Anomaly Intrusion Detection using recurrent Deep Neural Networks DNN in Commercial and Residents Building

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ABSTRACT
Buildings fulfill a multitude of societal needs, serving as shelters, ensuring security, and providing living and working spaces. However, ensuring the safety of these spaces, particularly homes, remains a significant challenge due to limitations in traditional intrusion and theft detection methods. These limitations includes: the inability of the system to detect an act of intrusion without human input, the inability of system to report the act of intrusion in real time manner. This research proposes a novel approach to address this challenge by leveraging deep learning-based automatic image classification systems, utilizing artificial intelligence (AI) techniques, specifically Deep Neural Networks (DNN). The research aims to investigate the effectiveness of deep learning models for intrusion and theft detection in commercial and residential buildings. , the study intends to develop and evaluate prototype systems capable of automatically detecting intrusions and thefts using footage captured by the camera within building premises. In addition to software components, the research will leverage cloud computing infrastructure for resource-intensive tasks such as storage and optimization. Hardware components such as cameras will be employed for data collection, enabling the training and testing of deep learning models on real-world datasets

Keywords
Deep Neural Networks

1. INTRODUCTION
A building is 'a structure that has a roof and walls and stands more or less permanently in one place'. Buildings serve several societal needs occupancy, primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. The security of our houses most times guarantee the security of humans that live in it. Commercial and residential buildings face numerous security challenges, including intrusion and theft.

Eddy et al, (2022) design a CCTV architectural for theft and intrusion detection in buildings and homes. The system is characterized with some limitations because it only captures the footage of intruders or thieves when perpetuating the act; it does not alert residential owners or appropriate authorities in real time which is similar to traditional security system. Traditional security systems often rely on manual monitoring and are limited in their ability to detect and respond to potential threats in real-time. This research proposal aims to develop a deep learning model specifically designed for intrusion and theft detection in commercial and residential buildings. The proposed model will leverage the power of deep learning algorithms to enhance security measures and provide more effective and efficient protection against unauthorized access and theft incidents.

A deep learning Building Intrusion Detection System (DLBIDS) is an intelligent system that uses deep learning techniques in artificial intelligence to detect intrusion in a building. Buildings play increasingly vital roles in our modern society, they have become the targets of intrusion by enemies and criminals. It is important to note that increasing population and crime rate will thus increase the rate of building intrusion and theft. Therefore, there is need to urgently design and implement an automated building intrusion and theft detection system that will detect intruders and report this crime on a real-time

2. AIMS OF THE STUDY
The aim of this research work is to develop a Deep Learning Model for Intrusion and Thefts Detection in Commercial and Residential Buildings. This study focused on: To identify act of intrusion resulting from a third party activities on the building. The study's second task was to design a deep learning model that will detect intrusion on the building and lastly is to Develop and test the model against intrusions and its ability to detect and prevent it.

3. BACKGROUND
Thieves and vandals can directly have a negative effect on the security of lives and properties, thereby posing considerable problem in our society today (Bardamova et al., 2018). The security of lives and properties is considered the most important in any society. Nikos et al, (2021), also described security as the protection of people and things, such as buildings, properties from harm, theft or sabotage and encompass several components such as physical, personal, investigations using automated gadget, awareness and information. Crime prevention on buildings and properties has become a major concern due to the importance of buildings in our society. Appropriate strategies currently used to curb and manage building intrusion and theft are implementing security plans according to the rate of occurrence. Washington Inc. (2008) suggests that firms, government and you, should relate history of reoccurrence of theft and building intrusion problems so as to adopt the best security plan required to reduce the problem.

The new innovation of surveillance system in perimeter protection enables one person on guard to do the job of ten persons in detecting and addressing security problems.

Marman, (2018), proposed video surveillance system, the surveillance system is monitored by a security staff operator. The system is attached to a camera that captures all activities that are happening within the perimeter of the building, where it has been installed. Then, through live streaming video, the

staff /operator sees exactly what is happening within the building and its environment.

Nega and Vijaya, (2021) stated some security measure to be employed that will help detect, prevent and reduce building burglary and theft. These measures are: -

i. Members of the public should quickly report any act of theft and building vandalism to the local police.
ii. Lighting: Good portable lights help ensure good visibility.
iii. CCTV and Alarm systems: Either standalone or integrated should be used to protect compounds and offices.
iv. Warning Notices: Stating that security precautions are enforced around the perimeter without providing details.
v. Security personnel should be deployed to manually detect and apprehend thieves and vandals.

4. RESEARCH METHODOLOGY

The selected system development model for this research work is the Agile Scrum methodology. This model is chosen for its ability to handle dynamic and evolving requirements, promote collaboration, and deliver incremental value to stakeholders. It enables the project team to work in short iterations, gather feedback, and adapt the system based on evolving needs and priorities.

Analysis of Existing System

In most commercial and residential buildings today, security measures against intrusion and theft typically rely on traditional methods such as locks, alarms, and surveillance cameras. While these measures provide a basic level of protection, they have several limitations that hinder their effectiveness in preventing and deterring security breaches. Traditional lock systems can be vulnerable to various forms of tampering, lock picking techniques, or unauthorized key duplication, allowing unauthorized access to the premises (Ranasinghe, 2023). Alarm systems, while effective in alerting owners or authorities of a potential intrusion, are reactive measures that do not actively prevent the incident from occurring.

Surveillance cameras have become increasingly prevalent in modern security systems, offering visual monitoring of the premises. However, their effectiveness is largely dependent on constant human monitoring, which can be resource-intensive, prone to errors, and subject to lapses in attention (Hampapur et al., 2019). Additionally, camera footage is typically reviewed after an incident has occurred, limiting its ability to prevent or deter intrusions or thefts in real-time (Valera & Velastin, 2004). One of the major challenges with traditional surveillance camera systems is the vast amount of data generated, which can overwhelm human operators and lead to missed events or delayed responses (Tun et al., 2019). Furthermore, these systems often lack advanced analytics capabilities, relying solely on human interpretation of the video footage, which can be subjective and inconsistent (Hampapur et al., 2019). Another limitation of existing surveillance systems is their inability to effectively track and identify individuals across multiple cameras or locations, making it difficult to monitor and prevent potential threats as they move through different areas of a building or complex (Javed and Shah, 2022).

The existing systems for intrusion and theft detection in commercial and residential buildings rely on traditional methods that have inherent limitations in terms of proactive prevention, real-time monitoring, and intelligent analysis of potential security threats. These limitations highlight the need for more advanced and integrated security solutions that can overcome the shortcomings of current systems.

5. THE PROPOSED SYSTEM

Requirement Elicitation

The requirements for the system were elicited through Observations: Observations were made of the current system and the work processes that are used to operate it. This information was used to identify areas where the system can be improved.

The information gathered from these techniques was used to develop a set of requirements for the system.

Requirements Definition

Based on the elicited information, both functional and non-functional requirements of the intrusion and theft detection were defined.

The Functional Requirements include:

Users:

a) Arming/Disarming System
b) Manage User
c) Receive Notification

System-Related

a) Unknown Person Detection
b) Intrusion Detection
c) Facial Recognition
d) Video Recording
e) Send Notification

Non-Functional Requirements:

Non-functional requirements are requirements that define how a system should behave, rather than what the system should do. Non-functional requirements are often overlooked, but they are just as important as functional requirements. Non-functional requirements can impact the system's usability, performance and reliability.

Non-functional requirements include:

a) Performance: The system must meet performance requirements, such as response time and throughput. (Pressman 2021)
b) Usability: The system must be easy to use by the intended users.
c) Reliability: The system must be reliable and available to users when they need it.

Requirement Analysis

The requirements were further analyzed using Use Case diagrams and descriptions. Use Case diagrams capture the interactions between system actors and the proposed system, highlighting the main functionalities and system boundaries.

The use case diagram of Figure 1 below shows the functionalities, users and their relationships of the proposed system. The use cases are described below:

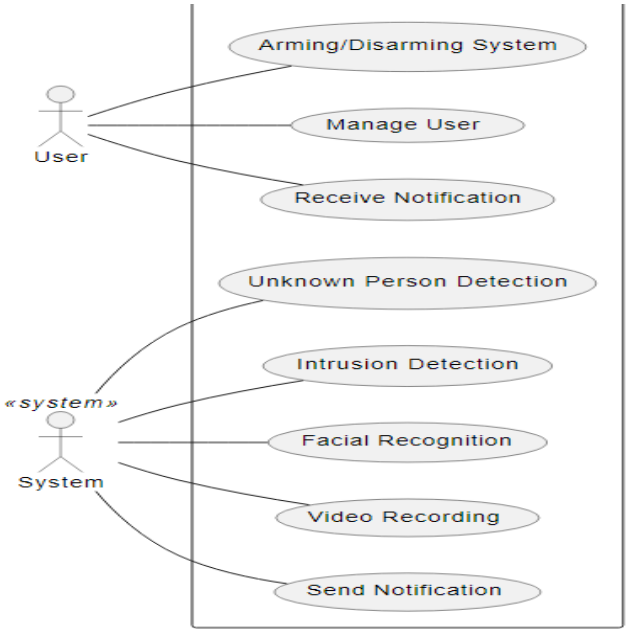


Figure 1. Use case diagram

1. **Arming/Disarming System**:
    - Actors: User
    - Description: Allows users to enable or disenable the system for monitoring intrusions and thefts.
2. **Manage User**:
    - Actors: User, Security Personnel
    - Description: Allows authorized users to manage system settings, including adding or removing authorized personnel from the facial recognition database.
3. **Receive Notification**:
    - Actors: User, Security Personnel
    - Description: Enables users and security personnel to receive real-time notifications regarding security incidents.

System-Related:

1. **Unknown Person Detection**:
    - Actors: System
    - Description: The system detects unknown individuals in restricted areas like trying to gain access via the windows, forceful entry, exerting force by breaking e.t.c. and initiates appropriate actions.
2. **Intrusion Detection**:
    - Actors: System
    - Description: The system monitors camera feeds for unauthorized access and detects intrusion attempts.
3. **Facial Recognition**:
    - Actors: System
    - Description: Utilizes facial recognition technology to identify known individuals with a high degree of accuracy.
4. **Video Recording**:
    - Actors: System
    - Description: The system records video footage upon detecting security incidents for later review and analysis.
5. **Send Notification**:
    - Actors: System
    - Description: Sends real-time notifications to users and security personnel when security incidents are detected.

6. SYSTEM DESIGN

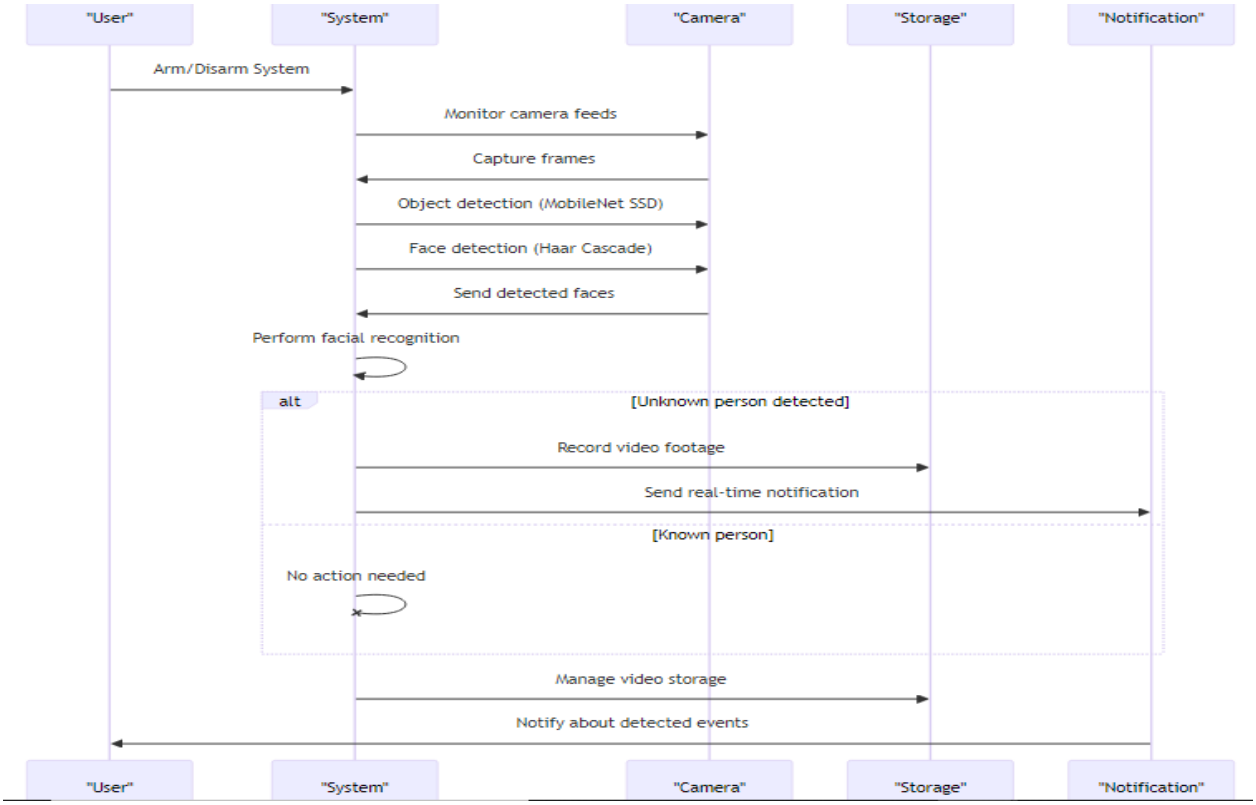
System design involves creating a plan for the architecture, modules, components, interfaces, and data flow of a system. The goal is to provide detailed information to ensure that the system is implemented according to the defined architectural models and views.

Description of Proposed System

The proposed system is described using sequence diagram. These diagram provide a visual representation of the system's workflow, illustrating the various activities and interactions involved in the intrusion detection process.

Sequence Diagram: A sequence diagram is a type of interaction diagram that shows how objects or parts of a system interact with each other over time. It uses horizontal lines to represent the lifelines of different objects and vertical arrows to show the messages exchanged between them.

Figure 2 below shows the Admin Sequence diagram describing the sequences of interactions of interacting with the proposed system.



7. DISCUSSION

The study focused on a robust model for intrusion and theft detection in commercial and residential buildings using Artificial Intelligence (AI) techniques, specifically Deep Neural Networks (DNN), implemented with OpenCV and NumPy libraries. The system was developed using deep learning algorithms and tested on two different buildings where it effectively detect an act of theft and intrusion. The system's has the ability to distinguish between an intruder and legal users. Using various performance metrics, including accuracy, precision, recall, and F1-score, which demonstrated high levels of performance in disease classification. The results obtained through the experimental evaluation showed that the proposed system achieved an accuracy rate of 95.7%, indicating its effectiveness intrusion and theft detection system. Furthermore, the proposed system's performance was evaluated against other state-of-the-art algorithm, and it was found to outperform them in terms of accuracy, sensitivity, and specificity. This demonstrates the system's superiority over existing solutions for home security, intrusion and theft detection. The proposed system's success is attributed to the robustness of the Deep Neural Networks (DNN), implemented with OpenCV and NumPy libraries architectures, which enables the model to detect capture video frames of different patterns and features from the input data, resulting in highly accurate and reliable of detecting and intruder.

8. CONCLUSION

In conclusion, the development of a robust system for intrusion and theft detection in commercial and residential represents a significant to security architecture of our homes; it has also will add to the technology of improving security. The proposed model deep learning model for intrusion and thefts detection in commercial and residential buildings using Deep Neural Networks (DNN), implemented with OpenCV and NumPy libraries is a highly promising approach that can revolutionize the security systems by providing an efficient, accurate, and reliable method for detecting the act of intrusion and theft in commercial and residential buildings.

9. RECOMMENDATION

The system's ability to classify the disease's severity level can help in providing the necessary intervention at an early stage, thus preventing the disease's spread, which is crucial in enhancing the overall yield and quality of the tomato crops. The success of this system is a significant step towards improving crop management practices and ensuring food security for the growing global population. The developed system provides a reliable and efficient method for classifying tomato leaves diseases, which can be used by farmers and other stakeholders in the agricultural industry to improve crop yield and reduce losses due to diseases. The system developed for this study will be beneficial to farmers and agricultural experts in the early detection and prevention of tomato plant diseases. With early detection, it will be possible to minimize crop damage and losses, leading to increased yields and profitability for farmers.

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