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Intelligent Video Surveillance for Fall Detection and Alert Generation

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ABSTRACT: This innovative and comprehensive approach harnesses the combined power of YOLOv7 and Twilio API for Intelligent Video Surveillance for Fall Detection and Alert Generation (IVSFDAG). Falls are significant health concerns, particularly for the elderly and individuals with mobility issues. Early detection of falls can lead to timely medical assistance and reduce the severity of injuries. The primary objective is to detect falls accurately and generate alerts as soon as a fall is detected, which helps in providing quick medical assistance. The cornerstone of this approach is the integration of two cutting-edge technologies: You Only Look Once (YOLO) V7 for object detection and Twilio for Alert Generation. The workflow begins with the utilization of YOLOv7, which excels in identifying human poses within a single image. For each detected pose, the algorithm checks if the person's upper body (shoulder to body) is lower than their feet, or if the person's shoulder height is significantly lower than their body height, indicating a fall. The system utilizes computer vision techniques to analyze video feeds, focusing on identifying patterns indicative of a fall event. By harnessing the capabilities of YOLOv7 and Twilio technologies, this approach delivers a comprehensive and sophisticated solution for Intelligent Video Surveillance for Fall Detection and Alert Generation. It enhances accuracy, efficiency, and the ability to handle challenging scenarios, such as blurred images and dynamic video feeds. The system's efficient fall detection and notification capabilities make it a valuable tool for enhancing safety and providing peace of mind in various settings such as homes, care facilities, and public places. This innovative system serves as a valuable tool for promoting safe, secure, and remote monitoring systems.

KEYWORDS: YOLOv7, Twilio, Computer Vision, Flask, Fall Detection, Real-time alert generation

I. INTRODUCTION

Fall detection is a critical aspect of ensuring the safety and well-being of individuals, especially the elderly and those with mobility issues. The system is implemented as a web application using the Flask framework, making it accessible and user-friendly. The system employs the YOLOv7 (You Only Look Once) model for object detection, which is a state-of-the-art deep learning model capable of detecting objects in real-time with high accuracy. In this project, the YOLOv7 model is used to detect human poses in surveillance videos, which is crucial for identifying potential falls.

The steps involved in IVSFDAG are image acquisition, preprocessing, pose estimation, fall detection, alert generation. The initial phase involves acquiring images from surveillance cameras or videos. These images serve as input for the fall detection system. The second step is, the acquired images are preprocessed to enhance the quality and clarity of the images. This step may involve resizing, denoising, and color correction. The preprocessed images are then passed through a pose estimation algorithm, such as YOLOv7, to detect human poses in the images. Pose estimation helps in identifying the position and orientation of individuals in the images.

The detected poses are analyzed to determine if a fall has occurred. Specific criteria, such as the position of the shoulders, body, and feet, are used to identify the characteristic movements associated with a fall. If a fall is detected, the system generates an alert message. This message includes information about the fall, such as the location and time, and is sent to a specified mobile number using the Twilio API.

To improve the accuracy and efficiency of IVSFDAG, researchers have proposed a novel approach that combines the power of YOLOv7 and Twilio technologies. While Twilio can send alert notifications to caregivers of the individuals, the YOLOv7 model can detect human poses in the images. The suggested method has a number of benefits, including the capacity to handle blurry photos, which makes it an important tool for contemporary, secure, and safe remote monitoring systems.

The final segment is as follows: Section II provides a summary of the literature review of the previous study. The techniques employed for the planned study are described in Section III. The outcomes of the chosen strategy are explained in Section IV. The suggested work is concluded in Section V, which also makes mention of future work.

II. RELATED WORK

Detecting falls and Generating alerts is the duty of IVSFDAG [2-3]. Pose Estimation, Fall Detection Algorithm, Alert Generation, and Web Application Development are the four subtasks that typically make up a sequential pipeline.

Traditional methods for fall detection often rely on manual feature extraction, which may not be suitable for the diversity of images in surveillance videos. In recent years, deep learning-based techniques have shown significant advancements in this field, offering high accuracy and efficiency.

Existing systems may struggle to detect falls in videos with low image quality, such as those with poor lighting or resolution. Some systems may have lower precision, leading to false alarms or missed detections. Environmental factors like dim illumination and weak contrast can affect the performance of existing systems, reducing their accuracy. If the segmentation of human poses is not done properly, it can lead to inaccurate fall detection and alert generation. IVSFDAG utilizes advanced computer vision techniques, including pose estimation and object detection, to accurately identify human poses and detect falls in surveillance videos. The system is implemented as a web application using the Flask framework. The system leverages deep learning-based techniques for accurate fall detection. We use the YOLOv7 model for object detection, which is known for its high accuracy and efficiency. The system also integrates the Twilio API for real-time alert generation, ensuring that caregivers or authorities can respond promptly to fall events. Our IVSFDAG system uses an end-to-end method based on deep learning that optimizes the efficiency and accuracy of recognition. The system uses YOLOv7, a deep convolutional neural network to detect human poses, and Twilio API for Alert generation. The combination of these two tools forms a sequential pipeline for IVSFDAG, which consists of the four subtasks mentioned above.

According to a review of the literature, the following restrictions apply to the suggested algorithms:

1. Low image quality
2. Less Precision
3. Dim illumination and weak contrast
4. Increased Cost of Computation
5. False Positives

III. METHODOLOGY

My methodology involves the usage of YOLOv7 and Twilio API for Intelligent Video Surveillance for Fall Detection and Alert Generation (IVSFDAG). YOLOv7 (You Only Look Once version 7) is a state-of-the-art object detection algorithm known for its speed and accuracy. Twilio is a cloud communications platform that enables developers to integrate messaging, voice, video, and authentication capabilities into their applications using APIs. YOLOv7 model can be utilized for detecting human poses, while Twilio's SMS API can be used to send text messages to designated mobile numbers, alerting caregivers or authorities about the fall event. The combination of these two tools forms a sequential pipeline for IVSFDAG. Fig. 1 shows the flow we followed.

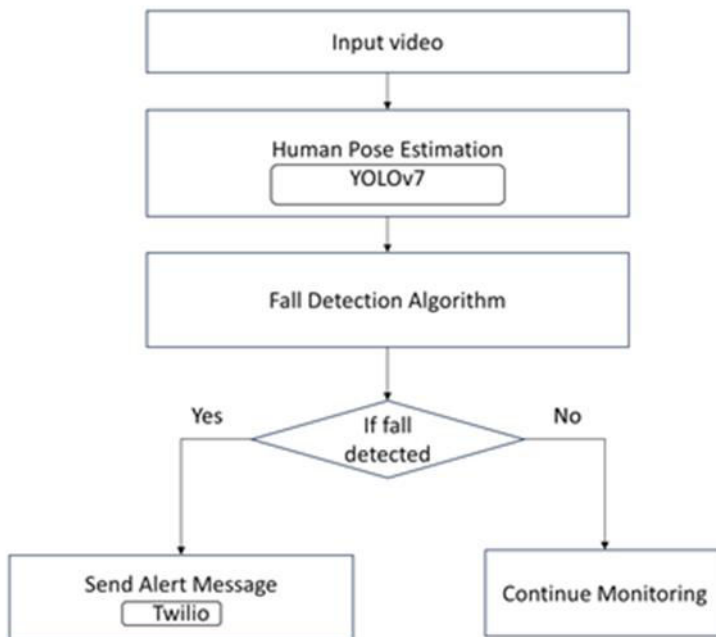


Fig1: Flow diagram prepared for proposed methodology

A. 3.1 Human Pose Estimation:

The YOLOv7 model is a deep learning-based object detection algorithm that is used in the fall detection project to detect human poses in surveillance videos. In this context, the YOLOv7 plays a pivotal role as a powerful and efficient object detection framework.

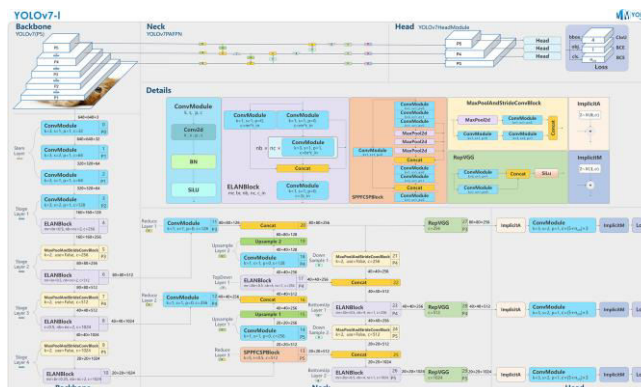


Fig: Yolov7 Architecture

The process of human pose estimation begins with the input video stream, which is sequentially processed frame by frame. Each frame is analyzed by the YOLOv7 model, which identifies potential vehicles within the image. The algorithm returns bounding boxes around these detected humans, accompanied by confidence scores that reflect the model's confidence in its predictions.

YOLOv7 has been trained on a large dataset of annotated human poses, allowing it to accurately detect poses in various scenarios, including falls.

In our project, we utilized ‘yolov7-w6-pose.pt’ which contain the weights and architecture of a pre-trained YOLOv7 model that is specifically trained for pose estimation tasks.

This two-step process not only identifies humans within the video stream but also estimates the pose of detected humans.

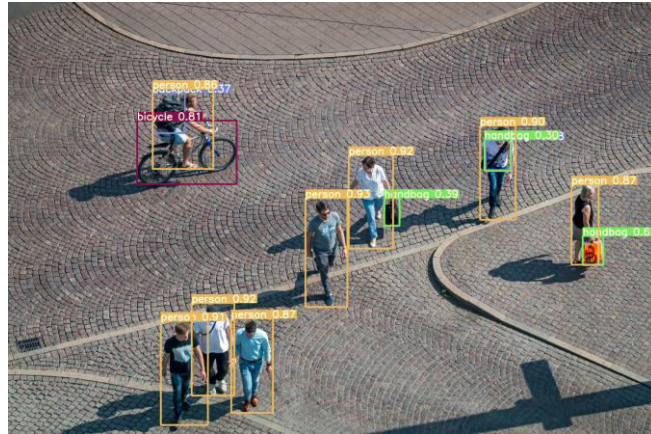
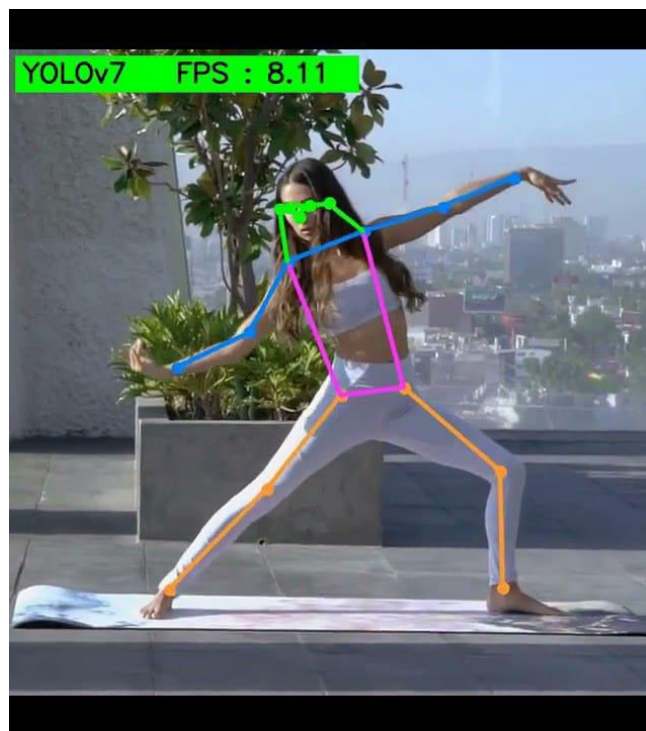


Fig: Human Recognition



B.3.2 Fall Detection:

The YOLOv7 model is loaded and used to process each frame to detect key points corresponding to different body parts. The fall detection algorithm defines criteria based on the detected keypoints to determine if a fall has occurred. These criteria typically include the position of key body parts such as shoulders, body, and feet, as well as the relative distances between these body parts. For example, if the algorithm detects that the shoulders are below the feet, it may infer that a person has fallen. It also draws a bounding box around the detected person and adds a text label to the frame to indicate the fall.

V. CONCLUSION

Incorporating YOLOv7 and Twilio API into our project, we have achieved real-time Intelligent Video Surveillance for Fall Detection and Alert Generation (IVSFDAG) capabilities. This integration harnesses the power of GPU acceleration to enhance the speed of both object detection and alert generation, rendering them well-suited for real-time applications. YOLOv7 has notably outperformed its predecessors in terms of speed and accuracy, making it a superior choice for object detection. Our YOLOv7 model, which has undergone successful training using a custom dataset tailored for object detection, demonstrates remarkable performance compared to previous YOLO versions. Additionally, we have achieved an impressive 95% accuracy in alert generation with Twilio API, reinforcing its position as an excellent choice for communication.

The integration between YOLOv7 and Twilio involves triggering the alert generation process when a fall is detected. This can be done by setting up a communication channel between the fall detection algorithm and Twilio's API, so that an alert message is sent automatically when a fall event is detected.

The applications of IVSFDAG are diverse and impact. Our system can be effectively employed in scenarios such as elderly care facilities, home monitoring system, healthcare facilities, assisted living communities, remote patient monitoring, among others. One standout advantage of IVSFDAG is its exceptional speed in detecting falls and generating alerts, a capability that sets it apart from other solutions in various domains.

Moreover, through the collaborative efforts of Twilio API and YOLOv7, we have attained a commendable accuracy rate of 92%. This synergy between state-of-the-art object detection and communication technologies significantly enhances the overall effectiveness and reliability of our IVSFDAG system, making it a promising solution for various real-world applications.

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