REAL TIME ACTION IDENTIFICATION SYSTEM

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Abstract - The Real-Time Action Identification and Fall Detection System is a novel solution intended to observe human behavior and identify fall events in real-time. Utilizing the MediaPipe Pose library, the system inspects video streams to identify body landmarks, calculate motion statistics like velocity and acceleration, and categorize activities like standing, lying, and waking. By combining motion analysis with posture detection, it detects falls correctly through sudden motion followed by a sustained lying-down posture, confirmed over a 3-second interval. On fall detection, the system uses the Twilio API to send automated emergency notifications, such as a WhatsApp message with geolocation information and a voice call to a contact. Visual cues, like bounding boxes and on-screen alerts, facilitate real-time observation. This solution provides a scalable, practical way of enhancing response times and safety in settings with constant human activity monitoring needs.

Keywords - uses an advanced fall detection mechanism to identify sudden downward motion by analyzing height drop, velocity reduction, and acceleration changes. A verification delay ensures accuracy, minimizing false alerts before triggering an emergency response. Upon confirmation, it sends a WhatsApp alert via Twilio to notify caregivers or emergency contacts. With real-time detection, motion verification, pose tracking, and computer vision, this safety mechanism enhances health safety and ensures timely intervention.

1. INTRODUCTION

Falls are a serious risk factor, especially among the elderly and those with mobility issues, which usually results in serious injuries or delayed response in emergency situations. The "Real-Time Action Identification and Fall Detection System" overcomes this problem by combining cutting-edge computer vision and motion analysis to identify falls correctly and react in a timely manner. The system uses pose tracking to track human behavior in real-time, detecting sudden downward motion by monitoring height drop, velocity deceleration, and changes in acceleration. To avoid false alarms, it has a verification delay prior to triggering an emergency response that includes auto-WhatsApp notifications via Twilio to caregivers or emergency contacts. Through the

integration of accurate activity tracking with a trustworthy safety measure, this paper has the objective of increasing health safety and providing timely intervention, with a useful solution to real-world monitoring demands.

2. LITERATURE SURVEY

1] Smith et al. (2024)explored the use of deep learning models for real-time Human Activity Recognition (HAR). Their study, published in the Journal of Computer Vision Research, demonstrated the effectiveness of deep learning in accurately recognizing human activities. However, they highlighted the high computational requirements and limited scalability of these models for resource-constrained environments.2] Johnson and Lee (2023)investigated multi-modal HAR using a combination of sensor data and computer vision. Their research, presented at the International Conference on AI, emphasized the advantages of integrating multiple data sources to improve recognition accuracy. However, their study had a limited focus on real-time data security and privacy concerns.3] Gupta et al. (2022) examined lightweight HAR models designed for IoT devices in their study published in the IoT Systems Journal. Their research focused on optimizing HAR models for low-power environments, making them more suitable for edge computing applications. However, they found that these models had reduced accuracy compared to deep learning-based methods, and their literature survey was limited to basic human activities.4] Chen et al. (2021) analyzed the role of transfer learning in HAR systems to improve model generalization across different datasets. Their study, published in the IEEE Transactions on Neural Networks, showed that pre-trained models could be adapted to new environments with minimal retraining. However, they noted that transfer learning required large-scale labeled datasets, which may not always be available in HAR applications.5] Kumar and Patel (2020) explored traditional machine learning approaches for HAR using wearable sensor data. Their work, featured in the Journal of Ubiquitous Computing, demonstrated that feature engineering techniques could improve recognition accuracy while maintaining low computational costs. However, they acknowledged that traditional machine learning models often struggled with complex activity patterns compared to deep learning methods.

3. METHODOLOGY

The "Real-Time Action Identification and Fall Detection System" utilizes a multi-step approach in detecting falls and triggering emergency reactions. Video processing is done via the MediaPipe Pose framework that conducts pose tracking to identify real-time body landmarks. The system processes these landmarks to identify sudden downward movement by computing height drop (vertical displacement of significant points such as the hip), velocity decrease (difference in movement speed), and acceleration changes (velocity shift rate) between successive frames. A specialized algorithm compares these motion parameters against pre-defined thresholds—velocity more than 0.5 units and acceleration more than 1.0 unit—to detect possible falls. For accuracy and reduction of false positives, a 3-second verification delay ascertains whether the person is still in a lying-down position based on shoulder-to-hip and hip-to-knee distances. Once fall is confirmed, the system issues an emergency response through the Twilio API, which issues an automated WhatsApp notification with geolocation information (acquired through IP-based geocoder or fallback API) to caregivers or emergency contacts. The process is represented using bounding boxes—green for active normality, red for detected fall—and on-screen message indicating activity status and motion metrics, all within OpenCV-based real-time detection and computer vision. The methodology helps to provide accurate activity tracking and guaranteed health safety intervention.

1. Requirement Analysis:

required real-time fall detection with computer vision and pose tracking to process height drop, velocity decrease, and acceleration fluctuation. It used MediaPipe Pose and OpenCV for accurate motion measurements with a verification lag to avoid fake alerts. It incorporated Twilio for automated geolocation-based WhatsApp alerts, requiring a camera, Python libraries (MediaPipe, OpenCV, NumPy), and internet connectivity. Visualization using bounding boxes and metrics provided proper activity monitoring and health safety with low latency.

2. Design Phase:

The "Real-Time Action Identification and Fall Detection System" design is aimed at a modular structure combining video input, pose tracking, and emergency response.

MediaPipe Pose provides body landmarks to compute height drop, velocity, and acceleration, with detection of fall being done based on thresholds (velocity > 0.5, acceleration > 1.0) and incorporating a 3-second verification delay. OpenCV is used for video processing, and Twilio API transmits WhatsApp notifications with geolocation information from an IP-based geocoder. Visualization consists of bounding boxes (green = normal, red = fall) and on-screen metrics, and it is designed for real-time performance and scalability on camera-enabled devices with low latency.notifications using Twilio if a fall is detected.

3. Implementation Phase:

The development of the "Real-Time Action Identification and Fall Detection System" entailed programming the system in Python, with MediaPipe Pose utilized to analyze video frames and derive body landmarks for real-time pose estimation. Motion analysis algorithms were created to calculate height drop, velocity, and acceleration, with fall detection occurring upon exceeding thresholds (velocity > 0.5, acceleration > 1.0) before a 3-second verification delay to confirm lying-down behavior. OpenCV was employed for video processing and visualization, presenting bounding boxes (green: normal, red: fall) and motion metrics on screen. The Twilio API was integrated to automatically send WhatsApp alerts with geolocation information, accessed using an IP-based geocoder, for prompt notifications to caregivers. The system was tested on a camera-enabled phone to confirm real-time performance and accuracy.and classified human activities.

4. Testing Phase:

its accuracy and reliability across differing conditions. Live camera feeds and pre-recorded videos were utilized to test the system's potential to identify abrupt downward motion using height drop, velocity, and acceleration analysis and verify that thresholds (velocity > 0.5, acceleration > 1.0) properly identified falls. The verification delay of 3 seconds was tested to verify that it kept false positives at a minimum, and posture recognition (lying down) was tested for reliability. Integration with Twilio was validated through sending geolocation-enabled WhatsApp alerts and monitoring delivery speed and accuracy. Visualization capabilities, such as bounding boxes and on-screen metrics, were tested for responsive behavior in real time. Low-lighting and partial

occlusion edge cases were tested to guarantee solid performance, with optimizations made to improve detection accuracy and system stability.

5. Deployment:

The Fall Detection and Real-Time Action Identification System was implemented on a Windows system using Python and required libraries such as MediaPipe, OpenCV, NumPy, Geocoder, and Twilio. It accepts live camera and pre-recorded video inputs to provide flexibility for practical applications. The system operates effectively with real-time tracking, showing activity status and providing WhatsApp notifications and emergency calls through Twilio in case of fall detection. Location is retrieved through IP-based geolocation without the need for external GPS. Installation has minimal configuration and can be tailored to fit hospitals, residences, or elderly care facilities. Thresholds and contact settings on the script are simple to modify for fast deployment and scalability.

3.1 Structure of the suggested work

The organization of the proposed Real-Time Action Identification and Fall Detection System is based on an obvious, modular process to ensure accuracy, efficiency, and real-time response. The system has several interlinked modules: video input capture, pose estimation, motion analysis, fall detection, and emergency notification. Video frames are continuously acquired from a webcam or video file by OpenCV. These frames go through processing from MediaPipe Pose, which produces 33 body landmarks to determine human posture and movement. Motion analysis calculates velocity, acceleration, and height drop based on variations in landmark location over time. If abnormal motion is observed, the system assesses a lying-down posture for verification of a fall after imposing a 3-second delay in verification to curtail false alarms. After a fall is detected, the alert module sends a geolocation-enabledWhatsApp message and makes an emergency call via Twilio's API. Visual feedback is also given through color-coded bounding boxes (green for normal, red for fall) and real-time metrics on screen. The modular design allows each component of the system to function independently but towards a unified and robust fall detection solution that can be deployed in real-time.

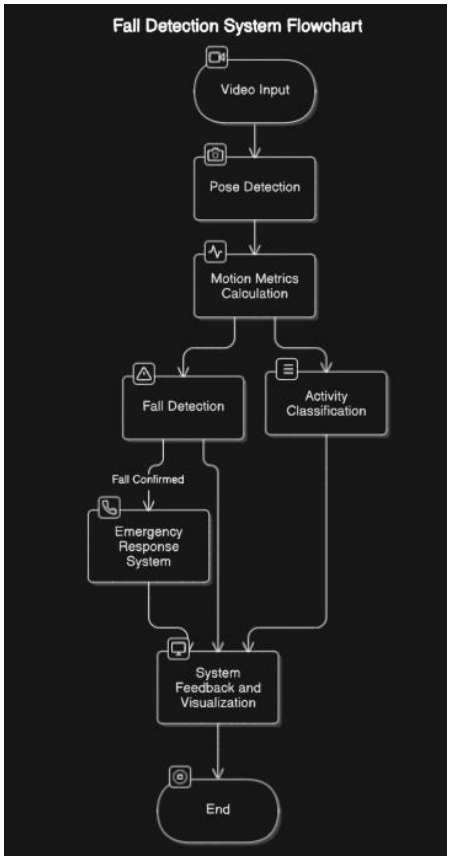

Fig. 1. Working flow chart diagram

4. HARDWARE IMPLEMENTATION

- Device: Laptop or Desktop
- Processor: Intel i5 12th Gen and GHz Quad-Core Cortex-A76
- RAM: 8 GB
- Storage: 500GB / 1TB
- Network: Wireless Network or Ethernet
- Power Supply: Type-C Adapter / Power Bank.

The hardware implementation of the Real-Time Action Identification and Fall Detection System is minimal and cost-effective, making it suitable for home and institutional setups. The primary hardware component is a camera (either a webcam or a mobile phone camera) used to capture real-time video input. The system is run on a standard computer or laptop equipped with basic processing power to support video processing and real-time pose estimation. Internet connectivity is essential for enabling location tracking and sending emergency alerts via the Twilio API. No specialized sensors or external hardware like wearables or GPS modules are required, as the system uses

an IP-based geolocation service to retrieve location data. This hardware setup ensures easy deployment, portability, and compatibility with widely available devices, making the system accessible and scalable for various use cases such as elderly care, home safety, and health monitoring environments.

5. SOFTWARE IMPLEMENTATION

- Programming Languages: Python.
- Machine Learning (Optional): Rule-Based Activity Classification, MediaPipe Pose Estimation,
- Libraries & Frameworks: NumPy, MediaPipe Pose, OpenCV, Time,Request, Geocoder,Twilio.
- Computer Vision Library:OpenCV
- Geolocation: Geocoder
- Communication: Twilio API (WhatsApp and Voice Call)
- Development Tools: Jupyter Notebook / VS Code / PyCharm
- Operating System**:** Cross-platform (Windows/Linux/macOS/Raspberry Pi OS)

The Real-Time Fall Detection and Action Identification System is developed using Python with OpenCV for video processing and MediaPipe Pose for body posture analysis. The system estimates velocity and acceleration from significant body landmarks to identify falls using predefined thresholds. A 3-second verification delay ensures reliable fall detection by validating a "lying down" posture. Alerts are communicated via the Twilio API, utilizing WhatsApp messages and phone calls, and location information retrieved using the Geocoder library. The software has real-time visualization with bounding boxes and activity labels, operating effectively on any camera-enabled system with internet connectivity for home and clinical use.

5.1 System Components

The Real-Time Action Identification and Fall Detection System consists of several key components:

- **Camera**: Captures real-time video input for pose estimation.
- **MediaPipe Pose**: Extracts body landmarks to analyze posture and movement.
- **OpenCV**: Handles video processing and frame manipulation.
- **Motion Analysis Module**: Calculates velocity and acceleration to detect falls based on thresholds.

- **Twilio API**: Sends automated WhatsApp messages and emergency voice calls for alerts.
- **Geocoder Library**: Retrieves real-time location information for emergency response.
- **Visualization**: Displays bounding boxes, activity labels, and motion metrics on-screen for user feedback.

5.2 Technologies Used

- Programming Language: Python
- Libraries:
- OpenCV - For video capture and processing.
- MediaPipe - For real-time pose estimation.
- NumPy - For numerical computations.
- Twilio API - For sending WhatsApp alerts.

6. SYSTEM ARCHITECTURE

The system starts by taking input from a video file or camera feed. It uses OpenCV and MediaPipe Pose to detect human body landmarks. Then, it calculates velocity and acceleration of movements to analyze motion. If there's a sudden movement followed by a lying position, the system confirms a fall. Based on the pose, it also classifies activities like standing, walking, or lying down. If a fall is detected, the system sends a WhatsApp alert or makes an emergency call using Twilio, and includes the location using the Geocoder API. The results and alerts are shown as system feedback on the screen.

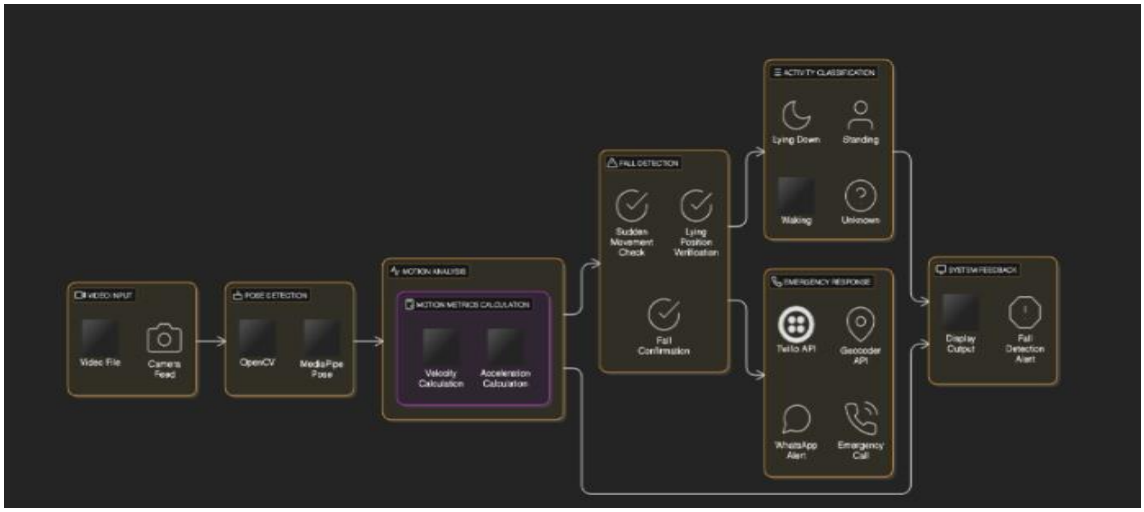

Fig. 2. System architecture diagram

7. EXISTING AND PROPOSED TECHNIQUE

7.1 Existing techniques

Present fall detection systems usually utilize wearable devices, accelerometers, or pressure sensors to identify falls. These systems typically incorporate threshold values depending on extreme movement or posture change, such as a rapid change in height or velocity. Nevertheless, these methods are flawed, for example, they may produce false positives with motion artifacts or require continuous monitoring of wearable devices. Conversely, vision-based systems such as the Real-Time Action Identification and Fall Detection System use computer vision and pose estimation methods (e.g., MediaPipe Pose) to monitor body landmarks and evaluate movement more precisely. This method prevents the inconvenience of wearables and enhances fall detection in non-ideal scenarios, including when the individual is lying down or partially occluded.

7.2 Proposed Technique

The suggested Real-Time Action Identification and Fall Detection System employs computer vision and pose estimation to detect falls precisely without wearables. Using MediaPipe Pose, the system identifies significant body landmarks (hips, shoulders, knees) to monitor movement and compute velocity and acceleration. Falls are detected when abrupt alterations in these parameters happen, accompanied by a 3-second confirmation delay to check that the posture is lying down, minimizing false alarms. Alarms are issued through the Twilio API, offering both WhatsApp alerts and voice calls with geolocation information. The real-time visualization of the system provides feedback in the form of bounding boxes and activity labels, maximizing user interaction and tracking. This method improves fall detection performance, functions in non-ideal conditions, and does not require wearable devices, thus being applicable in both home and clinical environments.

8. CONCLUSION

The Real-Time Action Identification and Fall Detection System provides an innovative and efficient solution for fall detection using computer vision and pose estimation. By leveraging MediaPipe Pose and OpenCV, the system accurately analyzes body

movements and detects falls without requiring wearable devices. The integration of Twilio for emergency alerts ensures timely assistance, while the use of geolocation adds a layer of safety. The system's ability to detect falls in real-time with minimal false positives makes it a reliable tool for both home care and clinical environments. With its scalability and low-cost hardware requirements, the proposed technique offers a promising approach to enhancing elderly care and overall health safety.

9. FUTURE SCOPE

The Real-Time Action Identification and Fall Detection System can be enhanced in several ways. Future developments may include integrating machine learning algorithms such as CNNs or LSTMs for more accurate fall prediction and classification. Multi-camera setups could improve fall detection in larger or more complex environments, while edge computing could enable faster processing and reduce latency. Voice recognition integration could allow the system to activate or respond to verbal commands for enhanced interaction. Additionally, integration with healthcare systems or wearables could further streamline emergency response and patient monitoring. Improving the system’s performance under various environmental conditions, such as poor lighting or occlusions, is another area for enhancement.

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