP cameras by residential/commercial, indoor/outdoor, and the presence of people. It aims to provide an understanding of how IP cameras are deployed across different environments and usage scenarios, as well as identifying pattern and trends.

7.2.1 By Residential and Commercial

Figure 7.1 shows the distribution of IP camera by residential and commercial properties in percentage and the total count of each category. The number of IP cameras placed in residential properties is almost six times greater than those in commercial properties. This suggests that in the United Kingdom, IP cameras are more commonly used for remote monitoring of the house. Whereas in commercial properties, property owners may be more likely to hire professional CCTV installation teams instead of installing IP camera themselves due to the specific needs and security requirements of commercial environments. Some commercial properties may even

require their cameras to be integrated with security infrastructure, such as gates. Also, it is important to secure value assets and the safety of customers and employees in a commercial environment. CCTV or IP cameras installed by professionals are generally more secure due to the higher standards and legal obligations they must adhere to, such as due diligence and regulatory compliance.

It is noticeable that there are 29 IP cameras in the Unknown category. This is potentially due to dark images taken at nighttime, lack of details, low resolution, and unclear images, which make it difficult for ChatGPT-4o to perform accurate analysis. ChatGPT-4o was trained to return ‘Unknown’ if it is uncertain about the scene. This ensures that the analysis maintain a high level of accuracy and that ChatGPT-4o does not attempt to analyse images with poor quality, which helps to reduce the number of inaccurate results.

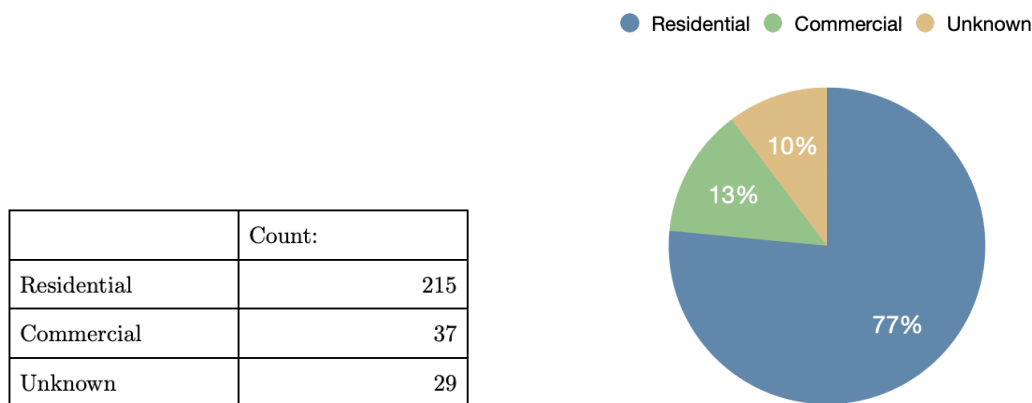


Figure 7.1: Distribution of IP Camera by Residential and Commercial

7.2.2 By Indoor and Outdoor

Figure 7.2 shows the distribution of IP camera by indoor and outdoor settings in percentage and the total count of each category. The number of IP cameras placed outdoors is over 1.5 times greater than those placed indoors. This suggests that in the United Kingdom, IP camera users prioritise monitoring and securing the surrounding of their properties. By placing IP cameras outdoor, property owners able to detect potential intruders, monitor entry points of the property such as gates and doors, and record and provide evidence of any suspicious activities around the property. The higher distribution of outdoor IP cameras also suggests that the growing awareness of the importance of the external security measures, as well as internal measures.

7.2.3 By Residential/Commercial and Indoor/Outdoor

Table 7.2 presents the total counts of the distribution of IP camera by residential or commercial properties and indoor or outdoor settings. It shows that the total counts of both residential outdoor IP cameras and commercial outdoor IP cameras are greater than residential indoor

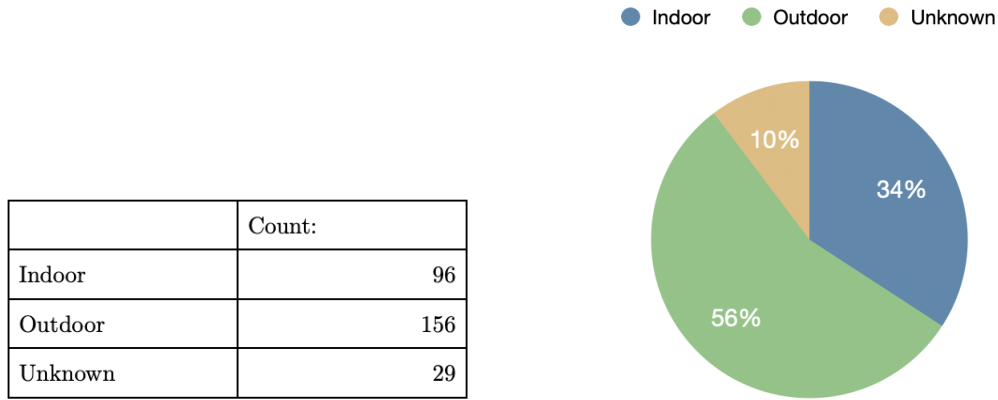


Figure 7.2: Distribution of IP Camera by Indoor and Outdoor

and commercial indoor IP cameras. The fact that residential outdoor IP cameras constitute the majority of the sample supports the point made in Section 7.2.2 that the awareness of the importance of the external security measures is growing in the United Kingdom, especially among the general public.

This pattern indicates that compared to commercial properties, which are likely to have more robust security measures in-house, such as hardened doors and gates, alarm systems for intruders, and 24/7 guards, residential property owners are more likely to invest in external security measures, such as placing IP cameras outdoors. This could be due to the lack of indoor security measures and possibly the difficulty of implementing indoor security measures.

Furthermore, the accessibility, affordability, and easy installation of IP cameras have provided a cost-effective and simple way to enhance security for homeowners. Also, the advancement in IP camera technology, such as weather resistance and night vision capability have made them more reliable for outdoor monitoring.

The count differences between residential indoor and residential outdoor, and commercial indoor and commercial outdoor are roughly the same, with outdoor cameras being twice as many as indoor cameras. This consistent pattern across both residential and commercial properties highlights a boarder trend of prioritising the safety of the surrounding environment. This further suggests that both residential and commercial property owners acknowledge the importance of monitoring and securing the surrounding of their properties.

Table 7.2: Distribution of IP Camera by Residential/Commercial and Indoor/Outdoor

	Count:
Residential Indoor	71
Residential Outdoor	143
Commercial Indoor	13
Commercial Outdoor	24

7.2.4 By The Presence of People

Figure 7.3 shows that among 281 samples, there are 268 images with no people present and 13 images with one or more people present. This significant difference could be due to various reasons such as empty scene because of the time of the day when the images were taken. It also indicates that the majority of IP cameras are likely placed to monitor unoccupied areas where people are not expected to present.

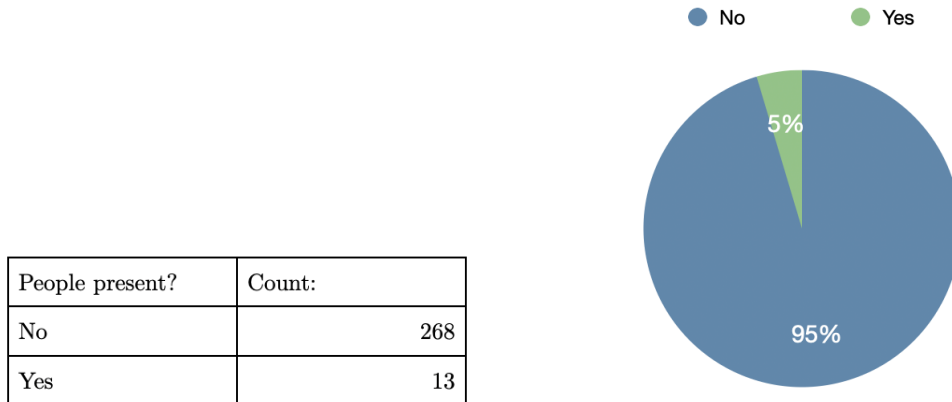


Figure 7.3: Distribution of IP Camera by the presence of people

7.2.5 By Indoor/Outdoor and Presence of People

Table 7.3 suggests that among 281 samples, 8.33% of indoor images have people present, whereas 3.21% of outdoor images have people present. This suggests that indoor IP cameras are more likely to capture images with people than outdoor IP cameras. This meets the expectation since indoor IP cameras are commonly used to monitor places where human activity is frequent, while outdoor IP cameras are typically used to monitor entry points and the surroundings of the properties, where human activity is less frequent.

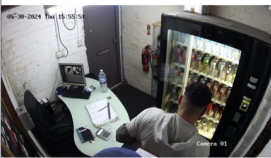
Table 7.3: Distribution of IP Camera by Indoor/Outdoor and Presence of People

	Count:
Indoor with people	8
Indoor without people	88
Outdoor with people	5
Outdoor without people	151

7.3 Qualitative Analysis on Selected Samples

To test the accuracy of the analysis and identify anomalies, seven results have been selected for further analysis based on their categories. The selected images and the corresponding ChatGPT-4o results are shown in Table 7.4. These include Sample-4, an outdoor residential scene with people present; Sample-85, an indoor commercial scene with people present; Sample-187, an indoor residential scene with no people present; Sample-188, an unknown scene; Sample-269, an outdoor commercial scene with people present; Sample-36 and Sample-273, two anomalies that require further analysis.

Table 7.4: Seven Selected Images For Further Analysis

Sample	Image	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People present?	Detailed Description
4		2.30.82.201-554.jpg	Leeds, England, United Kingdom	Residential	The typical residential entryway with a gate and people present.	Outdoor	Yes	The photo shows an outdoor entryway with paving stones and a fence, with two people standing near the gate.
36		51.148.131.41-554.jpg	London, England, United Kingdom	Residential	The dark image indicates night-time, likely in a residential area.	Unknown	No	The photo is dark, and it is difficult to discern any details.
85		81.134.6.207-8554.jpg	Great Barton, England, United Kingdom	Commercial	The presence of a vending machine, office supplies, and an industrial setup suggests a commercial or industrial area.	Indoor	Yes	The photo shows an indoor area with a vending machine, a desk with office supplies, and an industrial setup. A person is visible in the foreground, indicating this is a working environment, likely in a commercial or industrial setting.
187		86.172.173.243-554.jpg	Bedford, England, United Kingdom	Residential	The presence of a kitchen with household items and a teddy bear indicates a residential area.	Indoor	No	The photo shows an indoor area with a kitchen, household items, and a teddy bear, indicating a residential area.
188		86.174.91.105-554.jpg	Fulham, England, United Kingdom	Unknown	The image shows window blinds in low light, making it difficult to determine the setting.	Unknown	No	The photo shows window blinds in low light, making it difficult to determine the setting.
269		193.237.245.201-554.jpg	London, England, United Kingdom	Commercial	The workers sitting outside a car wash indicate a commercial setting.	Outdoor	Yes	The photo shows an outdoor area of a car wash with workers sitting and resting. The area is well-lit and organized.
273		212.159.89.201-554.jpg	Evington, England, United Kingdom	Unknown	The image is too dark to determine.	Indoor	No	The image is completely dark, suggesting it might be a garage or storage room with the lights off.

7.3.1 Sample-4

Sample 4 is an image with the filename 2.30.82.201-554.jpg, downloaded from Shodan. The result of the Python script used to convert IP addresses into locations suggests that this IP address is located in Leeds. The images includes an entrance area of a residential property. The ground is paved with stone slabs and there is grass along the road. It is considered to be a residential property due to the layout of the fence and the present of a car parked on the road. There are two individuals present in the image, the person positioned closer to the fence is holding a cup. It appears that they are both looking at the same object in the same direction, probably discussing the fence or some objects located close it.

ChatGPT-4o identified it as residential, outdoor, and with people present, described as "The typical residential entryway with a gate and people present. The photo shows an outdoor entryway with paving stones and a fence, with two people standing near the gate.". The identification and description are accurate but missing details such as the parked car and the behaviour of the two individuals. The individual holding a cup has a tattoo on the right forearm, which may be used to identify identity.

Table 7.5: Sample-4 Results

Sample	Image	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People present?	Detailed Description
4		2.30.82.201-554.jpg	Leeds, England, United Kingdom	Residential	The typical residential entryway with a gate and people present.	Outdoor	Yes	The photo shows an outdoor entryway with paving stones and a fence, with two people standing near the gate.

7.3.2 Sample-85

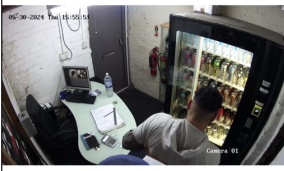
Sample-85 has a filename of 81.134.6.207-8554.jpg. The Python script suggests that this IP address is located in Great Barton. The image suggests an indoor setting with a desk, a chair, and a vending machine filled with various beverages. There is an individual standing near the vending machine and facing away from the camera. There are various objects placing on the desk, including a notebook, a calculator, and an unlocked desktop. The screen of the desktop displaying what seems to be surveillance footage from other cameras. With the presence of the desktop, the calculator and two fire extinguishers hanging on the white brick wall, it is suggested that this is an image with commercial indoor scene.

ChatGPT-4o identified it as commercial, indoor with people present, described as "The photo shows an indoor area with a vending machine, a desk with office supplies, and an industrial setup. A person is visible in the foreground, indicating this is a working environment, likely in a

commercial or industrial setting.". The identification is accurate. However, the description lacks details. For example, ChatGPT-4o fails to describe the appearance of the individual, who has short hair and wearing a light gray hoodie, and the presence of two fire extinguishers.

Great Barton has a population of 2000 people only, making it relatively easy to find the exact location of this image.

Table 7.6: Sample-85 Results

Sample	Image	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People present?	Detailed Description
85		81.134.6.207-8554.jpg	Great Barton, England, United Kingdom	Commercial	The presence of a vending machine, office supplies, and an industrial setup suggests a commercial or industrial area.	Indoor	Yes	The photo shows an indoor area with a vending machine, a desk with office supplies, and an industrial setup. A person is visible in the foreground, indicating this is a working environment, likely in a commercial or industrial setting.

7.3.3 Sample-187

Sample-187 has a filename of 86.172.173.243-554.jpg. The Python script suggests that this IP address is located in Bedford. The image appears to be a corner of a kitchen, indicating a residential indoor scene. On the left side of the image, there is a toaster on top of a kitchen worktop. On the right side of the image, there is a radiator against the wall. A pet bed with blankets and pillows is placed on the floor, along with a stuffed teddy bear.

ChatGPT-4o identified it as residential, indoor with no people present, described as "The photo shows an indoor area with a kitchen, household items, and a teddy bear, indicating a residential area.". The identification and description are accurate. There are not many details in this image that can be used to identify an individual. However, the purpose of this IP camera appears to be to monitor the pet, as the pet bed is located in the centre of the camera's view. If the pet were captured in the image, this could be used to identify a specific pet in the area and potentially identify its owner.

Table 7.7: Sample-187 Results

Sample	Image	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People present?	Detailed Description
187		86.172.173.243-554.jpg	Bedford, England, United Kingdom	Residential	The presence of a kitchen with household items and a teddy bear indicates a residential area.	Indoor	No	The photo shows an indoor area with a kitchen, household items, and a teddy bear, indicating a residential area.

7.3.4 Sample-188

Sample-188 has a filename of 86.174.91.105-554.jpg. The Python script suggests that this IP address is located in Fulham. The images seems to be captured through a window with blinds.

The camera is placed indoor, facing outward, as fences can be identified through the blinds.

ChatGPT-4o fails to identify the scene, with the reason described as "The photo shows window blinds in low light, making it difficult to determine the setting.". It is appropriate to classify this image as Unknown due to the lack of details and low light.

Table 7.8: Sample-188 Results

Sample	Image	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People present?	Detailed Description
188		86.174.91.105-554.jpg	Fulham, England, United Kingdom	Unknown	The image shows window blinds in low light, making it difficult to determine the setting.	Unknown	No	The photo shows window blinds in low light, making it difficult to determine the setting.

7.3.5 Sample-269

Sample-188 has a filename of 193.237.245.201-554.jpg. The Python script suggests that this IP address is located in London. The image appears to be taken at a hand car wash business. The sign at the top says "WELCOME TO SOUTHEND'S PREMIER HAND CAR WASH", indicating it is located in Southend. The background of the image includes equipment and tools used for car wash. There are three individuals present in the image, possibly employees. It is unlikely that the individuals are customers due to no cars are captured in the image.

ChatGPT-4o identified it as commercial, outdoor with people present, described as "The photo shows an outdoor area of a car wash with workers sitting and resting. The area is well-lit and organized.". The identification and description are accurate, even though the sign at the top is not mentioned. The sign indicates that the car wash is located in Southend. In fact, images from the first Google review result of Google search for "car wash Southend" match the sign in this image, making it possible to identify the working location of these individuals.

Table 7.9: Sample-269 Results

Sample	Image	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People present?	Detailed Description
269		193.237.245.201-554.jpg	London, England, United Kingdom	Commercial	The workers sitting outside a car wash indicate a commercial setting.	Outdoor	Yes	The photo shows an outdoor area of a car wash with workers sitting and resting. The area is well-lit and organized.

7.3.6 Sample-36 and Sample-273

Sample-36 and Sample-273 are identified as anomalies during the analysis of the distribution of IP camera. They are completely dark, yet ChatGPT-4o identified Sample-36 as residential and Sample-273 as indoor.

For Sample-36, ChatGPT-4o identified it as residential, unknown about indoor or outdoor settings, and no people present, described as "The photo is dark, and it is difficult to discern any details. The dark image indicates night-time, likely in a residential area.". ChatGPT-4o suggests that it is likely in a residential area without providing any valid reason.

For Sample-273, ChatGPT-4o identified it as unknown whether it is a residential or commercial scene, indoor and no people present, described as "The image is completely dark, suggesting it might be a garage or storage room with the lights off.". While the possibility of it being a garage or storage room with the lights off exists, this is not what the image shows and is only a prediction from ChatGPT-4o.

To confirm the accuracy of dark image analysis by ChatGPT-4o, all dark images and the corresponding results were reviewed and summarised in Table 7.10. It appears that for other dark images, ChatGPT-4o identified them as Unknown successfully with description similar to "The photo is very dark, making it difficult to determine the setting or any details.". It is unclear why ChatGPT-4o fails to identify Sample-36 and Sample-273 correctly. This issue should be avoidable by refining the pre-training of the model.

Table 7.10: Dark Samples Results

Sample	Image	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People present?	Detailed Description
36		51.148.131.41-554.jpg	London, England, United Kingdom	Residential	The dark image indicates night-time, likely in a residential area.	Unknown	No	The photo is dark, and it is difficult to discern any details.
48		80.5.41.190-554.jpg	Nottingham, England, United Kingdom	Unknown	The photo is completely dark.	Unknown	No	The photo is completely dark with no visible details.
97		81.154.35.236-554.jpg	Shenley Church End, England, United Kingdom	Unknown	The image is too dark to determine the setting.	Unknown	No	The photo is very dark, making it difficult to determine the setting or any details.
135		86.5.176.30-554.jpg	Lincoln, England, United Kingdom	Unknown	The image is completely dark, making it impossible to determine the setting.	Unknown	No	The photo is completely dark, making it impossible to determine the setting or any details.
141		86.14.181.245-554.jpg	Waltham Forest, England, United Kingdom	Unknown	The image is completely black, making it impossible to determine the setting.	Unknown	No	The photo is entirely black, with no visible features to describe or determine the setting.
202		86.189.202.113-554.jpg	Coalville, England, United Kingdom	Unknown	The image is very dark, making it difficult to determine the setting.	Unknown	No	The photo is very dark, making it difficult to determine the setting or any details.
228		92.27.143.102-554.jpg	Islington, England, United Kingdom	Unknown	The image is very dark and does not provide enough context to determine the setting.	Unknown	No	The photo is very dark, showing minimal details, making it difficult to determine the setting.
273		212.159.89.201-554.jpg	Evington, England, United Kingdom	Unknown	The image is too dark to determine.	Indoor	No	The image is completely dark, suggesting it might be a garage or storage room with the lights off.

8 Discussion

The Discussion chapter aims to explain and interpret the findings, answer the research questions, and propose mitigation strategies for both technical and social aspects. This chapter dives into the underlying root cause of the results, providing a detailed analysis of how these factors contributed to the observed outcomes. The proposed strategies aim to provide a comprehensive, balanced, and effective approach to mitigate the challenges identified in this project, including both technical and social solutions, such as advancements in technology, changes in processes, or policy changes.

The research questions are:

- *RQ #1: To what extent does publicly accessible data from IP cameras listed on Shodan expose individuals' privacy, even if the data itself is not personally identifiable?*
- *RQ #2: How does the discoverability of IP cameras on Shodan impact the attack surface for malicious actors?*
- *RQ#3: How can industry standards, policies and regulatory frameworks for IoT device help in mitigating the risks associated with publicly accessible IP camera data on platforms like Shodan? What are the changes required to ensure responsible practices across the entire IoT lifecycle?*
- *RQ #4: What mitigation strategies can be applied to address the identified challenges?*

8.1 Level of personal identifiability of the footage

The level of personal identifiability of the footage found on Shodan varies significantly depending on the content of the footage. It is essential for the image to include people in order to be personal identifiable. Therefore, footage without people present is not considered to be personal identifiable. Results show that only 5% of the samples, which amounts to 13 images, have people present. This low percentage of identifiable images suggests the general anonymity of the footage available on Shodan in the United Kingdom. However, since the exact data collection and indexing time of Shodan scan engine are unknown, it is likely that the percentage would increase if outdoor footage were captured during daytime compared to nighttime, and residential indoor footage were captured during nighttime when people are more likely to be present.

To answer RQ#1, it is essential to look at the three samples with people present were analysed in Section 7.3. All three samples are personal identifiable to a certain extent. In Sample-4, it

is possible to identify a person due to the tattoo on the right forearm. If the pattern is unique, with the correct use of photo editing apps, it is possible to enhance and clarify blurry photos, extract the tattoo pattern, and used it to identify the individual.

In Sample-85, it would not be possible to identify an individual just by analysing the image. However, it is possible to deduce the height and the body size of the individual appearing in the image. Also, the image was captured from a device located in Great Barton based on its IP address. Great Barton is a small town with a population less than 2,000 people [58]. Given that this is a commercial property, it is relatively easy to locate the exact location of this property and find the individual with a certain body size and height.

In Sample-269, it is clear that the individuals appearing in the image are employees of the car wash. The fact that images from the first Google review result of Google search for "car wash Southend" match the sign in this image makes it easy for anyone to visit this car wash in person and find the individuals.

However, due to the quality of the images, it is unlikely that any personal identifiers can be identified just by analysing the image. Nevertheless, with the use of the Internet and other tools like photo editing apps, it is possible to find information that might be related to the individuals appearing in the images.

From the samples described above, it is obvious that footage from IP cameras listed on Shodan can significantly expose individuals' identity and privacy. Although the footage may not contain personal identifiers or may be too blurry to identify, the context of the footage can often lead to indirect identification of individuals through observation of surrounding environment, living patterns, and habits. Also, geolocation data from the footage helps to locate the physical location of cameras. Combined with other information, such as the living patterns of individuals, further targeted attack such as stalking can be performed by malicious actors. To mitigate these risks, it is important to implement technical solution onto the IP cameras, such as encryption and authentication, as well as policy changes that encourage stricter data protection practices.

8.2 Level of open access to IP cameras found on Shodan

There are 144,712 IP cameras located in the United Kingdom that were found and indexed by Shodan scan engine at the time of this research. Only 1.9% of these cameras, which amounts to 281 IP cameras, have footage captured and the last online date within one week. The low percentage suggests that the majority of the IP cameras have reasonable authentication and encryption mechanisms implemented.

However, The presence of 281 unprotected cameras indicates that vulnerabilities still exist. These cameras have no authentication enabled and are at risk of being exploited by malicious

actors. It is possible that malicious actors gain unauthorised access into the cameras and further infiltrate the home networks where the IP cameras are connected to, and conduct further attack. Once the malicious actors are inside the network, they can potentially compromise other connected devices, for example, mobile phones, laptops, routers, and install malware or even use the compromised devices as a bot to conduct extensive cyber attacks such as DDoS attacks.

Furthermore, Shodan also exposes other vulnerabilities such as outdated firmware or unpatched system, which can be used by the malicious actors to compromise protected IP cameras with security measures implemented. These vulnerabilities can be exploited to bypass existing security measures. It is important to keep firmware updated and systems patched to prevent vulnerabilities from being exploited. Manufacturers play a crucial role in enhancing the security of IP cameras in both pre-market and post-market phases as NIST IR 8259 [39] suggests.

This findings also highlights the need for user education regarding the security of IP cameras. 1.9% may not seem like a lot, but 281 unprotected cameras means there are 281 households or shops at risk. Many users may not be aware of the risks associated with unsecured IP and the consequences of a security breach.

8.3 Legislation and Standards

Industry standards, policies and regulatory frameworks play an important role in helping to mitigating the risks associated with publicly accessible IP camera data on online platform like Shodan. They ensure responsible practices across the entire IoT lifecycle.

Industry standards like ISO/IEC 27402 and NIST IR 8259 provides general guidelines for securing both the hardware and software aspects of IoT devices and communication with customers. Adherence to these standards ensure IoT devices have a strong default security settings and receive regular firmware updates, significantly reducing the risk of unauthorised access and compromised devices. These standards combined provide a comprehensive framework for robust IoT security.

However, it is important to note that compliance to these standards is not mandatory. Manufacturers are not legally required to adhere to these standards, which can result in inconsistent security measures across different IoT devices and IoT manufacturers, leading to certain devices being more vulnerable to specific types of attacks. Without mandatory compliance, it solely depends on the commitment of manufacturers to security practices, which may not always be correct and consistent.

Legislation such as GDPR and CCPA enhances data protection and privacy by enforcing data controllers and collectors, such as manufacturers, to be compliant and adopt robust security measure during data collection. Newer legislation, such as The California IoT Security Law and

The Cyber Resilience Act regulates the hardware and software security requirements of IoT devices. However, the requirements in these laws are not always specific and often lack clear definition. This ambiguity can lead to different interpretations and implementations, resulting in inconsistencies in the level of security provided in IoT devices.

Also, there is a inconsistency across different legislation worldwide. While some regions, such as the EU, have stricter regulations, others may have more lenient regulations, allowing malicious actors to target specific regions with more relaxed regulations. This inconsistency required manufacturers to be compliant with different set of requirements, increasing their costs to improve the security measures of the devices.

8.4 Mitigation strategy

To address these challenges, a holistic approach that combines user education, manufacturer responsibility, and regulatory oversight is required. User education can be enhanced by providing easily accessible resources that emphasise the importance of securing IoT devices and detailing steps for users to enhance their own devices' security measures. This includes changing default passwords, installing firmware updates, and understand the risks associated.

Manufacturers must also take greater responsibility and integrate security features into the design and production phases of their devices, achieving the goal of security-by-design. This includes setting strong default and one-time password, ensuring regular firmware updates even in the post-market phase, and performing thorough security testing before launching the products. Also, manufacturers should provide clear, easy-to-understand instructions to help users maintain a high standard of security.

Regulatory oversight also plays a crucial role in establishing, enforcing, and maintaining consistent security standards across different regions. Governments and regulatory bodies should work together to create harmonised regulations that offer clear guidelines for IoT security, mandating essential security measures such as encryption and authentication to set up a baseline level of security for all IoT devices. Consistent security standards and regulations across different regions also helps in international cooperation when dealing with international IoT security threats. Countries can establish an unified approach to secure IoT devices, making it difficult for malicious actors to exploit regulatory gaps.

9 Conclusion

This research aims to investigate the privacy and security implication of publicly accessible IP cameras available on Shodan using a thorough analysis. The study shows that the widespread deployment of IP cameras in the United Kingdom, combined with the ease of discovering and accessing these devices through the internet, presents significant privacy and security risks to individuals.

Data analysis suggested that a large number of IP cameras were exposed online with inadequate security controls. This included IP camera live stream that can be accessed without authentication, potentially revealing sensitive information about individuals' daily routines and the layout of their house or surrounding area. The use of RTSP and similar protocols without encryption implemented makes it easier for malicious actors to exploit the devices for unauthorised purposes.

Threat modeling using the STRIDE and LINDDUN frameworks identified key security and privacy threats, highlighting the need for more robust security measures in IP cameras. These should include encrypted communications, strong authentication mechanisms, and regular updates to address vulnerabilities.

We also examined current standards and regulations governing IoT devices. While frameworks such as ISO/IEC 27402:2023 and NIST IR 8259 are in place, the analysis revealed that gaps exist in effectively enforcing these standards across different regions and manufacturers. The recent adoption of the Cyber Resilience Act in the EU represents a positive step toward enhancing IoT security, though its practical impact is yet to be determined.

In conclusion, this research highlights the need for increased security awareness among manufacturers, regulators, and end-users. The findings advocate for a better integrated approach to IoT security, where manufacturers are held accountable for implementing robust security measures and users are educated on the importance of securely configuring their devices. Further research should focus on exploring legislative enhancements to keep pace with the rapid evolution of IoT technologies, as well as developing automated tools to aid in identifying and mitigating vulnerabilities in IoT devices with the use of Shodan.

A Appendix - Full Results

Table A.1: Results

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
1	2.24.98.102-554.jpg	Belfast, Northern Ireland, United Kingdom	Residential	The presence of curtains and a domestic window setup.	Indoor	No	The photo shows an indoor area with curtains drawn slightly apart, letting in sunlight. Part of a wall is visible to the left, and the window seems to be behind the curtains.
2	2.25.46.190-554.jpg	Barnet, England, United Kingdom	Residential	The typical residential entryway with a utility box and door mat.	Outdoor	No	The photo captures a doorstep with brick paving, a black mat, and part of a beige wall with a utility box.
3	2.30.56.82-554.jpg	Merthyr Tydfil, Wales, United Kingdom	Residential	The garden setup with lawn and pots indicates a residential area.	Outdoor	No	The image shows an outdoor garden area at night, with a grass lawn, a garden bed, and some pots.
4	2.30.82.201-554.jpg	Leeds, England, United Kingdom	Residential	The typical residential entryway with a gate and people present.	Outdoor	Yes	The photo shows an outdoor entryway with paving stones and a fence, with two people standing near the gate.
5	2.97.67.235-554.jpg	Southwark, England, United Kingdom	Residential	The living room setup with typical furnishings indicates a residential area.	Indoor	No	The photo captures a living room with a sofa, table, and various furnishings. The image is in black and white, likely taken at night.
6	2.99.19.69-554.jpg	Southend-on-Sea, England, United Kingdom	Residential	The backyard setup with furniture and plants indicates a residential area.	Outdoor	No	The image shows a backyard at night, with garden furniture and plants visible.
7	2.101.245.218-554.jpg	Tower Hamlets, England, United Kingdom	Residential	The indoor setting with a light fixture indicates a residential area.	Indoor	No	The photo shows the ceiling of an indoor room with a light fixture.
8	2.102.32.74-554.jpg	Ashford, England, United Kingdom	Residential	The presence of a bed and a person sleeping indicates a residential area.	Indoor	Yes	The image shows a person sleeping on a bed in a dark room.
9	2.102.84.2-554.jpg	Hackney, England, United Kingdom	Residential	The indoor hallway setup with utility equipment indicates a residential area.	Indoor	No	The photo captures a hallway with a door and some utility equipment on the wall.
10	2.121.197.166-554.jpg	Leicester, England, United Kingdom	Residential	The driveway setup with parked cars and a residential street view indicates a residential area.	Outdoor	No	The image shows a driveway with two cars parked and a road in the background.
11	2.218.136.161-554.jpg	Southend-on-Sea, England, United Kingdom	Commercial	The presence of a parking area and multiple vehicles near a large building suggests a commercial location.	Outdoor	No	The photo shows an outdoor view from a window looking down on a parking area with several vehicles and a building.
12	2.220.202.85-554.jpg	Southall, England, United Kingdom	Residential	The presence of houses and a typical residential street setup.	Outdoor	No	The image captures a street view with several houses and cars. The view is from a window.
13	2.220.227.26-554.jpg	Wembley, England, United Kingdom	Residential	The driveway setup with a trash bin and bushes indicates a residential area.	Outdoor	No	The photo shows a paved driveway with a trash bin and some bushes.
14	2.223.242.179-554.jpg	St Helens, England, United Kingdom	Residential	The driveway setup with a car and typical residential street view.	Outdoor	No	The image shows a driveway with a car parked, a grassy area, and a street in the background.
15	5.71.174.172-554.jpg	Southampton, England, United Kingdom	Residential	The garden or backyard setup indicates a residential area.	Outdoor	No	The photo shows a blurry view of a garden or backyard.
16	5.80.1.64-554.jpg	Gloucester, England, United Kingdom	Residential	The garage setup with tools and equipment indicates a residential area.	Indoor	No	The image shows a garage with various tools and equipment.
17	5.81.42.99-554.jpg	Nottingham, England, United Kingdom	Residential	The street view with a parked car and grassy area indicates a residential area.	Outdoor	No	The photo captures a street view with a parked car and a grassy area.
18	5.81.172.46-554.jpg	Skegness, England, United Kingdom	Unknown	The blurry view with bright lights makes it difficult to determine the location.	Unknown	No	The image shows a blurry night view with bright lights, possibly headlights.
19	31.49.89.192-554.jpg	Crewe, England, United Kingdom	Residential	The barn setup with sheep indicates a residential farm area.	Indoor	No	The photo shows a barn or shed with several sheep inside, possibly on a farm.
20	31.53.164.101-554.jpg	Rhyl, Wales, United Kingdom	Residential	The indoor staircase setup indicates a residential area.	Indoor	No	The image captures an indoor staircase with dim lighting.
21	31.54.20.154-554.jpg	Sunderland, England, United Kingdom	Residential	The presence of a garden setup with toys and plants indicates a residential area.	Outdoor	No	The photo shows a garden with toys on a table, plants, and a pathway.
22	31.96.34.211-554.jpg	Margate, England, United Kingdom	Commercial	The presence of a large open field with parked cars indicates a commercial area, likely a parking lot.	Outdoor	No	The image shows a large open field with several parked cars and a bright sky.
23	31.96.238.130-554.jpg	London, England, United Kingdom	Commercial	The presence of a large open field with parked cars indicates a commercial area, likely a parking lot.	Outdoor	No	The image shows a large open field with several parked cars and a bright sky.
24	31.104.159.139-554.jpg	Guildford, England, United Kingdom	Unknown	The image is unclear, showing some structure with reflections, making it difficult to determine the location.	Unknown	No	The image shows an unclear structure with reflections, making it difficult to identify the location.
25	31.104.229.83-554.jpg	St Austell, England, United Kingdom	Residential	The presence of a residential street with parked cars and houses indicates a residential area.	Outdoor	No	The photo shows a residential street with parked cars, houses, and greenery.
26	31.113.54.45-554.jpg	Parson Drove, England, United Kingdom	Commercial	The presence of an indoor corridor with professional lighting and setup indicates a commercial area.	Indoor	No	The image shows an indoor corridor with professional lighting and a clean setup.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
27	31.117.13.175-554.jpg	Schell City, Missouri, United States	Commercial	The presence of people walking in front of a building entrance indicates a commercial area.	Outdoor	Yes	The photo shows people walking in front of a building entrance with professional surroundings.
28	31.120.26.12-554.jpg	London, England, United Kingdom	Commercial	The presence of multiple areas and scenes in one image indicates a commercial setup, likely a surveillance system.	Indoor	Yes	The image shows multiple scenes, including a restaurant, parking area, and storage, indicating a commercial surveillance system.
29	31.124.130.231-554.jpg	Crawley, England, United Kingdom	Residential	The presence of an indoor hallway with domestic items indicates a residential area.	Indoor	No	The image shows an indoor hallway with domestic items and a view towards a room with plants.
30	31.125.46.187-554.jpg	London, England, United Kingdom	Residential	The presence of a garden with a conservatory and plants indicates a residential area.	Outdoor	No	The photo shows a garden with a conservatory, plants, and a pathway.
31	31.127.24.208-554.jpg	Deeside, Wales, United Kingdom	Residential	The chandelier and wallpaper indicate a residential setting.	Indoor	No	The photo shows an indoor area with a ceiling featuring a decorative chandelier. The walls have patterned wallpaper.
32	31.127.77.143-554.jpg	Connahs Quay, Wales, United Kingdom	Residential	The presence of cars in a driveway suggests a residential setting.	Outdoor	No	The photo shows a driveway with two cars parked. The surrounding area includes paved ground and some vegetation.
33	46.208.121.165-554.jpg	Northwich, England, United Kingdom	Residential	The presence of multiple houses and a driveway suggests a residential setting.	Outdoor	No	The photo shows a driveway with cars and a van parked. The surrounding area includes houses, greenery, and a paved pathway.
34	51.9.29.74-554.jpg	Lancaster, England, United Kingdom	Residential	The backyard setting with a patio and garden indicates a residential area.	Outdoor	No	The photo shows a backyard with a patio, garden, and some outdoor furniture. The setting is at night with some lighting visible.
35	51.9.57.232-554.jpg	Felixstowe, England, United Kingdom	Residential	The presence of residential buildings and garbage bins indicates a residential area.	Outdoor	No	The photo shows an alleyway with garbage bins, paved ground, and parked vehicles in a residential area.
36	51.148.131.41-554.jpg	London, England, United Kingdom	Residential	The dark image indicates night-time, likely in a residential area.	Unknown	No	The photo is dark, and it is difficult to discern any details.
37	51.148.188.136-554.jpg	London, England, United Kingdom	Commercial	The interior of a fast-food restaurant indicates a commercial setting.	Indoor	Yes	The photo shows the interior of a fast-food restaurant with tables, chairs, and a counter area. Some people are visible inside the restaurant.
38	62.30.150.104-554.jpg	Birmingham, England, United Kingdom	Commercial	The interior of a small restaurant or café indicates a commercial setting.	Indoor	Yes	The photo shows the interior of a small restaurant or café with tables, chairs, and some people visible inside.
39	62.49.233.172-554.jpg	Fulham, England, United Kingdom	Residential	The backyard setting with garden and patio furniture indicates a residential area.	Outdoor	No	The photo shows a backyard with garden and patio furniture. The setting is at night with some lighting visible.
40	62.56.59.159-554.jpg	Kensington, England, United Kingdom	Residential	The patterned ceiling indicates a residential setting.	Indoor	No	The photo shows a patterned ceiling in an indoor setting.
41	77.86.118.13-554.jpg	Hull, England, United Kingdom	Residential	The setting of a car parked in a narrow space by a fence indicates a residential area.	Outdoor	No	The photo shows a car parked in a narrow space next to a fence. The photo is taken at night.
42	77.97.162.161-554.jpg	Maidstone, England, United Kingdom	Residential	The backyard setting with a clothesline indicates a residential area.	Outdoor	No	The photo shows a backyard with a clothesline, some plants, and a paved area. The photo is taken at night.
43	77.100.32.253-554.jpg	Motherwell, Scotland, United Kingdom	Residential	The interior setting with a living room layout indicates a residential area.	Indoor	No	The photo shows a living room with a sofa, TV, decorative items, and a patterned wallpaper.
44	77.103.148.38-554.jpg	Torquay, England, United Kingdom	Residential	The indoor setting with personal items indicates a residential area.	Indoor	No	The photo shows an indoor setting with various personal items hanging and stored, likely in a shed or storage area.
45	78.149.6.219-554.jpg	Norwich, England, United Kingdom	Residential	The garage setting with stored items indicates a residential area.	Indoor	No	The photo shows the interior of a garage with various stored items and a closed garage door.
46	79.77.68.187-554.jpg	Colchester, England, United Kingdom	Residential	The plain ceiling view indicates an indoor residential area.	Indoor	No	The photo shows a plain ceiling in an indoor setting.
47	80.1.113.50-554.jpg	Middlesbrough, England, United Kingdom	Residential	The outdoor setting with bins and a garage indicates a residential area.	Outdoor	No	The photo shows an outdoor area with bins, a garage, and some construction materials.
48	80.5.41.190-554.jpg	Nottingham, England, United Kingdom	Unknown	The photo is completely dark.	Unknown	No	The photo is completely dark with no visible details.
49	80.5.85.181-554.jpg	Leicester, England, United Kingdom	Residential	The cluttered basement or workshop setting indicates a residential area.	Indoor	No	The photo shows a cluttered basement or workshop with various tools and items stored.
50	80.7.23.155-554.jpg	Antrim, Northern Ireland, United Kingdom	Residential	The kitchen setting with personal items indicates a residential area.	Indoor	No	The photo shows a kitchen area with a table, chair, and some personal items.
51	80.7.97.154-554.jpg	Rumcorn, England, United Kingdom	Residential	The workshop setting with tools indicates a residential area.	Indoor	No	The photo shows a workshop area with tools and equipment.
52	80.43.216.66-554.jpg	Stoke-on-Trent, England, United Kingdom	Residential	The garden setting with potted plants indicates a residential area.	Outdoor	No	The photo shows a garden area with potted plants, a small tree, and a paved ground.
53	80.45.30.201-554.jpg	Nottingham, England, United Kingdom	Unknown	The photo is unclear.	Unknown	No	The photo is unclear and difficult to discern.
54	80.45.146.157-554.jpg	Doncaster, England, United Kingdom	Residential	The living room setting indicates a residential area.	Indoor	No	The photo shows a living room with sofas, cushions, and a large window.
55	80.189.77.214-554.jpg	Leicester, England, United Kingdom	Commercial	The nail salon setting indicates a commercial area.	Indoor	Yes	The photo shows the interior of a nail salon with clients and staff.
56	80.189.208.50-554.jpg	Matlock, England, United Kingdom	Residential	The backyard setting with garbage bins indicates a residential area.	Outdoor	No	The photo shows a backyard with garbage bins and a paved area.
57	80.192.72.254-554.jpg	Wolverhampton, England, United Kingdom	Residential	The street view with parked cars indicates a residential area.	Outdoor	No	The photo shows a street view with parked cars and a pavement.
58	80.192.121.95-554.jpg	Maidstone, England, United Kingdom	Residential	The indoor setting with a staircase indicates a residential area.	Indoor	No	The photo shows an indoor setting with a staircase and a living room area.
59	80.192.127.230-554.jpg	Cheltenham, England, United Kingdom	Residential	The car parked next to a house indicates a residential area.	Outdoor	No	The photo shows a car parked next to a house.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
60	80.195.137.23-554.jpg	Gloucester, England, United Kingdom	Residential	The backyard setting with greenery indicates a residential area.	Outdoor	No	The photo shows a backyard with greenery and a paved area.
61	80.209.182.140-554.jpg	Hemsby, England, United Kingdom	Commercial	The yard with multiple vehicles and a warehouse-like building indicates a commercial area.	Outdoor	No	The photo shows a yard with several vehicles and a warehouse-like building.
62	80.229.14.120-554.jpg	London, England, United Kingdom	Residential	The driveway with a parked car and residential bins indicates a residential area.	Outdoor	No	The photo shows a driveway with a parked car and residential garbage bins.
63	81.6.248.232-554.jpg	Cheltenham, England, United Kingdom	Residential	The narrow alleyway with residential bins indicates a residential area.	Outdoor	No	The photo shows a narrow alleyway with residential bins and a paved path.
64	81.77.26.140-554.jpg	Wakefield, England, United Kingdom	Residential	The backyard with patio furniture indicates a residential area.	Outdoor	No	The photo shows a backyard with patio furniture and a garden area.
65	81.78.246.73-554.jpg	Camden, England, United Kingdom	Unknown	The unclear image.	Unknown	No	The photo is unclear and difficult to discern details.
66	81.79.4.193-554.jpg	Newham, England, United Kingdom	Residential	The backyard with a garden and patio furniture indicates a residential area.	Outdoor	No	The photo shows a backyard with a garden, patio furniture, and some greenery.
67	81.79.44.117-554.jpg	Tower Hamlets, England, United Kingdom	Residential	The cluttered garage with various items indicates a residential area.	Indoor	No	The photo shows a cluttered garage with various items and a closed garage door.
68	81.79.104.49-554.jpg	Basingstoke, England, United Kingdom	Residential	The indoor hallway with doors indicates a residential area.	Indoor	No	The photo shows an indoor hallway with multiple doors.
69	81.97.73.28-554.jpg	Brighton, England, United Kingdom	Residential	The street view with parked cars and residential buildings indicates a residential area.	Outdoor	No	The photo shows a street view with parked cars and residential buildings.
70	81.100.89.249-10554.jpg	Dundee, Scotland, United Kingdom	Residential	The front yard with greenery and residential buildings indicates a residential area.	Outdoor	No	The photo shows a front yard with greenery and residential buildings in the background.
71	81.100.241.211-554.jpg	Middlesbrough, England, United Kingdom	Residential	The view of a ceiling or canopy indicates a residential area.	Indoor	No	The photo shows a view of what appears to be a ceiling or canopy, with little else visible.
72	81.102.203.19-554.jpg	Paisley, Scotland, United Kingdom	Commercial	The interior of a shop with displays indicates a commercial area.	Indoor	No	The photo shows the interior of a shop with displays of items and a counter.
73	81.104.156.196-554.jpg	Johnstone, Scotland, United Kingdom	Residential	The street view with a sidewalk and residential buildings indicates a residential area.	Outdoor	No	The photo shows a street view with a sidewalk, some greenery, and residential buildings in the background.
74	81.106.98.94-554.jpg	Loughborough, England, United Kingdom	Residential	The front yard with a pathway and grass indicates a residential area.	Outdoor	No	The photo shows a front yard with a pathway leading to the entrance of the house, surrounded by grass.
75	81.106.172.37-554.jpg	Stockport, England, United Kingdom	Residential	The side view of a house with a bin indicates a residential area.	Outdoor	No	The photo shows the side view of a house with a bin and some greenery.
76	81.108.37.242-554.jpg	Rumcor, England, United Kingdom	Residential	The driveway with vehicles parked indicates a residential area.	Outdoor	No	The photo shows a driveway with vehicles parked, including a van and a car.
77	81.108.55.25-554.jpg	Gateshead, England, United Kingdom	Residential	The view of a house through a window indicates a residential area.	Indoor	No	The photo shows the view of a house through a window, partially obstructed by an object inside the room.
78	81.109.53.83-554.jpg	Belfast, Northern Ireland, United Kingdom	Residential	The staircase with a coat hanging indicates a residential area.	Indoor	No	The photo shows an indoor setting with a staircase and a coat hanging on a railing.
79	81.109.247.248-554.jpg	Coventry, England, United Kingdom	Residential	The kitchen area with appliances indicates a residential area.	Indoor	No	The photo shows a kitchen area with appliances and some utensils.
80	81.111.240.71-554.jpg	Grays, England, United Kingdom	Residential	The backyard with a small soccer goal and various toys indicates a residential area.	Outdoor	No	The photo shows a backyard with a small soccer goal, various toys, and a paved area.
81	81.130.169.139-554.jpg	London, England, United Kingdom	Commercial	The presence of a counter with a "CASH ONLY PLEASE" sign, a vase with artificial flowers, and a decorative screen indicates a commercial area.	Indoor	No	The photo shows an indoor area that appears to be part of a commercial setting, such as a small shop or cafe. There is a counter with a sign that reads "CASH ONLY PLEASE". A vase with artificial flowers is placed on the counter. There is a decorative screen on the left side, and various decorative items on the walls. The lighting and decor suggest a customer-facing area in a small business.
82	81.131.247.209-554.jpg	York, England, United Kingdom	Residential	The presence of bushes, a hedge, and a car parked on a driveway suggests a residential setting.	Outdoor	No	The photo shows an outdoor area with a hedge and bushes, with a car partially visible behind the hedge. The setup suggests a residential driveway or garden area. The background is sunny with a clear sky.
83	81.132.205.118-554.jpg	Chatham, England, United Kingdom	Residential	The presence of parked cars in a driveway, and residential houses in the background indicates a residential area.	Outdoor	No	The photo shows an outdoor area with two cars parked in a driveway. There is a fence separating the driveway from the street. Residential houses are visible in the background, indicating that this is a residential area.
84	81.133.110.180-554.jpg	Tunstall, England, United Kingdom	Commercial	The presence of a gated entry, a green bin, and an industrial-looking setup indicates a commercial or industrial area.	Outdoor	No	The photo shows an outdoor area with a gated entry, a green bin, and brick walls. The setup suggests an industrial or commercial area, possibly a loading dock or service entrance. There are signs and security features visible in the background.
85	81.134.6.207-8554.jpg	Great Barton, England, United Kingdom	Commercial	The presence of a vending machine, office supplies, and an industrial setup suggests a commercial or industrial area.	Indoor	Yes	The photo shows an indoor area with a vending machine, a desk with office supplies, and an industrial setup. A person is visible in the foreground, indicating this is a working environment, likely in a commercial or industrial setting.
86	81.134.89.79-554.jpg	London, England, United Kingdom	Commercial	The presence of storage shelves, industrial lighting, and boxes suggests an industrial or commercial warehouse.	Indoor	No	The photo shows an indoor area with storage shelves, industrial lighting, and boxes. The setting indicates a warehouse or storage area, which is typically part of a commercial or industrial facility.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
87	81.134.95.123-554.jpg	London, England, United Kingdom	Commercial	The presence of a chandelier, storefront windows, and interior decor suggests a commercial area like a shop or cafe.	Indoor	No	The photo shows an indoor area with chandeliers, storefront windows, and interior decor, indicating a commercial setting such as a shop or cafe. The setup is designed to be customer-facing with decorative elements.
88	81.135.85.174-554.jpg	West Wickham, England, United Kingdom	Residential	The presence of personal items, a workbench, and a garage door suggests a residential garage or workshop.	Indoor	No	The photo shows an indoor area with personal items, a workbench, and a garage door, indicating a residential garage or workshop. The presence of tools and storage items suggests it is used for personal projects or storage.
89	81.136.52.181-554.jpg	Wolverhampton, England, United Kingdom	Residential	The presence of residential houses, a street, and parked cars indicates a residential neighborhood.	Outdoor	No	The photo shows an outdoor area with residential houses, a street, and parked cars. The setting indicates a residential neighborhood. The view captures a typical suburban street with multiple houses and vehicles parked along the road.
90	81.136.162.230-554.jpg	London, England, United Kingdom	Commercial	The presence of a parking lot, signage, and a street view suggests a commercial area, possibly near a store or office building.	Outdoor	No	The photo shows an outdoor area with a parking lot, signage, and a street view, indicating a commercial area. The setup suggests it could be near a store, office building, or other commercial establishments.
91	81.143.4.33-554.jpg	Letchworth Garden City, England, United Kingdom	Residential	The presence of vegetation, a car parked on a driveway, and residential-looking shrubs suggests a residential area.	Outdoor	No	The photo shows an outdoor area with vegetation, a car parked on a driveway, and residential-looking shrubs. The night vision effect suggests it is taken in low light conditions, typical for residential surveillance.
92	81.143.223.204-554.jpg	London, England, United Kingdom	Commercial	The presence of multiple parked cars, industrial equipment, and a concrete surface indicates a commercial or industrial area.	Outdoor	Yes	The photo shows an outdoor area with multiple parked cars, industrial equipment, and a concrete surface, suggesting a commercial or industrial parking lot. A person is visible near the vehicles.
93	81.147.105.224-554.jpg	Monmouth, Wales, United Kingdom	Residential	The narrow pathway, brick wall, and fencing suggest a residential side gate or alleyway.	Outdoor	No	The photo shows a narrow pathway with a brick wall on one side and a fence on the other, indicating a residential side gate or alleyway. The night vision effect indicates it is taken in low light conditions.
94	81.149.131.246-554.jpg	London, England, United Kingdom	Residential	The presence of potted plants, a window, and interior decor suggests a residential indoor area.	Indoor	No	The photo shows an indoor area with potted plants, a window, and interior decor. The night vision effect suggests it is taken in low light conditions, indicating a residential setting, possibly a conservatory or indoor garden.
95	81.151.81.153-554.jpg	Borehamwood, England, United Kingdom	Residential	The presence of trees and a pathway in a dark outdoor setting suggests a residential garden or outdoor area.	Outdoor	No	The photo shows a dark outdoor area with trees and a pathway, indicating a residential garden or outdoor space. The low light conditions suggest it is taken at night.
96	81.151.83.9-554.jpg	Harringay, England, United Kingdom	Residential	The presence of a sofa, cushions, and indoor furnishings suggests a residential living room.	Indoor	No	The photo shows an indoor area with a sofa, cushions, and indoor furnishings, indicating a residential living room. The night vision effect suggests it is taken in low light conditions.
97	81.154.35.236-554.jpg	Shenley Church End, England, United Kingdom	Unknown	The image is too dark to determine the setting.	Unknown	No	The photo is very dark, making it difficult to determine the setting or any details.
98	81.154.205.171-554.jpg	Banbury, England, United Kingdom	Residential	The presence of a TV, furniture, and home decor suggests a residential living room.	Indoor	No	The photo shows an indoor area with a TV, furniture, and home decor, indicating a residential living room. The night vision effect suggests it is taken in low light conditions.
99	81.155.200.240-554.jpg	Eastbourne, England, United Kingdom	Residential	The presence of a curtain, window, and interior items suggests a residential indoor setting.	Indoor	No	The photo shows an indoor area with a curtain, window, and interior items. The low light conditions suggest it is taken in a residential setting, possibly a living room or bedroom.
100	81.159.42.219-554.jpg	Southampton, England, United Kingdom	Commercial	The presence of a storefront, seating, and customer-facing area suggests a commercial setting, such as a shop or cafe.	Indoor	No	The photo shows an indoor area with a storefront, seating, and a customer-facing area, indicating a commercial setting such as a shop or cafe. The setup is designed to welcome customers with seating arrangements and a clear view of the outside.
101	81.159.102.218-554.jpg	Hyde, England, United Kingdom	Residential	The presence of a parked car in a narrow space next to a fence suggests a residential garage or driveway.	Outdoor	No	The photo shows a parked car in a narrow space next to a fence, indicating a residential garage or driveway. The night vision effect suggests it is taken in low light conditions.
102	81.168.1.187-554.jpg	Aldeburgh, England, United Kingdom	Residential	The presence of a driveway with a garbage bin and overgrown vegetation suggests a residential setting.	Outdoor	No	The photo shows a driveway with a garbage bin and overgrown vegetation, indicating a residential setting. The night vision effect suggests it is taken in low light conditions.
103	81.174.133.18-554.jpg	London, England, United Kingdom	Commercial	The photo shows a cityscape at night, indicating a commercial or urban area.	Outdoor	No	The photo shows a cityscape at night, with lights from buildings and streets visible, indicating a commercial or urban area.
104	82.1.25.10-554.jpg	Leicester, England, United Kingdom	Residential	The presence of indoor furniture and children's toys suggests a residential living room.	Indoor	No	The photo shows an indoor area with furniture and children's toys, indicating a residential living room. The setup suggests a comfortable living space.
105	82.1.155.152-554.jpg	Burton-on-Trent, England, United Kingdom	Residential	The presence of a car parked next to a house and vegetation suggests a residential driveway.	Outdoor	No	The photo shows a car parked next to a house with vegetation around, indicating a residential driveway.
106	82.3.79.33-554.jpg	Woking, England, United Kingdom	Residential	The presence of a bench, garden hose, and residential-looking brick wall suggests a residential backyard or patio.	Outdoor	No	The photo shows a bench, garden hose, and a brick wall, indicating a residential backyard or patio. The setup suggests a private outdoor space.
107	82.6.162.126-554.jpg	Waterlooville, England, United Kingdom	Unknown	The image is too blurry to determine the setting.	Unknown	No	The photo is blurry, making it difficult to determine the setting or any details.
108	82.11.214.202-554.jpg	Nottingham, England, United Kingdom	Residential	The presence of vertical blinds and an outdoor view suggests a residential window setting.	Indoor	No	The photo shows vertical blinds with an outdoor view, indicating a residential window setting. The view through the blinds suggests a typical residential area.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
109	82.15.132.30-554.jpg	Newton Abbot, England, United Kingdom	Residential	The presence of a car parked in a garage with various household items suggests a residential garage.	Indoor	No	The photo shows a car parked in a garage with various household items, indicating a residential garage. The night vision effect suggests it is taken in low light conditions.
110	82.17.120.216-554.jpg	Derby, England, United Kingdom	Residential	The presence of blinds and a reflection of indoor items suggests a residential window setting.	Indoor	No	The photo shows blinds with a reflection of indoor items, indicating a residential window setting. The night vision effect suggests it is taken in low light conditions.
111	82.28.58.178-554.jpg	Norwich, England, United Kingdom	Residential	The presence of various household items, bikes, and storage in a tight space suggests a residential garage or storage area.	Indoor	No	The photo shows a residential garage or storage area filled with various household items, including bikes and storage boxes. The setup suggests a personal storage space.
112	82.30.23.249-554.jpg	Ipswich, England, United Kingdom	Residential	The presence of an indoor staircase with personal items such as a hanging light fixture and wall decor suggests a residential home.	Indoor	No	The photo shows an indoor staircase with a hanging light fixture and wall decor, indicating a residential home. The night vision effect suggests it is taken in low light conditions.
113	82.30.203.244-554.jpg	Harrogate, England, United Kingdom	Unknown	The image is too blurry to determine the setting.	Unknown	No	The photo is blurry, making it difficult to determine the setting or any details.
114	82.34.163.129-554.jpg	Dudley, England, United Kingdom	Residential	The presence of a small outdoor area with bricks and a fence suggests a residential backyard.	Outdoor	No	The photo shows a small outdoor area with bricks and a fence, indicating a residential backyard. The setup suggests a private outdoor space.
115	82.34.246.231-554.jpg	Falkirk, Scotland, United Kingdom	Residential	The presence of cars parked next to a house and vegetation suggests a residential driveway.	Outdoor	No	The photo shows cars parked next to a house with vegetation around, indicating a residential driveway.
116	82.39.67.84-554.jpg	Birmingham, England, United Kingdom	Residential	The presence of a backyard garden with a fence and sheds suggests a residential area.	Outdoor	No	The photo shows a backyard garden with a fence and sheds, indicating a residential area. The setup suggests a private outdoor space with storage sheds.
117	82.41.174.213-554.jpg	Telford, England, United Kingdom	Residential	The presence of a gated outdoor area with patio furniture suggests a residential garden or backyard.	Outdoor	No	The photo shows a gated outdoor area with patio furniture, indicating a residential garden or backyard. The night vision effect suggests it is taken in low light conditions.
118	82.44.120.26-554.jpg	Hayes, England, United Kingdom	Unknown	The image shows a ceiling with a fixture, making it difficult to determine the setting.	Unknown	No	The photo shows a ceiling with a fixture, making it difficult to determine the setting.
119	82.69.53.112-10554.jpg	London, England, United Kingdom	Residential	The presence of a chicken coop and outdoor furniture suggests a residential backyard or garden.	Outdoor	No	The photo shows a residential backyard or garden with a chicken coop and outdoor furniture. The night vision effect suggests it is taken in low light conditions.
120	82.163.155.128-554.jpg	Towcester, England, United Kingdom	Residential	The presence of an indoor staircase with white walls and a modern design suggests a residential home.	Indoor	No	The photo shows an indoor staircase with white walls and a modern design, indicating a residential home. The setup suggests a comfortable living space.
121	84.9.115.227-554.jpg	Accrington, England, United Kingdom	Commercial	The presence of a bar area with stools and a setup for patrons suggests a commercial setting, such as a bar or restaurant.	Indoor	No	The photo shows an indoor area with a bar counter, stools, and a setup for patrons, indicating a commercial setting such as a bar or restaurant. The chairs are stacked on tables, suggesting it might be after hours or closed.
122	84.9.137.161-554.jpg	London, England, United Kingdom	Commercial	The presence of a well-stocked bar area with taps, glasses, and a cash register indicates a commercial setting, such as a bar.	Indoor	No	The photo shows an indoor area with a well-stocked bar, including taps, glasses, and a cash register, indicating a commercial setting such as a bar. The clean and organized setup suggests a professional environment.
123	84.65.47.234-554.jpg	Reading, England, United Kingdom	Residential	The presence of a hallway with coats hanging and personal items suggests a residential home.	Indoor	No	The photo shows an indoor hallway with coats hanging and personal items, indicating a residential home. The night vision effect suggests it is taken in low light conditions.
124	84.66.90.21-554.jpg	Birmingham, England, United Kingdom	Unknown	The image shows the underside of a roof or attic, making it difficult to determine the setting.	Unknown	No	The photo shows the underside of a roof or attic with wooden beams, making it difficult to determine the setting. The night vision effect suggests it is taken in low light conditions.
125	84.67.61.149-554.jpg	Aylesbury, England, United Kingdom	Residential	The presence of a well-maintained garden with flowers and a house in the background suggests a residential area.	Outdoor	No	The photo shows a well-maintained garden with flowers and a house in the background, indicating a residential area. The setup suggests a private outdoor space with landscaping.
126	84.67.71.250-554.jpg	Greenwich, England, United Kingdom	Residential	The presence of a ceiling with a fan and indoor decor suggests a residential living room.	Indoor	No	The photo shows an indoor ceiling with a fan and indoor decor, indicating a residential living room. The setup suggests a comfortable living space.
127	84.67.206.87-554.jpg	Eversley, England, United Kingdom	Unknown	The image shows an attic or crawl space with insulation, making it difficult to determine the setting.	Unknown	No	The photo shows an attic or crawl space with insulation, making it difficult to determine the setting. The night vision effect suggests it is taken in low light conditions.
128	84.68.118.90-554.jpg	Greenwich, England, United Kingdom	Unknown	The image is too bright to determine the setting.	Unknown	No	The photo is too bright, making it difficult to determine the setting or any details.
129	84.68.158.110-554.jpg	Newham, England, United Kingdom	Unknown	The image shows an outdoor view with trees, making it difficult to determine the setting.	Unknown	No	The photo shows an outdoor view with trees, making it difficult to determine the setting or any specific details.
130	84.68.233.167-554.jpg	Glasgow, Scotland, United Kingdom	Residential	The presence of a wooden deck with a mat and outdoor furniture suggests a residential backyard or patio.	Outdoor	No	The photo shows a wooden deck with a mat and outdoor furniture, indicating a residential backyard or patio. The night vision effect suggests it is taken in low light conditions.
131	84.69.114.17-554.jpg	Birmingham, England, United Kingdom	Residential	The presence of a large grassy area with multiple vehicles and a garage suggests a residential property.	Outdoor	No	The photo shows a large grassy area with multiple vehicles and a garage, indicating a residential property. The setup suggests a spacious residential yard.
132	84.69.140.248-554.jpg	Paisley, Scotland, United Kingdom	Residential	The presence of a well-maintained garden with various plants and seating areas suggests a residential backyard.	Outdoor	No	The photo shows a well-maintained garden with various plants and seating areas, indicating a residential backyard. The setup suggests a private outdoor space.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
133	86.4.201.68-554.jpg	Nottingham, England, United Kingdom	Residential	The presence of a garbage bins next to a brick wall suggests a residential side entrance or alley.	Outdoor	No	The photo shows garbage bins next to a brick wall, indicating a residential side entrance or alley. The setup suggests a typical residential waste disposal area.
134	86.5.48.21-554.jpg	Stockport, England, United Kingdom	Residential	The presence of a driveway with a parked car next to a house suggests a residential property.	Outdoor	No	The photo shows a driveway with a parked car next to a house, indicating a residential property. The setup suggests a typical residential parking area.
135	86.5.176.30-554.jpg	Lincoln, England, United Kingdom	Unknown	The image is completely dark, making it impossible to determine the setting.	Unknown	No	The photo is completely dark, making it impossible to determine the setting or any details.
136	86.7.223.98-554.jpg	Middlesbrough, England, United Kingdom	Residential	The presence of a hedge, gravel pathway, and a trash bin suggests a residential front yard or garden.	Outdoor	No	The photo shows a hedge, gravel pathway, and a trash bin, indicating a residential front yard or garden. The setup suggests a well-maintained residential outdoor space.
137	86.8.244.227-554.jpg	Bristol, England, United Kingdom	Residential	The presence of a motorcycle and various tools in a garage suggests a residential setting.	Indoor	No	The photo shows a motorcycle and various tools in a garage, indicating a residential setting. The night vision effect suggests it is taken in low light conditions.
138	86.10.220.161-10554.jpg	Ellesmere Port, England, United Kingdom	Residential	The presence of a brick wall and potted plants suggests a residential property.	Outdoor	No	The photo shows a brick wall and potted plants, indicating a residential property. The setup suggests a well-maintained residential outdoor space.
139	86.11.136.57-554.jpg	Peterborough, England, United Kingdom	Residential	The presence of a small indoor room with personal items suggests a residential home.	Indoor	No	The photo shows a small indoor room with personal items, indicating a residential home. The setup suggests a comfortable living space.
140	86.13.128.224-554.jpg	Bolton, England, United Kingdom	Residential	The presence of a garden view from inside a house suggests a residential property.	Indoor	No	The photo shows a garden view from inside a house, indicating a residential property. The setup suggests a well-maintained residential garden and indoor living space.
141	86.14.181.245-554.jpg	Waltham Forest, England, United Kingdom	Unknown	The image is completely black, making it impossible to determine the setting.	Unknown	No	The photo is entirely black, with no visible features to describe or determine the setting.
142	86.16.1.233-10554.jpg	Greenwich, England, United Kingdom	Residential	The presence of a tiled patio and garden area suggests a residential setting.	Outdoor	No	The photo shows an outdoor area with a tiled patio and garden. There are plants and grass visible, indicating a residential backyard or garden.
143	86.18.131.126-554.jpg	Reading, England, United Kingdom	Residential	The presence of a children's play area, laundry drying, and garden furniture suggests a residential backyard.	Outdoor	No	The photo shows a residential backyard with a children's play area, laundry drying on a line, and garden furniture. The overall setup suggests a family home.
144	86.19.142.5-554.jpg	Darlington, England, United Kingdom	Residential	The presence of parked cars in a driveway and residential houses indicates a residential area.	Outdoor	No	The photo shows an outdoor area with parked cars in a driveway and residential houses visible along the street. The setup indicates a typical residential neighborhood.
145	86.19.251.144-554.jpg	Kirkby in Ashfield, England, United Kingdom	Residential	The presence of residential houses, a street, and parked cars indicates a residential neighborhood.	Outdoor	No	The photo shows an outdoor area with residential houses, a street, and parked cars. The night vision effect suggests it is taken in low light conditions, typical for residential surveillance.
146	86.20.205.27-554.jpg	Salford, England, United Kingdom	Residential	The presence of a garden area with plants and night vision effect suggests a residential setting.	Outdoor	No	The photo shows a garden area with plants, captured in night vision. The setup indicates a residential backyard or garden area.
147	86.21.54.79-554.jpg	Basildon, England, United Kingdom	Unknown	The image has heavy visual distortion, making it impossible to determine the setting.	Unknown	No	The photo is heavily distorted with vertical lines, making it difficult to identify any features or determine the setting.
148	86.21.66.132-554.jpg	Dagenham, England, United Kingdom	Residential	The presence of a driveway, parked car, and residential houses suggests a residential neighborhood.	Outdoor	No	The photo shows a residential driveway with a parked car and houses visible in the background. The setup indicates a typical suburban residential area.
149	86.21.241.221-554.jpg	Bangor, Northern Ireland, United Kingdom	Residential	The presence of a porch, parked car, and residential street suggests a residential setting.	Outdoor	No	The photo shows a residential porch area with a parked car and a street visible in the background. The setup suggests a suburban residential area.
150	86.22.131.237-554.jpg	March, England, United Kingdom	Residential	The presence of an indoor area with windows looking out into a backyard suggests a residential setting.	Indoor	No	The photo shows an indoor area with large windows looking out into a backyard. There are garden items and a patio visible outside, indicating a residential setting.
151	86.23.237.53-554.jpg	Portsmouth, England, United Kingdom	Residential	The presence of a backyard with garden sheds and fences suggests a residential setting.	Outdoor	No	The photo shows a backyard with garden sheds and fences, indicating a residential setting. The presence of a tree and garden decorations further supports this.
152	86.24.222.144-554.jpg	Bracknell, England, United Kingdom	Residential	The presence of a living room with a TV and household furniture suggests a residential setting.	Indoor	No	The photo shows a living room with a TV, household furniture, and personal items, indicating a residential setting. The setup suggests a family home.
153	86.25.119.249-554.jpg	Swindon, England, United Kingdom	Residential	The presence of a driveway with parked cars and residential houses in the background suggests a residential area.	Outdoor	No	The photo shows a driveway with parked cars and residential houses in the background, indicating a residential area. The setup suggests a suburban neighborhood.
154	86.26.9.11-554.jpg	Huddersfield, England, United Kingdom	Residential	The presence of a front yard with plants and a fence suggests a residential setting.	Outdoor	No	The photo shows a front yard with plants and a fence, indicating a residential setting. The setup suggests a suburban residential area.
155	86.26.39.40-554.jpg	Cambridge, England, United Kingdom	Residential	The presence of a kitchen with home appliances and personal items suggests a residential area.	Indoor	No	The photo shows a kitchen with home appliances and personal items, indicating a residential setting. The presence of utensils, dishes, and other household items further supports this.
156	86.29.112.129-554.jpg	Market Harborough, England, United Kingdom	Residential	The presence of a backyard with garden furniture and decorations suggests a residential area.	Outdoor	No	The photo shows a backyard with garden furniture and decorations, indicating a residential area. The setup suggests a family home.
157	86.29.173.63-554.jpg	Mansfield, England, United Kingdom	Residential	The presence of a backyard with garden sheds and fences suggests a residential setting.	Outdoor	No	The photo shows a backyard with garden sheds and fences, indicating a residential setting. The presence of a tree and garden decorations further supports this.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
158	86.29.188.103-554.jpg	Mansfield, England, United Kingdom	Residential	The presence of a driveway with parked cars and residential houses in the background suggests a residential area.	Outdoor	No	The photo shows a driveway with parked cars and residential houses in the background, indicating a residential area. The setup suggests a suburban neighborhood.
159	86.30.215.89-554.jpg	Poole, England, United Kingdom	Residential	The presence of a front yard with plants and a fence suggests a residential setting.	Outdoor	No	The photo shows a front yard with plants and a fence, indicating a residential setting. The setup suggests a suburban residential area.
160	86.30.236.63-554.jpg	Dagenham, England, United Kingdom	Residential	The presence of a porch with household items and a view of the residential street suggests a residential setting.	Outdoor	No	The photo shows a porch with household items and a view of a residential street. The setup indicates a suburban residential area.
161	86.130.124.116-554.jpg	Sheffield, England, United Kingdom	Residential	The presence of a backyard with a paved patio and plants suggests a residential setting.	Outdoor	No	The photo shows a backyard with a paved patio and plants, indicating a residential setting. The caption "I can see you." is visible at the top of the image.
162	86.130.237.191-554.jpg	Bedford, England, United Kingdom	Residential	The presence of a driveway with a parked car and bins suggests a residential area.	Outdoor	No	The photo shows a driveway with a parked car and bins, indicating a residential area. The night vision effect suggests it is taken in low light conditions.
163	86.132.4.168-554.jpg	Saffron Walden, England, United Kingdom	Residential	The presence of a driveway and a residential street in the background suggests a residential setting.	Outdoor	No	The photo shows a driveway with a parked car and a residential street in the background, indicating a residential area.
164	86.135.65.8-554.jpg	Purley, England, United Kingdom	Commercial	The presence of a cashier counter with products and displays suggests a commercial setting.	Indoor	No	The photo shows a cashier counter with products and displays, indicating a commercial setting, likely a small retail store.
165	86.138.49.229-554.jpg	Manchester, England, United Kingdom	Residential	The presence of a kitchen with home appliances and personal items suggests a residential area.	Indoor	No	The photo shows a kitchen with home appliances and personal items, indicating a residential setting. The presence of utensils, dishes, and other household items further supports this.
166	86.140.48.70-554.jpg	Berkhamsted, England, United Kingdom	Residential	The presence of a front yard with a bike and garden items suggests a residential area.	Outdoor	No	The photo shows a front yard with a bike and garden items, indicating a residential setting. The night vision effect suggests it is taken in low light conditions.
167	86.140.50.104-554.jpg	Newham, England, United Kingdom	Residential	The presence of parked cars on a residential street suggests a residential setting.	Outdoor	No	The photo shows parked cars on a residential street, indicating a residential area.
168	86.141.110.128-554.jpg	Kirkwall, Scotland, United Kingdom	Residential	The presence of open fields and a few houses suggests a rural residential area.	Outdoor	No	The photo shows open fields with a few houses in the distance, indicating a rural residential area.
169	86.142.68.48-554.jpg	Chester, England, United Kingdom	Residential	The presence of a kitchen with home appliances and personal items suggests a residential area.	Indoor	No	The photo shows a kitchen with home appliances and personal items, indicating a residential setting. The presence of utensils, dishes, and other household items further supports this.
170	86.142.72.237-554.jpg	Luton, England, United Kingdom	Residential	The presence of a ceiling with a residential light fixture suggests an indoor residential area.	Indoor	No	The photo shows a ceiling with a residential light fixture, indicating an indoor residential setting.
171	86.142.135.163-554.jpg	Hook, England, United Kingdom	Residential	The presence of a residential door, a brick wall, and an outdoor pathway indicates a residential area.	Outdoor	No	The photo shows an outdoor area with a residential door, a brick wall, and an outdoor pathway. The setting suggests a residential area.
172	86.144.255.66-554.jpg	Coleraine, Northern Ireland, United Kingdom	Residential	The presence of residential houses and rooftops viewed from a window suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a view of residential houses and rooftops, viewed from a window. The setup indicates a residential area.
173	86.146.178.102-10554.jpg	Huddersfield, England, United Kingdom	Residential	The presence of vegetation and a garden area viewed at night suggests a residential garden.	Outdoor	No	The photo shows an outdoor area with vegetation and a garden area, viewed at night with a night vision camera. The setting indicates a residential garden.
174	86.153.44.112-554.jpg	Lymington, England, United Kingdom	Residential	The presence of a car parked in a driveway and residential vegetation indicates a residential area.	Outdoor	No	The photo shows an outdoor area with a car parked in a driveway and residential vegetation. The setting suggests a residential area.
175	86.156.234.253-554.jpg	Fareham, England, United Kingdom	Residential	The presence of a road, greenery, and a residential-looking pathway suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a road, greenery, and a residential-looking pathway. The setting indicates a residential area.
176	86.156.247.23-554.jpg	Prescot, England, United Kingdom	Unknown	The image is blurry and unclear, making it difficult to determine the setting.	Unknown	No	The photo is blurry and unclear, making it difficult to determine the setting or any details.
177	86.157.192.13-554.jpg	Greenwich, England, United Kingdom	Residential	The presence of parked cars in a residential driveway indicates a residential area.	Outdoor	No	The photo shows an outdoor area with parked cars in a residential driveway, indicating a residential area.
178	86.157.218.244-554.jpg	Havant, England, United Kingdom	Commercial	The presence of office furniture and computer equipment suggests a commercial office space.	Indoor	No	The photo shows an indoor area with office furniture and computer equipment, suggesting a commercial office space.
179	86.160.68.189-554.jpg	Great Dunmow, England, United Kingdom	Residential	The presence of indoor residential furnishings and decor indicates a residential living space.	Indoor	No	The photo shows an indoor area with residential furnishings and decor, indicating a residential living space.
180	86.160.130.253-554.jpg	Uttoxeter, England, United Kingdom	Unknown	The image is too dark to determine the setting.	Unknown	No	The photo is very dark, making it difficult to determine the setting or any details.
181	86.164.194.243-554.jpg	Dagenham, England, United Kingdom	Residential	The presence of parked cars in a driveway and a person walking indicates a residential area.	Outdoor	Yes	The photo shows an outdoor area with parked cars in a driveway and a person walking. The setting suggests a residential area.
182	86.165.89.62-554.jpg	Manchester, England, United Kingdom	Commercial	The presence of a street, sidewalks, and commercial buildings indicates a commercial area.	Outdoor	No	The photo shows an outdoor area with a street, sidewalks, and commercial buildings. The setting suggests a commercial area.
183	86.168.107.226-554.jpg	Clydebank, Scotland, United Kingdom	Residential	The presence of residential rooftops and trees indicates a residential neighborhood.	Outdoor	No	The photo shows an outdoor area with residential rooftops and trees, indicating a residential neighborhood.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
184	86.169.72.234-554.jpg	Bury, England, United Kingdom	Unknown	The image is too unclear to determine the setting.	Unknown	No	The photo is very unclear, making it difficult to determine the setting or any details.
185	86.170.186.180-554.jpg	Crewe, England, United Kingdom	Residential	The presence of a car parked in a driveway and residential greenery suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a car parked in a driveway and residential greenery. The setting suggests a residential area.
186	86.172.120.58-554.jpg	Leeds, England, United Kingdom	Residential	The presence of indoor residential furnishings such as a radiator and a wooden floor suggests a residential area.	Indoor	No	The photo shows an indoor area with residential furnishings such as a radiator and a wooden floor, indicating a residential area.
187	86.172.173.243-554.jpg	Bedford, England, United Kingdom	Residential	The presence of a kitchen with household items and a teddy bear indicates a residential area.	Indoor	No	The photo shows an indoor area with a kitchen, household items, and a teddy bear, indicating a residential area.
188	86.174.91.105-554.jpg	Fulham, England, United Kingdom	Unknown	The image shows window blinds in low light, making it difficult to determine the setting.	Unknown	No	The photo shows window blinds in low light, making it difficult to determine the setting.
189	86.174.213.131-554.jpg	Market Harborough, England, United Kingdom	Residential	The presence of plants growing indoors with specialized equipment suggests a residential indoor garden.	Indoor	No	The photo shows an indoor area with plants growing using specialized equipment, indicating a residential indoor garden.
190	86.174.220.93-554.jpg	Lockerbie, Scotland, United Kingdom	Residential	The presence of outdoor furniture, a garden shed, and greenery indicates a residential backyard.	Outdoor	No	The photo shows an outdoor area with furniture, a garden shed, and greenery, suggesting a residential backyard.
191	86.177.57.63-10554.jpg	Huddersfield, England, United Kingdom	Residential	The presence of a well-manicured garden with flowers and greenery suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a well-manicured garden, flowers, and greenery, indicating a residential setting.
192	86.178.37.86-554.jpg	Harringay, England, United Kingdom	Commercial	The presence of a warehouse-like environment with industrial equipment suggests a commercial area.	Indoor	No	The photo shows an indoor area with a warehouse-like environment and industrial equipment, indicating a commercial setting.
193	86.178.207.161-554.jpg	Tonypre, Wales, United Kingdom	Residential	The presence of residential houses and a neighborhood street suggests a residential area.	Outdoor	No	The photo shows an outdoor area with residential houses and a neighborhood street, indicating a residential setting.
194	86.178.241.127-554.jpg	Ossett, England, United Kingdom	Residential	The presence of bikes, a ladder, and residential greenery suggests a residential front yard.	Outdoor	No	The photo shows an outdoor area with bikes, a ladder, and residential greenery, indicating a residential front yard.
195	86.180.248.152-554.jpg	Woodbridge, England, United Kingdom	Residential	The presence of a backyard with a small building and a garden suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a backyard, a small building, and a garden, indicating a residential setting.
196	86.181.24.88-10554.jpg	Salford, England, United Kingdom	Residential	The presence of indoor furnishings like a radiator and wooden floor suggests a residential area.	Indoor	No	The photo shows an indoor area with furnishings like a radiator and wooden floor, indicating a residential setting.
197	86.181.117.253-554.jpg	Alloa, Scotland, United Kingdom	Residential	The presence of a cozy indoor area with a bed, teddy bear, and kitchen setup suggests a residential area.	Indoor	No	The photo shows an indoor area with a bed, teddy bear, and kitchen setup, indicating a residential setting.
198	86.183.152.240-554.jpg	Haverhill, England, United Kingdom	Unknown	The image shows window blinds in low light, making it difficult to determine the setting.	Unknown	No	The photo shows window blinds in low light, making it difficult to determine the setting.
199	86.185.54.93-554.jpg	Wells, England, United Kingdom	Residential	The presence of indoor plants and specialized equipment suggests a residential indoor garden.	Indoor	No	The photo shows an indoor area with plants growing using specialized equipment, indicating a residential indoor garden.
200	86.185.124.23-554.jpg	Prescot, England, United Kingdom	Residential	The presence of a well-maintained backyard with a garden shed and outdoor furniture suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a well-maintained backyard, garden shed, and outdoor furniture, indicating a residential setting.
201	86.186.146.28-554.jpg	Ashbourne, England, United Kingdom	Residential	The presence of a garden with various plants and a residential fence suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a garden, various plants, and a residential fence, indicating a residential setting.
202	86.189.202.113-554.jpg	Coalville, England, United Kingdom	Unknown	The image is very dark, making it difficult to determine the setting.	Unknown	No	The photo is very dark, making it difficult to determine the setting or any details.
203	86.191.36.111-554.jpg	Rotherham, England, United Kingdom	Residential	The presence of indoor furniture and a dimly lit room suggests a residential area.	Indoor	No	The photo shows an indoor area with furniture and dim lighting, indicating a residential setting.
204	87.74.221.187-554.jpg	Childwickham, England, United Kingdom	Residential	The presence of parked cars in a driveway and residential houses suggests a residential area.	Outdoor	No	The photo shows an outdoor area with parked cars in a driveway and residential houses, indicating a residential setting.
205	88.97.16.42-554.jpg	London, England, United Kingdom	Residential	The presence of a well-maintained front yard with a tree and parked cars suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a well-maintained front yard, a tree, and parked cars, indicating a residential setting.
206	89.168.155.230-554.jpg	Luton, England, United Kingdom	Residential	The presence of a garden with various plants and a residential fence suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a garden, various plants, and a residential fence, indicating a residential setting.
207	89.240.12.85-554.jpg	London, England, United Kingdom	Residential	The presence of a well-maintained golf course suggests a recreational residential area.	Outdoor	No	The photo shows an outdoor area with a well-maintained golf course, indicating a recreational residential setting.
208	89.241.111.89-554.jpg	Worthing, England, United Kingdom	Residential	The presence of a well-maintained front yard with a tree and residential houses suggests a residential area.	Outdoor	No	The photo shows an outdoor area with a well-maintained front yard, a tree, and residential houses, indicating a residential setting.
209	90.197.156.221-554.jpg	Birmingham, England, United Kingdom	Residential	The presence of people in a bedroom setting suggests a residential area.	Indoor	Yes	The photo shows an indoor area with people in a bedroom setting, indicating a residential setting.
210	90.200.40.221-554.jpg	Salford, England, United Kingdom	Residential	The presence of a bird nesting in a box suggests a residential or natural area.	Indoor	No	The photo shows an indoor area with a bird nesting in a box, indicating a residential or natural setting.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
211	90.221.213.208-554.jpg	Sheffield, England, United Kingdom	Residential	The presence of a front garden, multiple cars parked, and a rural setting suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a small front garden and several cars parked along a driveway. The garden has a lawn, a pathway, and some bushes or trees. There is a road and more greenery in the background, suggesting a rural or suburban setting.
212	90.240.86.17-554.jpg	Glasgow, Scotland, United Kingdom	Unknown	The image is too dark and focused on bright lights, making it difficult to determine the setting.	Unknown	No	The photo is a dark image with bright lights arranged in a circular pattern, possibly a ceiling light fixture. The surrounding area is not visible.
213	90.243.4.77-554.jpg	Harrow, England, United Kingdom	Residential	The indoor setting with a welcome mat and typical home flooring indicates a residential area.	Indoor	No	The photo shows an indoor area, specifically a small hallway or entrance with a welcome mat and typical home flooring. The walls are light-colored, and there is a door with frosted glass panels.
214	90.243.62.225-554.jpg	Barnet, England, United Kingdom	Commercial	The parking lot with marked spaces for specific permits suggests a commercial area.	Outdoor	No	The photo shows a parking lot with marked spaces for specific permits. There are several cars parked, and the background shows a building, likely a commercial or institutional facility.
215	90.249.53.29-10554.jpg	Bolton, England, United Kingdom	Residential	The presence of a driveway, cars parked, and a night-time setting in a residential neighborhood suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area at night, with a driveway and cars parked along the street. The image is in black and white, indicating night vision from a security camera.
216	90.250.10.85-554.jpg	Milton Keynes, England, United Kingdom	Residential	The presence of a driveway, outdoor space, and residential street suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a driveway and a patio. The area is well-maintained with a wooden fence and some plants. There is a street in the background.
217	90.255.233.93-554.jpg	Islington, England, United Kingdom	Residential	The presence of a driveway, car parked, and residential street suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a car parked on a driveway. The area is well-maintained, with a wooden fence and some plants. There is a street in the background.
218	91.102.60.190-554.jpg	Bletchley, England, United Kingdom	Residential	The night-time setting with hedges and a car parked suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area at night, with hedges and a car partially visible. The image is in black and white, indicating night vision from a security camera.
219	91.110.173.244-554.jpg	Bishop Auckland, England, United Kingdom	Residential	The presence of a driveway, cars parked, and a residential street suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area at night, with a car parked on the street. The image is in black and white, indicating night vision from a security camera.
220	92.7.19.218-554.jpg	Lancaster, England, United Kingdom	Residential	The presence of a car parked on a driveway and a residential street suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a car parked on the driveway. The area is well-maintained, with a street in the background.
221	92.7.65.73-554.jpg	Manchester, England, United Kingdom	Residential	The photo shows an entrance area with a welcome mat, suggesting it is part of a residential setting.	Indoor	No	The photo shows a small indoor entrance area with a tiled floor and a welcome mat. There is a table with some items on it and a door leading outside.
222	92.9.231.127-554.jpg	Witham, England, United Kingdom	Residential	The image shows a dark interior corner with part of a wall and ceiling, indicating an indoor residential setting.	Indoor	No	The photo shows a dark corner of an indoor area, with part of a wall and ceiling visible. The details are minimal due to the darkness.
223	92.10.0.225-554.jpg	York, England, United Kingdom	Residential	The photo shows a garden with plants and a small pond, suggesting a residential outdoor setting.	Outdoor	No	The photo shows a residential garden with various plants, a small pond, and a bird bath. The area is well-maintained and appears to be part of a backyard.
224	92.12.208.231-554.jpg	Newport, Wales, United Kingdom	Residential	The photo shows a garden at night, with a wooden fence and plants, indicating a residential outdoor setting.	Outdoor	No	The photo shows a residential garden at night, with a wooden fence, some plants, and garden decorations visible in the dark. The image is in black and white, indicating night vision from a security camera.
225	92.13.76.150-554.jpg	Oldham, England, United Kingdom	Residential	The indoor area with laundry items and personal belongings suggests a residential setting.	Indoor	No	The photo shows an indoor area with a drying rack and some laundry items. The space appears to be part of a home, with tiled flooring and various household items.
226	92.14.6.98-554.jpg	Luton, England, United Kingdom	Residential	The photo shows a well-maintained garden with a flower bed, gravel paths, and adjacent houses, suggesting a residential area.	Outdoor	No	The photo shows a residential garden area with a brick building on the right, a raised flower bed in the center, gravel ground, wooden fence, shrubs and bushes in the background, and another building on the left. The yard has gravel pathways with stepping stones.
227	92.22.59.181-554.jpg	Norwich, England, United Kingdom	Residential	The indoor setting with furniture and a fireplace suggests a residential living room.	Indoor	No	The photo shows an indoor area, specifically a living room with a sofa, a fireplace, and various furniture items. The room is well-lit and appears to be part of a home.
228	92.27.143.102-554.jpg	Islington, England, United Kingdom	Unknown	The image is very dark and does not provide enough context to determine the setting.	Unknown	No	The photo is very dark, showing minimal details, making it difficult to determine the setting.
229	92.232.100.232-554.jpg	Rotherham, England, United Kingdom	Residential	The presence of a front garden, car parked, and a suburban street suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a front garden, a car parked in the driveway, and a suburban street. The area is well-maintained with a lawn and some bushes.
230	92.236.201.130-554.jpg	Sheffield, England, United Kingdom	Residential	The view through a window shows parked cars and houses, indicating a residential neighborhood.	Outdoor	No	The photo shows a view through a window of a residential street with parked cars and houses. The area appears to be a suburban neighborhood with well-maintained gardens.
231	94.4.96.224-554.jpg	Boldon Colliery, England, United Kingdom	Residential	The presence of trash bins and a residential driveway suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with trash bins placed near a driveway. The driveway is paved with bricks, and there is a grassy area adjacent to it.
232	94.174.80.189-10554.jpg	Wolverhampton, England, United Kingdom	Residential	The photo shows a narrow entrance hallway with typical home decor and personal items, indicating a residential area.	Indoor	No	The photo shows a small indoor area, possibly an entrance hallway, with typical home decor and some personal items. The walls are light-colored, and there is a door leading outside.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
233	94.195.205.232-554.jpg	Gateshead, England, United Kingdom	Residential	The presence of a fenced backyard and a park bench suggests a residential setting.	Outdoor	No	The photo shows a residential backyard with a fenced area and a park bench in the background. The grass is well-maintained, and there is a path leading to the bench.
234	109.147.97.17-554.jpg	Ossett, England, United Kingdom	Residential	The driveway with a parked car and adjacent houses suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a driveway and a car parked on it. There are adjacent houses visible in the background, suggesting a suburban neighborhood.
235	109.147.181.209-554.jpg	Boston, England, United Kingdom	Residential	The large front yard and driveway indicate a residential setting.	Outdoor	No	The photo shows a residential outdoor area with a large front yard and a driveway. The yard is well-maintained with grass and some bushes.
236	109.150.61.66-554.jpg	Braintree, England, United Kingdom	Residential	The presence of a driveway and paved area suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a paved driveway. The area is well-maintained, with a small grassy patch adjacent to the driveway.
237	109.150.231.178-554.jpg	Ashbourne, England, United Kingdom	Residential	The presence of a garden with raised flower beds and a shed suggests a residential area.	Outdoor	No	The photo shows a residential garden with raised flower beds and a shed. The area is well-maintained, with various plants and flowers.
238	109.151.131.158-554.jpg	South Benfleet, England, United Kingdom	Residential	The presence of a backyard with lawn and garden decorations suggests a residential setting.	Outdoor	No	The photo shows a residential backyard with a lawn and some garden decorations. The area is well-maintained, with a fence and a patio visible in the background.
239	109.151.175.76-554.jpg	Cardiff, Wales, United Kingdom	Residential	The driveway with a parked car and adjacent houses suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a driveway and a car parked on it. There are adjacent houses visible in the background, suggesting a suburban neighborhood.
240	109.153.160.198-554.jpg	Crewe, England, United Kingdom	Residential	The driveway with a parked car and adjacent houses suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a driveway and a car parked on it. There are adjacent houses visible in the background, suggesting a suburban neighborhood.
241	109.153.238.242-554.jpg	Ballymena, Northern Ireland, United Kingdom	Residential	The garage-like setting with various items suggests a residential storage area.	Indoor	No	The photo shows an indoor area that looks like a garage or storage room with various items scattered around, including boxes and tires.
242	109.156.228.135-554.jpg	Runcorn, England, United Kingdom	Residential	The view of a front yard with a brick wall and garden suggests a residential setting.	Outdoor	No	The photo shows a residential front yard with a brick wall and some garden plants. In the background, there is a building and more greenery, suggesting a residential area.
243	109.159.8.144-554.jpg	North Shields, England, United Kingdom	Residential	The presence of trash bins and a back alley suggests a residential setting.	Outdoor	No	The photo shows a back alley with multiple trash bins lined up against a brick wall. There is also a fenced area, indicating a residential neighborhood.
244	109.159.94.214-554.jpg	Brotherton, England, United Kingdom	Residential	The dark image with a garden and some structures suggests a residential backyard.	Outdoor	No	The photo shows a dark outdoor area with a garden and some structures, possibly a residential backyard. The image is in black and white, indicating night vision from a security camera.
245	143.159.38.144-554.jpg	Ashford, England, United Kingdom	Residential	The presence of a patio with a bench and potted plants suggests a residential backyard.	Outdoor	No	The photo shows a residential patio with a bench and some potted plants. There is a small building in the background, indicating a residential backyard.
246	146.198.204.132-554.jpg	Derby, England, United Kingdom	Residential	The presence of dining furniture and decor suggests a residential dining room.	Indoor	No	The photo shows an indoor area, specifically a dining room with a table, chairs, and some decor items. The room is well-lit and appears to be part of a home.
247	147.147.157.131-554.jpg	Shifnal, England, United Kingdom	Residential	The large lawn and outdoor setting with a shed suggest a residential area.	Outdoor	No	The photo shows a residential outdoor area with a large lawn and a shed. The area is well-maintained with some garden decorations and a fence.
248	149.22.239.20-554.jpg	Southall, England, United Kingdom	Residential	The indoor setting with furniture and people suggests a residential living room.	Indoor	Yes	The photo shows an indoor area, specifically a living room with furniture and two people. One person is lying on the couch, and another is standing nearby. The room appears to be part of a home.
249	149.22.248.24-554.jpg	Chigwell, England, United Kingdom	Residential	The view through the window showing parked cars and houses indicates a residential neighborhood.	Outdoor	No	The photo shows a view through a window of a residential street with parked cars and houses. The area appears to be a suburban neighborhood with well-maintained gardens.
250	149.50.24.29-554.jpg	Crewe, England, United Kingdom	Residential	The presence of a backyard with lawn and garden structures suggests a residential area.	Outdoor	No	The photo shows a residential backyard with a lawn and some garden structures. The area is well-maintained, with a fence and some plants visible in the background.
251	149.86.5.77-554.jpg	Carshalton, England, United Kingdom	Residential	The driveway with a parked car and adjacent houses suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a driveway and a car parked on it. The image is in black and white, indicating night vision from a security camera.
252	150.143.205.59-554.jpg	Merthyr Tydfil, Wales, United Kingdom	Residential	The fenced backyard with paved area and some bushes suggests a residential area.	Outdoor	No	The photo shows a residential backyard with a paved area and some bushes. The area is well-maintained, with a fence surrounding the yard.
253	150.143.222.205-554.jpg	Halifax, England, United Kingdom	Residential	The backyard with garden furniture and a bird feeder suggests a residential area.	Outdoor	No	The photo shows a residential backyard with a lawn, garden furniture, and a bird feeder. The area is well-maintained with various plants and flowers.
254	151.224.67.102-554.jpg	West Bromwich, England, United Kingdom	Residential	The indoor staircase with carpet and personal items suggests a residential setting.	Indoor	No	The photo shows an indoor area with a staircase. The stairs are carpeted, and there are some personal items such as shoes and bags on the steps.
255	154.60.82.53-554.jpg	Enniskillen, Northern Ireland, United Kingdom	Commercial	The presence of a barn with livestock indicates an agricultural setting.	Indoor	No	The photo shows the inside of a barn with livestock. The area is enclosed and appears to be part of a commercial farming operation.
256	157.125.36.22-554.jpg	Chipstead, England, United Kingdom	Unknown	The dark outdoor area with minimal details makes it difficult to determine the setting.	Unknown	No	The photo is very dark, showing minimal details. It is likely an outdoor area but the exact setting is unclear.

Sample	File Name	Location	Residential or Commercial	Reason	Indoor or Outdoor	People exist?	Detailed Description
257	176.122.246.215-554.jpg	Churchdown, England, United Kingdom	Residential	The presence of a car parked, trash bins, and garden furniture suggests a residential area.	Outdoor	No	The photo shows a residential outdoor area with a car parked, trash bins, and some garden furniture. The area is well-maintained.
258	176.250.253.144-554.jpg	Ramsgate, England, United Kingdom	Residential	The presence of a driveway and garden suggests a residential setting.	Outdoor	No	The photo shows a residential driveway with a garden. The area is surrounded by trees and greenery, indicating a suburban or rural setting.
259	185.34.235.168-554.jpg	Manchester, England, United Kingdom	Commercial	The large industrial interior suggests a commercial or manufacturing setting.	Indoor	No	The photo shows a large industrial interior with various equipment and storage areas. The area appears to be part of a manufacturing or commercial facility.
260	185.87.212.26-554.jpg	Braintree, England, United Kingdom	Residential	The backyard with fencing and some construction materials suggests a residential area.	Outdoor	No	The photo shows a residential backyard with fencing and some construction materials. The area appears to be under renovation or construction.
261	185.185.162.24-554.jpg	Londonderry, Northern Ireland, United Kingdom	Commercial	The livestock pen and agricultural setting indicate a commercial farm.	Indoor	No	The photo shows an indoor livestock pen on a farm. The area is enclosed with metal bars, and the floor is covered with straw or hay.
262	185.196.206.42-554.jpg	Cardiff, Wales, United Kingdom	Commercial	The well-lit industrial outdoor area with fencing and security lights suggests a commercial setting.	Outdoor	No	The photo shows a well-lit outdoor area with security fencing and lights. The industrial environment suggests it is a commercial setting.
263	185.245.237.225-554.jpg	Fulham, England, United Kingdom	Residential	The indoor staircase and front door suggest a residential setting.	Indoor	No	The photo shows an indoor area with a staircase and a front door. The area is well-lit and appears to be part of a home.
264	188.30.135.6-554.jpg	Islington, England, United Kingdom	Commercial	The store interior with various products on shelves indicates a commercial setting.	Indoor	No	The photo shows the interior of a store with shelves stocked with various products. The area is well-lit and organized, typical of a commercial retail space.
265	193.192.195.133-554.jpg	Hurley, England, United Kingdom	Commercial	The turnstile entry gate and industrial decor suggest a commercial setting.	Indoor	No	The photo shows an indoor area with a turnstile entry gate, typical of commercial or industrial buildings. The area is well-lit and clean.
266	193.237.177.210-554.jpg	Derby, England, United Kingdom	Commercial	The store interior with various products on shelves indicates a commercial setting.	Indoor	No	The photo shows the interior of a store with shelves stocked with various products. The area is well-lit and organized, typical of a commercial retail space.
267	193.237.207.44-554.jpg	Kensington, England, United Kingdom	Unknown	The dark image with minimal details makes it difficult to determine the setting.	Unknown	No	The photo is very dark, showing minimal details. It is likely an outdoor area but the exact setting is unclear.
268	193.237.213.222-554.jpg	Clevedays, England, United Kingdom	Residential	The paved area with a car parked and garden plants suggests a residential setting.	Outdoor	No	The photo shows an outdoor paved area with a car parked and garden plants. The area is well-maintained and appears to be part of a residential property.
269	193.237.245.201-554.jpg	London, England, United Kingdom	Commercial	The workers sitting outside a car wash indicate a commercial setting.	Outdoor	Yes	The photo shows an outdoor area of a car wash with workers sitting and resting. The area is well-lit and organized.
270	194.62.186.57-554.jpg	Craigavon, Northern Ireland, United Kingdom	Unknown	The dark outdoor area with minimal details makes it difficult to determine the setting.	Unknown	No	The photo is very dark, showing minimal details. It is likely an outdoor area but the exact setting is unclear.
271	195.226.55.129-554.jpg	London, England, United Kingdom	Commercial	The presence of machinery or equipment indicates a commercial or industrial setting.	Indoor	No	The image appears to show a dark indoor area with some machinery or equipment. The visibility is poor due to the darkness.
272	212.159.76.57-554.jpg	London, England, United Kingdom	Commercial	The barn and presence of livestock indicate a commercial farm.	Indoor	No	The image shows an indoor barn or stable with hay on the ground and a cow standing. Another cow is lying down.
273	212.159.89.201-554.jpg	Evington, England, United Kingdom	Unknown	The image is too dark to determine.	Indoor	No	The image is completely dark, suggesting it might be a garage or storage room with the lights off.
274	212.159.100.204-554.jpg	Ruislip, England, United Kingdom	Residential	The driveway and residential fencing indicate a house.	Outdoor	No	The image shows an outdoor night view of a residential area, including a driveway with cars and a wooden fence.
275	212.229.87.193-554.jpg	Milton Keynes, England, United Kingdom	Residential	The bushes and setting suggest a residential garden or yard.	Outdoor	No	The image shows a dark outdoor scene with bushes and a road or path.
276	213.31.21.244-554.jpg	Lincoln, England, United Kingdom	Residential	The presence of a birdhouse and rooftop view suggest a residential setting.	Outdoor	No	The image shows an outdoor view from a rooftop, likely residential, with a birdhouse or similar structure.
277	213.123.183.55-554.jpg	London, England, United Kingdom	Unknown	The image is too unclear to determine.	Unknown	No	The image is blurry and unclear, possibly an indoor shot of a wall or fabric.
278	217.35.229.149-554.jpg	Wolverhampton, England, United Kingdom	Residential	The presence of a pet bed and home appliances indicate a residential setting.	Indoor	No	The image shows an indoor area with a washing machine or other appliance and a pet bed.
279	217.42.107.231-554.jpg	Fradley, England, United Kingdom	Residential	The house and yard setting indicate a residential area.	Outdoor	No	The image shows an outdoor view of a grassy area next to a house, with a large field in the background.
280	217.44.73.20-8554.jpg	Crumlin, Northern Ireland, United Kingdom	Residential	The driveway and garden area suggest a residential home.	Outdoor	No	The image shows an outdoor view of a residential driveway or road, with a wooden fence and a garden area.
281	217.44.73.20-10554.jpg	Crumlin, Northern Ireland, United Kingdom	Residential	The presence of small sheds and gardening tools suggests a residential setting.	Outdoor	No	The image shows an outdoor yard area with two small structures, possibly sheds or barns, on either side. The ground is paved with concrete and the area appears clean and well-maintained. There are farming or gardening tools visible, and the background shows a field with greenery.

References

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