



Scalable Infrastructure for Automated Video Action Recognition Systems

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ABSTRACT :

This paper presents a real-time human fall detection system using YOLOv8-Pose estimation and geometric feature analysis. The system extracts skeletal keypoints and analyzes torso angle, shoulder inclination, bounding-box aspect ratio, and hip position to identify potential falls while distinguishing normal activities.

A temporal state machine manages fall confirmation, recovery monitoring, and alert escalation through a two-stage alert mechanism. Integrated with OpenCV-based motion detection and visual overlays, the proposed system provides a modular approach to automated fall monitoring, with further evaluation required to establish its accuracy and reliability.

Keywords — Human Fall Detection, YOLOv8-Pose, Computer Vision, Human Pose Estimation, Geometric Feature Analysis, OpenCV.

INTRODUCTION

- Human fall detection is essential for safety monitoring and elderly care.
- Traditional fall detection methods rely on wearable sensors or manual supervision, which may limit convenience and continuous monitoring.
- YOLOv8-Pose estimates human skeletal keypoints, enabling effective analysis of body posture and orientation from video frames.
- Geometric features such as torso angle, shoulder inclination, and hip position help distinguish potential falls from normal activities.
- A state-machine-based alert mechanism monitors recovery and escalates unresolved fall events through a visual alert system.
- The system processes video frames in real time and generates annotated visual outputs, providing a practical framework for automated fall monitoring and analysis.

OBJECTIVE:

- To detect potential human falls from video streams in real time.
- To estimate human skeletal keypoints using YOLOv8-Pose.
- To extract geometric features for posture analysis.
- To distinguish falls from normal activities such as bending and sitting.
- To implement a two-stage alert mechanism with recovery monitoring.
- To generate visual alerts and annotated video outputs for monitoring.

LITERATURE SURVEY

1. Human Fall Detection Based on Body Posture Spatio-Temporal Evolution

Zhang et al. proposed a fall detection method using body posture representation and spatio-temporal analysis. The approach examines changes in human posture over time to identify fall events in complex environments.

2. Using Deep Neural Networks for Human Fall Detection Based on Pose Estimation

Salimi et al. investigated deep neural networks for fall detection using human pose estimation. Their research demonstrates the relevance of skeletal posture information for identifying falls from video data.

3. The Impact of YOLO Algorithms Within Fall Detection Application: A Review

This study reviewed YOLO-based fall detection approaches, discussing model development, benchmark datasets, and evaluation metrics.

4. Language Models in Agriculture Advisory

The researchers proposed an optimized YOLOv8-based method and introduced the DiverseFALL10500 dataset. Their work explores improved feature extraction and fall detection performance using deep learning techniques.

METHODOLOGY

Input Processing

The system accepts video files as input and processes them frame by frame. Each frame is resized to the configured resolution of 360×640 pixels.

Human Pose Estimation

YOLOv8-Pose identifies the human bounding box and extracts 17 skeletal keypoints, including shoulders, hips, knees, and ankles.

Feature Extraction

Geometric features such as torso angle, shoulder inclination, bounding-box aspect ratio, and normalized hip position are calculated from the estimated keypoints.

Fall Detection

The extracted features are evaluated against predefined thresholds to identify potential falls and distinguish them from normal activities such as bending and sitting.

Temporal Validation

The system requires fall conditions to persist for four consecutive frames before confirming a potential fall, reducing transient detections.

Alert Management

A ten-second response timer starts after fall detection. If recovery is not recognized within this period, the system escalates the event to a high-priority visual alert.

Motion Detection

An OpenCV MOG2 background subtraction module provides auxiliary foreground-motion information when skeletal landmarks are obscured.

Display

The system displays skeletal landmarks, bounding boxes, detection status, and alert indicators while saving the processed video as an annotated output file.

EXISTING SYSTEM

1. Manual Human Monitoring How it works:

Caregivers or security personnel continuously observe individuals to identify possible falls.

Drawbacks:

- Requires continuous human supervision.
- Falls may go unnoticed when observers are unavailable.
- Monitoring multiple individuals is difficult.

2. Wearable Sensor-Based Detection Visits How It Works

Wearable devices use accelerometers and gyroscopes to detect sudden changes in body movement.

Drawbacks:

- Requires users to wear and maintain devices.
- Incorrect movement patterns may trigger false alarms.
- Battery charging and sensor placement affect usability.

3. Threshold-Based Video Detection How It Works:

Video frames are analyzed using body shape, motion, or bounding-box measurements to identify potential falls.

Drawbacks:

- Sensitive to camera position and viewing angle.
- Normal activities may resemble falls.
- Occlusion can reduce detection reliability.

4. Traditional Motion Detection How It Works:

Background subtraction and foreground movement analysis identify changes in the monitored scene.

Drawbacks:

- Slow and costly
- Needs trained staff and equipment
- Impractical for routine screening

PROPOSED SYSTEM
1. Video Input and Preprocessing Objective:

Prepare video frames for fall detection.

How It Works:

- Accepts a video file as input.
- Reads and resizes frames to the configured resolution.
- Passes processed frames to the pose estimation module..

2. Human Pose Estimation Objective:

Extract human body posture information.

How It Works:

- YOLOv8-Pose detects the person and estimates skeletal keypoints.
- Keypoints represent major anatomical joints.
- The detected landmarks are used for geometric analysis.

3. Geometric Feature Analysis Objective:

Identify posture changes associated with potential

falls. **How It Works:**

- Calculates torso angle and shoulder inclination.
- Computes bounding-box aspect ratio.
- Evaluates normalized hip position to assess body posture.

4. Fall Detection and Validation**Objective:**

Distinguish potential falls from normal activities.

How It Works:

- Evaluates extracted features against predefined thresholds.
- Uses combined posture and position criteria.
- Confirms potential falls using four consecutive qualifying frames.

5. Two-Stage Alert Mechanism Objective:

Monitor recovery and escalate unresolved fall events.

How It Works:

- Initiates a ten-second response timer after fall detection.
- Cancels the alert when recovery is recognized.
- Generates a high-priority red visual alert if recovery is not detected in time.

6. Auxiliary Motion Detection Objective:

Provide additional foreground-motion information.

How It Works:

- Uses OpenCV MOG2 background subtraction.
- Identifies foreground regions in video frames.
- Supplies auxiliary information when pose landmarks are obscured, subject to the implemented integration.

7. Visualization and Output Objective:

Display detection results and facilitate monitoring.

How It Works:

- Displays bounding boxes, skeletal landmarks, and status indicators..
- Shows fall alerts and countdown information.
- Saves annotated videos for subsequent inspection.

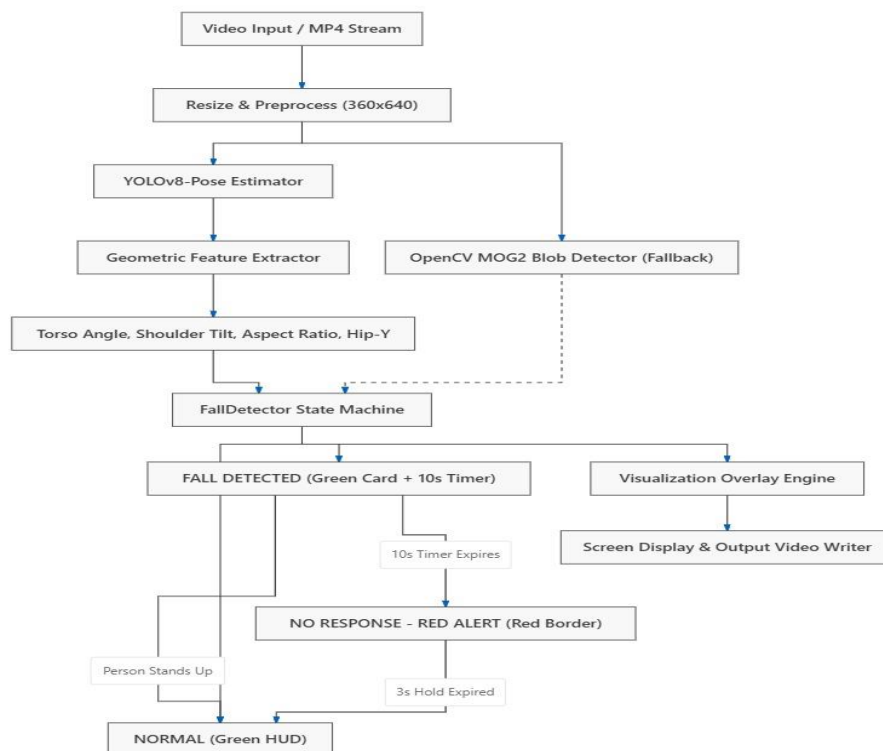
SYSTEM REQUIREMENT

Hardware Requirements

- Processor: Intel i3 or above
- RAM: Minimum 4 GB (8 GB recommended)
- Storage: Minimum 5 GB free space
- Camera: Webcam or video recording device, if capturing live footage.
- GPU: Optional; performance depends on the available inference hardware.

Software Requirements

- Programming Language: Python.
- Pose Estimation: YOLOv8-Pose.
- Computer Vision: OpenCV.
- Numerical Processing: NumPy.
- Video Processing: OpenCV video capture and video writer.
- Configuration: Python-based config.py.
- Development Environment: Visual Studio Code or another Python IDE
- Virtual Environment: Python venv.
- Input Format: Supported video sources, such as MP4 files.
- Output: Annotated video files and real-time visual overlays.

Flow Chart:**MODE OF DESCRIPTION:**

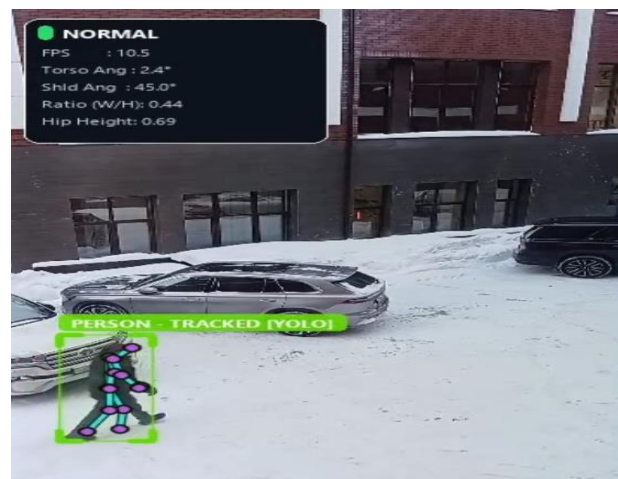
- Normal Human Posture Detection
- Fall Detection and Alert Monitoring
- Recovery and Normal State Recognition

Normal Human Posture Detection:

YOLOv8-Pose tracks the person and analyzes skeletal keypoints to identify normal posture.

Fall Detection and Alert:

The system detects a potential fall and starts a 10-second recovery countdown.

Recovery Recognition:

The system recognizes the person's return to an upright posture and restores the normal monitoring state.

CONCLUSION:

The proposed system detects potential human falls using YOLOv8-Pose and geometric feature analysis. It evaluates skeletal keypoints to distinguish falls from normal activities and uses temporal validation to reduce false detections. The two-stage alert mechanism monitors recovery and generates visual alerts when necessary. Real-time visualization provides clear information about posture and detection status. Overall, the system offers a promising approach to automated fall monitoring, with further testing required to establish its accuracy and reliability in real-world environments.

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