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A Systematic Review on Evaluation of Surveillance System for Unusual Behavior Using Artificial Intelligence

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Abstract— The latest advancements in Artificial Intelligence and Computer Vision have significantly enhanced video surveillance capabilities. The primary purpose of a Video Surveillance System (VSS) is to improve security and privacy through the meaningful analysis of video frames. VSS involves the supervision or remote monitoring of specific events using cameras and recorders. Although many current systems rely on conventional image processing and some incorporate machine learning, challenges such as dynamic scenes, performance improvements, and weather conditions impact accuracy and efficiency. This work proposes an efficient approach designed to be both fast and accurate, addressing these challenges. Intelligence will be integrated into the system to filter and interpret data captured by cameras, where human observers may struggle to assess developments in real-time. The proposed method will analyse video to detect and recognize humans, vehicles, attributes, and abnormal events. Combining AI, Computer Vision, and the Internet of Things (IoT) can lead to numerous benefits, including reduced human fatigue, enhanced audio and video analysis, movement pattern recognition, gesture tracking, and behavioural analysis, ultimately conserving human resources. Our aim is to develop a system capable of real-time object detection and classification using a live camera feed. The primary objective is to accurately identify and classify objects into two main categories: humans and vehicles. The system includes following approaches which was used to determine the objective of the project: Feature Extraction, Anomaly Detection Model, Training and Validation, Integration and Alert Mechanism. The obtained results will be compared using different deep learning approaches to ensure optimal performance.

Index Terms—*Computer Vision, artificial Intelligence, Surveillance, Security, Privacy*

I. INTRODUCTION

Nowadays, ensuring safety and security has become increasingly challenging in modern society, as people face numerous issues affecting their lives and valuable assets due to illegal activities. As a result, personal and social safety and security have gained greater importance in protecting individuals' personal information, daily activities, and valuable possessions. Surveillance video analysis plays a crucial role in detecting and tracking various moving objects, which is essential for identifying unexpected events, abnormal crowd behaviour, and human actions. Traditionally, conventional video surveillance systems (VSS) rely on a human operator to monitor footage and identify significant information, ensuring timely notifications to the public or themselves when necessary. Consequently, it is imperative to constantly alert a human operator without interruptions. However, in practice, determining whether an event is normal or abnormal based solely on the history of moving objects in a sequence of frames is both unattainable and time-consuming. Therefore, implementing an intelligent video surveillance system (VSS) is essential for efficiently capturing and promptly responding to various scenarios based on real-time conditions [1-3]. The increasing challenges in urban surveillance and crowd management have led to a demand for advanced technologies capable of identifying abnormal actions in crowded areas. The advent of deep learning has revolutionized anomaly detection, providing exceptional capabilities to detect and differentiate minor deviations from typical behaviour. Deep Guard, an innovative method, leverages advanced deep learning techniques to detect anomalies in crowds. A robust anomaly detection system is needed to adapt to the ever-changing dynamics of crowd behaviour influenced by factors such as social events, public gatherings, and urban activities.

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II. LITERATURE REVIEW

Muthurasu et. al. states that Abnormal activity in the modern environment suggests risks and threats to other people. Anomaly refers to anything that differs from what is typical, anticipated, or normal. Given the challenges of consistently monitoring public areas, the implementation of intelligent video surveillance is imperative. Detecting unusual crowd activities is a complex subject that has spurred research advancements in the field of surveillance video applications. The main objective of this research is to identify atypical gatherings, instances of anomalous crowd behaviour. Various techniques, including histogram representation, optical flow calculation, and deep learning-based algorithms, have been employed to address these issues. Nevertheless, there is a deficiency in effectively addressing this issue due to blockage, noise, and congestion. The introduction of AI techniques resulted in significant technological advancements. During the real-time monitoring of video material, the system employs various techniques to differentiate between different suspicious activities. The unpredictability of human behaviour makes it challenging to discern whether it is suspicious or typical. Conducting monitoring commonly involves pulling consecutive frames from a video. There are two components in the framework. During the initial stage, the framework computes the features from the video frames. In the subsequent step, the classifier utilizes these features to determine if the class is panic or normal. The suggested methodology is evaluated using three available datasets, namely PETS 2009, MED and UMN dataset. The suggested method is compared with existing techniques to assess its efficiency. [1]

Vermander et. al. states that the number of people who need to use wheelchair for proper mobility is increasing. The integration of technology into these devices enables the simultaneous and objective assessment of posture, while also facilitating the concurrent monitoring of the functional status of wheelchair users. In this way, both the health personnel and the user can be provided with relevant information for the recovery process. This information can be used to carry out an early adaptation of the rehabilitation of patients, thus allowing to prevent further musculoskeletal problems, as well as risk situations such as ulcers or falls. Thus, a higher quality of life is promoted in affected individuals. As a result, this paper presents an orderly and organized analysis of the existing postural diagnosis systems for detecting sitting anomalies in the literature. This analysis can be divided into two parts that compose such postural diagnosis: on the one hand, the monitoring devices necessary for the collection of postural data and, on the other hand, the techniques used for anomaly detection. These anomaly detection techniques will be explained under two different approaches: the traditional generalized approach followed to date by most works, where anomalies are treated as incorrect postures, and a new individualized approach treating anomalies as changes with respect to the normal sitting pattern. In this way, the advantages, limitations and opportunities of the different techniques are analysed. The main contribution of this overview paper is to synthesize and organize information, identify trends, and provide a comprehensive understanding of sitting posture diagnosis systems, offering researchers an accessible resource for navigating the current state of knowledge of this particular field. [2]

Mahareek et. al. states that the scientific community is paying more attention to the highly developed field of anomaly detection in video surveillance. Intelligent systems that can automatically spot unusual events in streaming videos are in high demand. This survey article gives a thorough summary of the several methods for spotting irregularities in surveillance videos. Both conventional methods—such as statistical modelling and motion analysis—and more current strategies—such as deep learning and artificial intelligence—are included in these methodologies. The study also identifies each technique's advantages and disadvantages as well as prospective uses in real-world situations. It also covers the difficulties in developing efficient anomaly detection algorithms for surveillance movies and points out potential future research topics. Overall, it is a useful tool for academics and professionals involved in the study of violent behaviour detection (VioBD). It proposes a road map for future research on anomaly identification in surveillance films and provides insights into the state of the field now. To ensure the best possible performance of the anomaly detection system, it is crucial to keep in mind that the success of anomaly identification in surveillance videos significantly depends on the availability and quality of training data. As a result, future studies should concentrate on creating reliable feature extraction methods and enhancing the readability of anomaly detection models. The survey also says that in order for large-scale video data to be used in real-world applications that use anomaly detection systems, future studies should look into new ways to make these systems more scalable and effective. [3]

Patthe et. al. states that the global drone market has surged, growing from $1.6 billion in 2015 to $5.6 billion in 2020. Despite their increasing prevalence, drones can pose challenges. For instance, drone sightings at Gatwick Airport in December 2018 disrupted around 1,000 flights, highlighting potential misuses and the need for effective regulation. Given such incidents, the effective detection,

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tracking, and identification of abnormal behaviours of small UAVs in complex environments become critical for ensuring security and mitigating potential threats. This paper presents a state-of-the-art review of abnormal behaviour detection of small UAVs, focusing on the role of data fusion in enhancing detection performance, especially when dealing with heterogeneous data from multiple sensors. Our research offers a structured overview of abnormal behaviour detection methods and emphasizes the role of data fusion in addressing challenges, especially in environments with multiple operating drones like Amazon's delivery system. In addition, our research highlights the need to promote standardization of performances measures used to abnormal behaviour detection algorithms. While metrics like precision, MOTA, and accuracy are standard for detection, tracking, and classification respectively, evaluating behaviour detection in a data fusion system remains a challenge [4]

Duong et. al. states that Anomaly detection in video surveillance is a highly developed subject that is attracting

increased attention from the research community. There is great demand for intelligent systems with the capacity to automatically detect anomalous events in streaming videos. Due to this, a wide variety of approaches have been proposed to build an effective model that would ensure public security. There has been a variety of surveys of anomaly detection, such as of network anomaly detection, financial fraud detection, human behavioural analysis, and many more. Deep learning has been successfully applied to many aspects of computer vision. In particular, the strong growth of generative models means that these are the main techniques used in the proposed methods. This paper aims to provide a comprehensive review of the deep learning-based techniques used in the field of video anomaly detection. Specifically, deep learning-based approaches have been categorized into different methods by their objectives and learning metrics. Additionally, preprocessing and feature engineering techniques are discussed thoroughly for the vision-based domain. This paper also describes the benchmark databases used in training and detecting abnormal human behaviour. Finally, the common challenges in video surveillance are discussed, to offer some possible solutions and directions for future research. [5]

III. OBJECTIVES OF PROPOSED SYSTEM

Following are the objectives in which the work will be achieved

- To develop a system capable of real-time object detection and classification using a live camera feed. The primary objective is to accurately identify and classify objects into two main categories: humans and vehicles.
- To design a comprehensive AI-powered surveillance system capable of not only detecting and classifying humans and vehicles in real-time but also identifying suspicious or unusual behaviours.
- To enhance security and situational awareness in the monitored environment.
- To apply methods for reducing the time consumption for training,

IV. NEED OF THE STUDY

In crowded areas, such as public spaces, the likelihood of unexpected or irregular behaviours creates significant obstacles for maintaining safety, security, and managing large groups effectively. The traditional approaches to identifying these irregularities struggle to keep up with the ever-changing and complex behaviours of crowds. There's now a pressing need for sophisticated surveillance technologies that can accurately spot irregularities in real-time. This study aims to tackle the following major issues:

A. Limitations of Traditional Anomaly Detection

The usual methods for detecting irregularities often miss subtle changes in crowded situations, resulting in a high number of false alarms or missing actual irregularities. This can lead to a compromise in public safety and security, causing slow reactions to potential dangers or disturbances.

B. Complex Behaviours of Crowds

Crowds display complex and ever-changing behaviours, making it difficult to establish what is considered normal. Quick shifts in crowd size, movement patterns, or the formation of groups can signal irregularities, but identifying these manually is challenging. Not being able to adapt to the changing nature of crowd dynamics makes it hard to spot unusual activities, leaving areas vulnerable to security threats or emerging dangers.

C. Challenges in Handling Large-scale Environments

The growth of crowded areas, including transportation hubs, public gatherings, or city centres, requires anomaly detection systems that can handle large volumes of data in real-time. The inability to scale efficiently limits the use of effective anomaly detection solutions in large and complex crowd situations.

D. Balancing Privacy and Ethical Issues

The use of advanced deep learning for crowd anomaly detection might unintentionally violate individual privacy rights, sparking ethical debates about the surveillance and monitoring of public spaces. Not considering these ethical issues could lead to public backlash, legal disputes, and the

potential misuse of surveillance technologies, undermining the acceptance of anomaly detection systems in society.

E. The Importance of Prompt Responses

Quick reactions to unusual activities are essential for preventing or minimizing threats. The current systems often fail to provide immediate insights into irregularities, leading to delayed actions. These delays weaken security measures, increasing the risk of harm or disruptions in crowded settings.

V. RESEARCH METHODOLOGY

Several crucial steps must be taken in order to develop a framework to develop the system for better security.

The framework's high-level description is given below:

A. Phase 1: Object Detection and Classification with Live Camera Feed

In Phase 1 of our project, we aim to develop a system capable of real-time object detection and classification using a live camera feed. The primary objective is to accurately identify and classify objects into two main categories: humans and vehicles.

- Data Collection: Gather a diverse dataset consisting of images containing humans and various types of vehicles from different angles, lighting conditions, and environments.
- Preprocessing: Preprocess the collected data to ensure uniformity in size, color, and orientation. Augment the dataset if necessary to improve model generalization.
- Model Selection: Choose a suitable deep learning model architecture for object detection and classification, such as YOLO (You Only Look Once), SSD (Single Shot MultiBox Detector), or Faster R-CNN (Region-based Convolutional Neural Network).
- Training: Train the selected model on the prepared dataset using a powerful GPU-accelerated infrastructure to expedite the training process.

B. Phase 2: Anomaly Detection for Humans and Vehicles

In Phase 2, our focus shifts to identifying unusual behaviours exhibited by humans and vehicles detected in Phase 1. The objective is to develop an anomaly detection system capable of flagging suspicious activities or behaviours in real-time.

- Feature Extraction: Extract relevant features from the detected objects, such as movement patterns, speed, direction, proximity to certain areas, etc.
- Anomaly Detection Model: Develop an anomaly detection model using techniques like unsupervised learning (e.g., clustering algorithms such as k-means) or supervised learning (e.g., classification algorithms trained on labelled anomalous behaviour).
- Training and Validation: Train the anomaly detection model on labelled data containing both normal and anomalous behaviours. Validate the model's performance using appropriate metrics, ensuring its ability to accurately detect anomalies while minimizing false positives.
- Integration: Integrate the anomaly detection module with the object detection and classification system developed in Phase 1, enabling seamless analysis of live camera feeds.
- Alert Mechanism: Implement an alert mechanism to notify relevant stakeholders (e.g., security personnel, system administrators) in real-time when anomalous behaviour is detected. This could involve triggering alarms, sending notifications to mobile devices, or integrating with existing security systems.

By completing both phases of the project, we will have a comprehensive AI-powered surveillance system capable of not only detecting and classifying humans and vehicles in real-time but also identifying suspicious or unusual behaviors, thus enhancing security and situational awareness in the monitored environment.

VI. CONCLUSION

In this way video surveillance systems have significant implications for security and privacy. An Intelligent Video Surveillance system can detect, track, and recognize objects based on classification criteria or features through meaningful analysis of video captured by strategically placed cameras. In today's world, security and monitoring systems are increasingly deployed globally to prevent abnormal events. Effective management and control across all societal sectors are needed to simplify human life, enhancing accuracy and efficiency. Technologies like Artificial Intelligence and Computer Vision can provide more robust and flexible video surveillance systems, improving the security of people and valuable assets while reducing human effort and errors. There remains a need for efficient applications in every sector of society to ensure security and safety.

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