Exploration of Non-Intrusive Identification Techniques to Locate Covert Camera Devices

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INTRODUCTION

Smart devices such as the Ring Doorbell are increasingly embedded in daily life due to their convenience (Lazar et al., 2015; Chen, 2020). Their applications range from home surveillance to childcare monitoring (FCDO Services, 2022; Herodotou & Hao, 2023; Szakolczai, 2022). However, these technologies are also being misused as covert surveillance tools (Yu et al., 2022; Stouffer, 2022).

Problem:

Spy cameras are now discreetly embedded into everyday objects (e.g keychains, clocks, sockets, even screws) making them difficult to detect (Eufy, 2025). The rise in sales of these disguised devices (Bug Sweeping UK, 2023) and increasing IoT proliferation (Arnott, 2024) signal a growing risk of privacy invasion and data theft (Zuniga et al., 2022; FCDO Services, 2022).

Impact:

Miniaturisation and affordability have expanded access to such technologies, posing challenges for law enforcement and ethical concerns about consent and surveillance (Zuniga et al., 2022; Yu et al., 2022). Detection tools like hidden camera detectors are becoming vital (Eyespysupplycom, 2024), yet academic evaluation of their efficacy remains limited (Stephenson et al., 2023).

Aim:

This project investigates non-intrusive methods to detect covert cameras, addressing a critical gap in academic research. A simulation using hidden cameras tested various detection techniques (thermal imaging, phone cameras, and torches), highlighting practical methods to safeguard personal privacy.

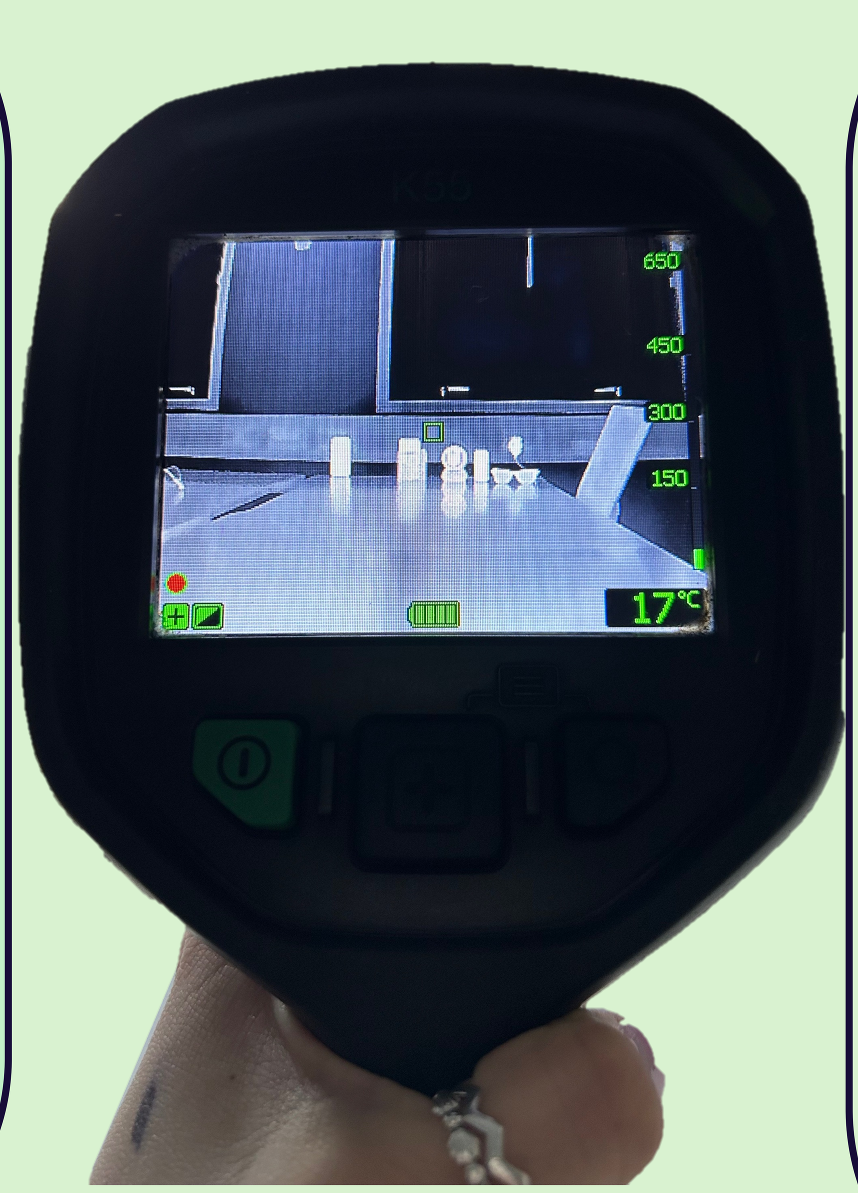

Figure 1: Thermal image display identifying the heat signature of covert devices

METHOD

Research Design and Experimental Setup

This study adopted an **experimental research design** for its replicability, high validity, and control over environmental variables. The environments used in the study simulated **real-life indoor settings** where covert devices could be commonly hidden. These included a **bedroom/living space**, an **office**, and a **shop**. These settings reflect real-world incidents of covert surveillance and criminal misuse, such as the discovery of 80 spy cameras in a home (Collins, 2023), and landlords secretly recording tenants (Luckhurst, 2023; Sandford, 2025).

Environmental Variables

Rooms varied in **luminosity** and **dimensions**.

Light levels were measured using a **SEKONIC Flashmate L-308X lux meter**, and **distance** was marked at 1, 2, and 5 meters using a tape measure.

3 distances × 2 lighting conditions = 6 test scenarios

Hidden covert devices

Five **covert devices** were selected based on affordability, disguise type, and market popularity:

- **TP-Link Tapo C210**
- **Alcatel VRB4K & Basic Samsung**
- **iPhone 8**
- **Ray-Ban Stories smart glasses**

These devices represent common technologies potentially misused for covert surveillance (West Mercia Police, 2021; BBC Bitesize, 2024; Curry, 2025).

Detection methods included:

- **White LED Torch**
- **UV Torch** (for fingerprints & lens detection)
- **Thermal Imaging Camera**
- **Smartphone Cameras**: iPhone 14 Plus vs. Samsung Galaxy A20e

Experimental Procedure

A step-by-step protocol was followed:

1. Light levels were recorded.
2. Devices were placed in consistent locations.
3. Distances marked and detection methods tested under lights **on** and **off**.
4. Observations were scored using a **visibility scale** ranging from 1 (poor) to 4 (excellent visibility).

Data Collection and Analysis

Results were manually documented and transcribed into **Microsoft Excel** for organisation and visual analysis. Filters and automatic chart generation tools supported data interpretation.

RESULTS & DISCUSION

Key Observations:

Thermal Imaging Camera

- Most reliable detection method, unaffected by light/distance.
- Detected battery heat signatures
- Limitations: Expensive, ineffective if the hidden device has cooled (Zuniga et al., 2022).

White Torch

- Effective only at close distances and specific angles.
- Low-cost and accessible

UV Torch

- Weak detection overall.
- Did highlight unique features (e.g. lens fluorescence).

Smartphone Cameras

- iPhone 14 Plus and Samsung A20e had limited effectiveness.
- Performance impacted by photo quality, lighting, and need for zoom.

Overall:

Thermal camera outperformed all others under all conditions.
White torch was moderately effective at close range.
Phone cameras and **UV torch** performed poorly beyond 1m.

Lighting & Distance Impact

- Lower lighting slightly improved detection overall, especially for torch-based methods.
- Distance significantly reduced effectiveness for all techniques except thermal imaging.

Hidden Device Considerations

- Tapo Camera: Easily detected due to IR LEDs; likely unsuitable for covert use.
- Ray-Ban Stories & Old Phones: Poor battery life and reflective surfaces influenced visibility.

Limitations

- Known camera locations may have biased scoring.
- Small sample size (5 devices).
- Results not double-checked; potential for researcher bias.

Table 1: The visibility score table

Visibility score	Visibility characterisations
1 Poor Visibility	Reflecting element not visible
2 Fair Visibility	Weak reflection visible
3 Good Visibility	Intermediate reflection visible
4 Excellent Visibility	Strong reflection visible

CONCLUSION

This study assessed the effectiveness of several non-intrusive techniques for detecting covert cameras, including thermal imaging, smartphone cameras, and both white and UV torches. Results showed that:

- **Thermal camera** = most effective tool, but costly
- **White torches** = low cost, angle-dependent
- **Smartphone cameras** = produced low-quality images, though zooming sometimes improved visibility
- Data analysis via **Microsoft Excel** enabled a clear comparison of performance across scenarios, highlighting critical information.

Research Contributions & Future Directions:

- Adds to the limited literature on covert camera detection.
- Suggests thermal imaging should be studied further in wider contexts and compared with **mobile app-based tools**.
- Recommends testing **newer devices** and other threats, like **audio bugs**.
- Proposes involving multiple researchers or participants to reduce bias and simulate realistic detection scenarios.
- Stresses the role of detection research in **public awareness** and **crime prevention**.

Final Insight

While thermal imaging remained the most reliable method, ongoing innovation in covert technology, including potential AI use, means adaptive and accessible detection methods are vital for both **investigative** and **protective** purposes.

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