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Motion Detection And Human Activity Recognition For Security

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***Abstract* — A key problem in computer vision called object detection involves locating and identifying objects in an image or video. Deep learning-based methods for object identification have recently produced cutting-edge results., particularly using convolutional neural networks (CNNs). However, real-time object detection remains a challenging problem, requiring great accuracy and rapid response. In this project, we propose a real-time object detection system using CNNs. We train the model on a large dataset of annotated images, enhancing performance via approaches such as data augmentation and transfer learning. We then optimize the model for deployment on a target hardware platform, such as a mobile device or embedded system. We illustrate the efficacy of our model. in several real-world applications, such as pedestrian detection and tracking in crowded urban environments, vehicle detection and tracking in traffic scenes, and object detection and tracking in industrial settings. Our system provides a scalable and robust solution for multi-object detection and tracking using deep learning and computer vision techniques.**

Keywords—Computer vision, Convolutional neural network (CNNs), LSTM, Haar Cascade Classifier, deep-learning.

1. Introduction

Object detection is a crucial task in computer vision that involves identifying and localizing objects within an image or video. This is a challenging problem, as objects may vary in appearance, size, and orientation, and may be occluded by other objects or have complex backgrounds.

Traditionally, object detection involved handcrafting features and designing algorithms to detect specific objects. However, this approach was limited by its reliance on prior knowledge and the ability to design effective features.

In recent years, machine learning, computer vision, and AI techniques have revolutionized object detection, leading to significant advances in accuracy and efficiency. Deep learning-based approaches, in particular, have shown great success in object detection, due to their capacity to learn complicated characteristics straight from data.

Convolutional neural networks (CNNs) are a popular deep learning architecture used in object detection. These networks consist of multiple layers that learn increasingly complex features from the input data. Using a big dataset of annotated images to train a CNN, it can learn to recognize objects and their features, such as edges, corners, and textures. Object detection can be formulated as a classification problem, where the task is to predict the class of each object in an image. It can also be formulated as a regression problem, where the task is to predict the location and size of each object. Many object detection algorithms combine these two approaches, predicting the class of each object and its location within the image.

Object detection is crucial in many applications, but related tasks such as object tracking and multi-object detection and tracking are also significant, such as surveillance, robotics, and autonomous driving. These tasks involve tracking the position and movement of objects over time and can be particularly challenging in crowded or dynamic environments.

Object detection using machine learning, computer vision, and AI has many practical applications, ranging from security cameras to autonomous vehicles. By accurately and efficiently detecting and tracking objects, these systems can improve safety, efficiency, and decision-making in a variety of domains.

2. Existing System

2.1 Motion Detection

Motion detection systems detect and monitor movement in a given area. To identify changes in pixel values across

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successive frames of a video stream, they often employ techniques such as frame differencing, background removal, or optical flow analysis. To distinguish between static and dynamic zones, these approaches can be supplemented with thresholding or machine learning algorithms. Video surveillance, object tracking, and activity monitoring all use motion detection systems.

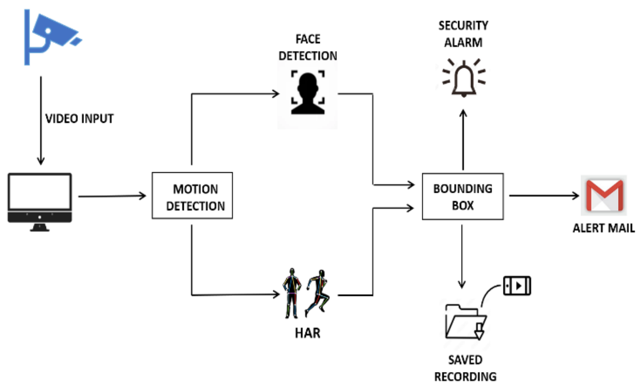
2.2 Face Detection

Face detection systems are intended to find and recognise human faces inside pictures or video frames. They recognise and discriminate face characteristics from other objects or backgrounds using various techniques such as Viola-Jones, Haar cascades, or deep learning-based approaches (e.g., convolutional neural networks). Face recognition, facial expression analysis, biometric identification, and video-based human-computer interaction are examples of uses for these systems.

2.3 Human Activity Recognition

Human activity recognition systems seek to recognise and categorise various activities or behaviours done by persons in films or sensor data. These systems analyse temporal patterns and spatial cues using techniques including feature extraction, machine learning, and deep learning. They can recognise behaviours such as walking, running, sitting, standing, pointing, and more complicated actions such as sporting activities. Human activity recognition systems are used in video surveillance, healthcare monitoring, sports analysis, and human-computer interaction.

3. PROPOSED SYSTEM



The proposed system combines motion detection, face detection, and human activity recognition. If there is any movement in front of the camera, the system will recognise it as motion detected. The following module is the face detection module, which recognises faces in front of the camera. It is important to note that if motion is detected, only the face detection module will be active; the reasoning for this is because if there is no motion, there will be no one in front of the camera. The next phase is to recognise human action. In our system, we have trained the model to detect rope climbing, walking with dog, punching, and hammering.

In addition, the video will be saved in the system, and an alert email with the image will be sent to surrounding stations. An alarm will sound to alert everyone that there is suspicious behaviour in the restricted area.

4. METHODOLOGY

4.1 Motion detection module

OpenCV (Open Source Computer Vision) is used to develop motion detection, which is a common method for identifying and tracking movement in video streams. OpenCV is a free and open-source library that contains a variety of computer vision algorithms and functionalities.

The first step is to capture a video stream or a sequence of frames with a camera or by loading a previously recorded video file. OpenCV includes routines for reading video files and accessing video streams from cameras.

Following that is the Pre-processing. It is usual to conduct pre-processing operations on the frames to increase the accuracy of motion detection. To differentiate the foreground (moving objects) from the backdrop, the frames may be converted to grayscale, noise reduction techniques used, or background subtraction performed. Frame differencing is one of the most basic ways for detecting motion. It entails subtracting successive frames to determine their differences. The differential picture that results emphasises regions where motion has occurred.

Following the acquisition of the difference picture, a thresholding operation is frequently used to generate a binary image, in which pixels over a given threshold value are deemed part of the detected motion, while the rest are considered background. The binary picture may be analysed to find and extract contours or related components using OpenCV's contour detection methods. Each contour denotes a possible motion zone. To reduce

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noise or undesired areas, detected contours can be filtered using different criteria such as area, aspect ratio, or motion direction. To follow the identified objects over frames, tracking techniques such as centroid tracking or Kalman filtering can be used.

4.2 Face detection and Human activity recoginition

When motion is detected, the face detection and human activity detection modules are activated. The Haar Cascade classifier is utilised for face identification, while CNN and the LSTM method are used to train the model for human activity recognition.

The Haar Cascade Classifier is a machine learning-based object recognition approach that can recognise objects or patterns in pictures or videos. It makes use of a series of rectangular Haar-like characteristics to record brightness and contrast fluctuations. The classifier is trained on a dataset of positive and negative samples, with feature weights adjusted using the Adaboost method to optimise performance. It employs a cascade structure with several phases, each of which contains weak classifiers. To accelerate feature evaluation, integral pictures are employed. A sliding window method is used during detection to examine probable item areas at different sizes and locations. For finer detections, post-processing techniques such as non-maximum suppression can be used.

To represent sequential data, the CNN+LSTM technique combines Convolutional Neural Networks (CNNs) with Long Short-Term Memory (LSTM) networks. CNNs extract spatial characteristics, whereas LSTMs extract temporal relationships. This combination allows for the successful analysis of complicated sequential data in fields such as action recognition and video analysis.

4.3 Alert mail and recording

When a security event, such as motion or object recognition, is detected, the system can send an alert email to notify the chosen recipient. This entails collecting important frames or pictures from the video feed and utilising Python email modules to send the alert with accompanying graphics. The email may include event information, a timestamp, and any other pertinent facts.

The security system has the ability to record the current video stream and save it for later study or analysis. OpenCV has functions for interacting with and processing video streams. Frames can be continually collected and stored to disc using these functions. This recording can be initiated by specified events, run at regular intervals, or run indefinitely.

By combining these features, the security system may deliver real-time email warnings while also storing a recorded feed for subsequent reference or analysis. These features improve monitoring capabilities and provide a full security surveillance solution based on OpenCV and Python.

4.4 Security Alarm

When particular events or situations are identified, an alarm can be activated to deliver an auditory alert. To recognise particular events of interest, such as suspicious or questionable activity, the system can use techniques such as motion detection or object identification. Once an event has been recognised, a thresholding technique may be used to identify its severity or relevance depending on characteristics such as magnitude, duration, or location. The alert is triggered if the observed event exceeds the pre-set threshold.

5. CONCLUSION

Finally, a comprehensive security system that includes motion detection, face detection, and human activity identification modules provides robust monitoring capabilities. This technology not only identifies possible security breaches and suspicious activity, but also takes proactive efforts to guarantee rapid reaction. By merging these components, the system can detect unauthorised entrance, follow individuals, and recognise behaviours in real time. Furthermore, the technology goes beyond simple detection by sending alarm emails to adjacent stations, allowing for fast response. Furthermore, the system captures the incidences for future reference and study, assuring a thorough record of events. Furthermore, an audible alert is activated to draw attention and improve security measures on-site. By combining these capabilities, the security system provides a full solution for effective monitoring, rapid reaction, and evidence collecting.

6. RESULT

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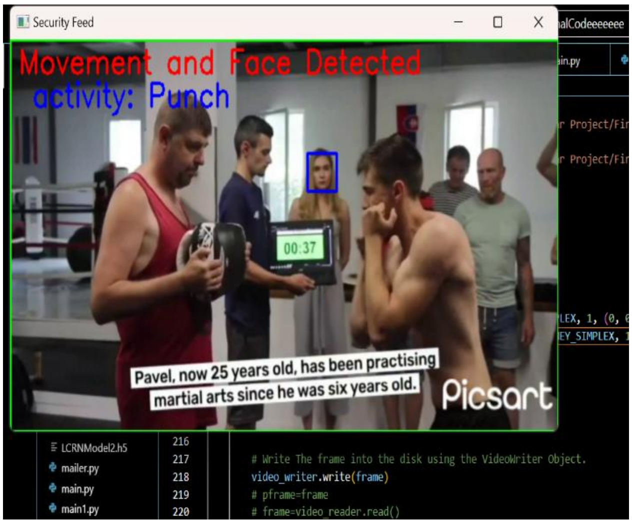

Fig 6.1 Motion and face detected with punch activity.

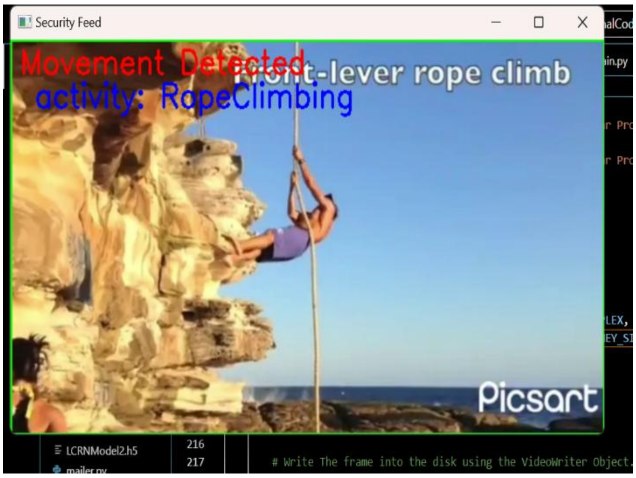

Fig 6.2 Rope Climbing Activity

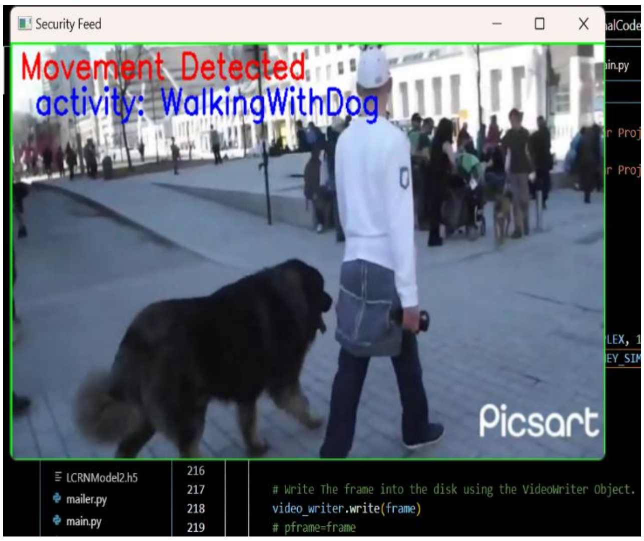

Fig 6.3 Walking with dog activity

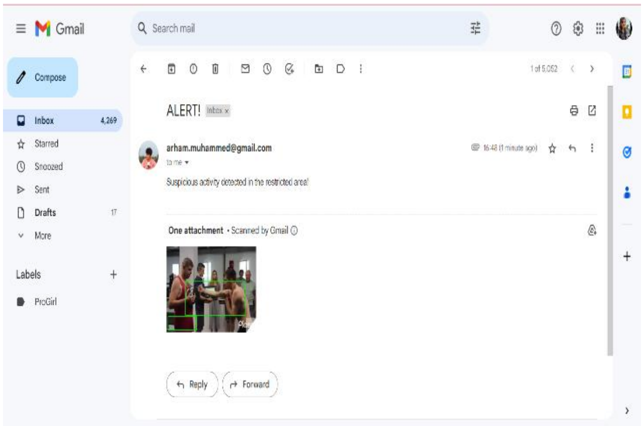

Fig 6.4 Alert mail

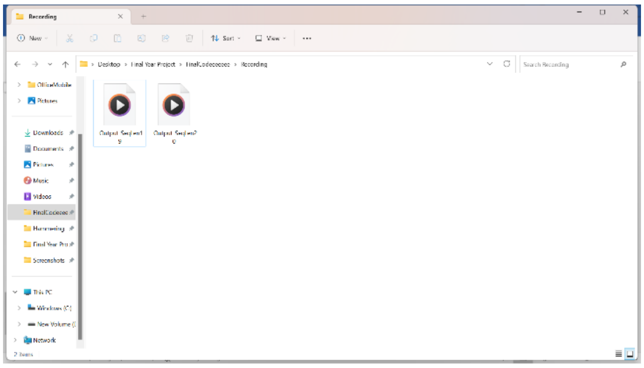

Fig 6.5 Saved Recording

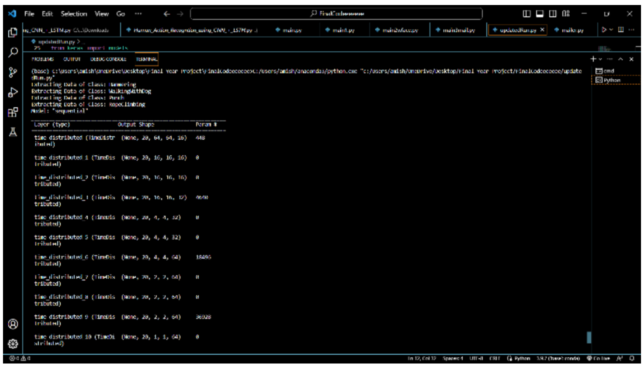

Fig 6.6 Training the model

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