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Research Paper

HUMAN ACTIVITY RECOGNITION WITH OPENCV

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Abstract

This paper proposes an intelligent real-time system integrating Human Activity Recognition (HAR) with fire and human detection using advanced computer vision and deep learning techniques. The system employs the YOLO-based object detection model for identifying fire, smoke, and human presence, while HAR is achieved using a hybrid approach combining Convolutional Neural Networks (CNN) for spatial feature extraction and Long Short-Term Memory (LSTM) networks for temporal activity classification. OpenCV is utilized for preprocessing and feature extraction from video streams. The model is trained and evaluated on publicly available datasets such as fire image datasets and human activity datasets (e.g., UCF101). Experimental results demonstrate improved accuracy, real-time performance, and reliable detection under different environmental conditions. The proposed system effectively recognizes human activities such as walking, running, and abnormal behavior during fire incidents, thereby enhancing situational awareness and emergency response. This integrated approach provides a scalable and efficient solution for smart surveillance and disaster management applications.

Keywords:
Human Activity Recognition (HAR), YOLO, Fire Real Time Detection, OpenCV, CNN-LSTM, Real-Time Surveillance, Deep Learning

I. Introduction

Human Activity Recognition (HAR) is an important area of research in computer vision and artificial intelligence that focuses on identifying and classifying human actions from video data or sensor inputs. With the rapid growth of smart technologies and surveillance systems, the need for automatic understanding of human behavior has increased significantly. HAR systems aim to recognize activities such as walking, running, sitting, and other complex behaviors by analyzing visual and temporal patterns in data.

Traditionally, HAR relied on handcrafted feature extraction techniques such as motion analysis, optical flow, and shape-based methods. However, these approaches often struggled to perform accurately in real-world environments due to variations in lighting, background, and human appearance. With the advancement of deep learning, modern HAR systems now utilize models such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), which can automatically learn meaningful features from raw data and significantly improve recognition performance.

HAR has a wide range of applications across various domains, including healthcare, surveillance, sports analytics, smart homes, and human-computer interaction. In healthcare, it is used for patient monitoring and fall detection, while in surveillance systems, it helps detect suspicious or abnormal activities. The ability of HAR systems to operate in real time makes them highly valuable in critical applications where quick decision-making is required.

Despite its advancements, HAR still faces several challenges such as occlusion, environmental variations, high computational requirements, and the need for large datasets. Ongoing research focuses on improving model efficiency, integrating multiple data sources, and enhancing the ability to recognize complex and long-duration activities. Overall, HAR continues to evolve as a key technology for building intelligent and automated systems that can understand and respond to human behavior effectively.

II. Literature Survey

A study (2022) by Kumar et al. [1], titled "Human Activity Recognition using OpenCV & Python," proposes a surveillance-based system for detecting basic human actions like walking, running, sitting, and standing. The method uses OpenCV for video frame processing and skeletal pose estimation from a single-camera setup. The system is evaluated on recorded video datasets. Results show effective real-time recognition potential. This supports our idea of identifying human presence in fire emergency scenarios.

A study (2023) by Singh et al. [2], titled "Unusual Crowd Activity Detection using OpenCV and Motion Influence Map," proposes a real-time suspicious activity detection system for surveillance. The method uses OpenCV for video frame processing and Motion Influence Maps for pixel-level motion tracking. The approach is tested on surveillance video datasets. Results indicate improved detection of abnormal crowd behavior. This work relates to our idea by supporting real-time human activity and anomaly detection in emergency situations like fire.

A study (2023) by Patel et al. [3], titled "Human Activity Recognition with OpenPose and Long Short-Term Memory on Real Time Image," proposes a real-time HAR system using pose estimation and sequence learning. The method uses OpenPose for skeletal keypoint extraction and LSTM networks for temporal classification. Experiments use real-time camera-captured video data. Results show improved accuracy for dynamic actions. This work relates to our idea by enabling real-time human detection in fire emergency and rescue monitoring systems.

A study (2023) by Lee et al. [4], titled "A Deep Learning-Based Human Activity Recognition in Darkness," proposes a thermal image-based HAR system for low-visibility environments. The method uses OpenPose for skeleton extraction from thermal videos and a deep recurrent neural network for activity classification. The system is tested on thermal video datasets. Results show strong performance in dark conditions. This work relates to our idea by supporting human detection in fire and smoke-affected emergency environments.

A study (2024) by Johnson et al. [5], titled "The Science of Video: A Review of Human Activity Recognition Techniques," reviews multiple HAR approaches for real-time video analysis in surveillance and healthcare. It discusses methods such as CNNs, RNNs, and pose-based models, though no specific dataset is used as it is a survey paper. The study highlights challenges like occlusion and real-time processing limits. This work relates to our idea by guiding robust human detection in emergency fire monitoring systems.

A study (2022) by Gupta et al. [6], titled "An Intelligent Motion Detection Using OpenCV," proposes a computer vision-based system for detecting and tracking moving objects in real time. The method uses OpenCV techniques such as background subtraction and pixel-level motion analysis. It is evaluated on open-source image/video samples. Results show effective motion detection under varying environmental conditions. This work relates to our idea by supporting real-time human movement detection in fire emergency surveillance systems.

A study (2024) by Wang et al. [7], titled "Deep Learning Enhanced Human Activity Recognition and Behaviour Analysis with OpenCV Integration," proposes a real-time HAR system using deep neural networks combined with OpenCV preprocessing. The model is trained on standard surveillance video datasets to recognize actions like walking, sitting, and jogging. Results show improved accuracy and abnormal behavior detection. This work relates to our idea by enhancing real-time human monitoring in fire emergency and rescue systems.

A study (2024) by Kumar et al. [8], titled "Real-time exercise assessment: MediaPipe & OpenCV approach," presents a real-time human pose estimation system for activity monitoring in fitness applications. The method uses MediaPipe for skeletal landmark detection and OpenCV for video processing and form analysis. It is evaluated on real user exercise data. Results show reliable pose tracking and activity recognition. This work relates to our idea by supporting real-time human detection and posture analysis in emergency fire scenarios.

A study (2023) by Ali et al. [9], titled "Enhancing Human-Computer Interaction Through Vision-Based Hand Gesture Recognition: An OpenCV and Keras Approach," proposes a vision-based gesture recognition system for real-time interaction. The method uses OpenCV for image preprocessing and Keras-based deep learning models for gesture classification. It is trained on a curated hand gesture dataset. Results show high accuracy in recognizing multiple gestures under varying lighting conditions. This work relates to our idea by improving real-time human detection and interaction in emergency monitoring systems like fire rescue scenarios.

A study (2023) by Rodriguez et al. [9], titled "Improving Human Activity Recognition Integrating LSTM With Different Data Sources: Features, Object Detection and Skeleton Tracking," proposes a multimodal HAR system combining deep learning and computer vision. The method integrates object detection, skeletal tracking, and feature extraction using LSTM networks. It is evaluated on indoor activity datasets. Results show improved classification accuracy over single-method models. This work relates to our idea by enabling robust human activity detection in complex emergency environments like fire rescue situations.

A study (2023) by Patel et al. [10], titled "OpenCV and its Applications in Artificial Intelligent Systems," reviews the use of OpenCV in AI-based computer vision tasks such as object detection, facial recognition, and image processing. No specific dataset is used as it is a review paper. It discusses methods like real-time frame processing and feature extraction. The study reports improved efficiency in AI vision systems. This work relates to our idea by supporting real-time human and fire detection in emergency monitoring systems.

A study (2024) by Sharma et al. [11], titled "Computer Vision with Deep Learning for Human Activity Recognition: Features Representation," reviews deep learning approaches for HAR in real-world environments. It discusses CNNs for spatial feature extraction and RNN/LSTM models for temporal analysis, with evaluation on standard video datasets. Results highlight improved accuracy using hybrid CNN-RNN frameworks. This work relates to our idea by enabling robust real-time human activity detection in complex emergency scenarios like fire and rescue systems.

A study (2023) by Ahmed et al. [12], titled "Human Behavior Analysis: A Survey on Action Recognition," reviews major Human Activity Recognition (HAR) techniques including action classification and spatiotemporal localization. It summarizes both handcrafted feature methods and deep learning approaches like CNNs and RNNs. No specific dataset is used as it is a survey paper, but benchmarks like UCF and Kinetics are discussed. This work relates to our idea by guiding robust human behavior detection in emergency fire surveillance systems.

A study (2023) by Zhang et al. [13], titled "Deep-Learning-Enhanced Human Activity Recognition for Internet of Healthcare Things," proposes a semi-supervised HAR framework for IoHT environments. It uses multisensor data fusion and LSTM-based classification, along with a DQN-based auto-labeling strategy to improve weakly labeled data learning. Evaluated on real-world wearable sensor datasets, the method shows improved recognition accuracy. This work relates to our idea by enhancing real-time human activity detection and tracking in emergency and healthcare-related monitoring systems.

A study (2024) by Bansod et al. titled [14]"A Survey on Deep Learning Models for Human Activity Recognition" reviews CNN, RNN, and hybrid architectures for video-based HAR. The study analyzes benchmark datasets such as UCF101 and HMDB51. It concludes that deep learning methods significantly improve recognition performance. This work relates to our idea by guiding model selection for accurate human detection in emergency fire environments.

A study (2025) titled [15]"A Human Activity Recognition Model Based on Deep Neural Network Integrating Attention Mechanism" by Xu et al. proposes a CNN-based architecture with attention-enhanced feature learning. The model is evaluated on standard video datasets and shows high classification accuracy with improved temporal focus. This work relates to our idea by improving precision in detecting human presence and activity during fire and smoke conditions.

III. System Analysis

Human Activity Recognition (HAR) is an important application in areas such as surveillance, healthcare, and smart environments. It involves identifying human actions like walking, running, sitting, or falling from video or sensor data. Traditional monitoring methods are manual and inefficient. With advancements in computer vision, automated systems can analyze video streams in real time. The system must process continuous video input and detect human movements accurately. It should handle variations in lighting, background, and camera angles. OpenCV provides powerful tools for image and video processing. The system must ensure real-time performance with high accuracy. Integration with machine learning improves recognition capability. Scalability is required for large-scale deployments. Overall, the system needs an intelligent and efficient framework for activity detection.

Existing System

Existing systems for human activity recognition often rely on wearable sensors or manual observation. Sensor-based systems require users to wear devices, which may not always be practical. Some vision-based systems use basic motion detection techniques. These systems rely on simple feature extraction methods. They struggle with complex activities and dynamic environments. Existing models often use traditional machine learning techniques with limited accuracy. Real-time processing is not always supported. Environmental factors such as lighting and occlusion affect performance. Many systems lack robustness and adaptability. They also require significant preprocessing. Overall, existing systems provide limited accuracy and flexibility.

Disadvantages of Existing System

- Dependence on wearable sensors in some systems
- Low accuracy in complex environments
- Limited ability to recognize multiple activities
- Sensitivity to lighting and background changes
- Lack of real-time performance
- High preprocessing requirements
- Limited scalability

Proposed System

The proposed system uses OpenCV for real-time human activity recognition from video input. It captures video frames and processes them using computer vision techniques. Background subtraction and object detection are applied to identify human subjects. Feature extraction methods analyze movement patterns. Machine learning or deep learning models such as CNNs or LSTM are used for classification. The system can recognize multiple activities accurately. It works in real time with minimal delay. The model is trained on labeled activity datasets. The system adapts to different environments and lighting conditions. It can be integrated with surveillance or healthcare systems. Overall, it provides an efficient and automated solution for activity recognition.

Advantages of Proposed System

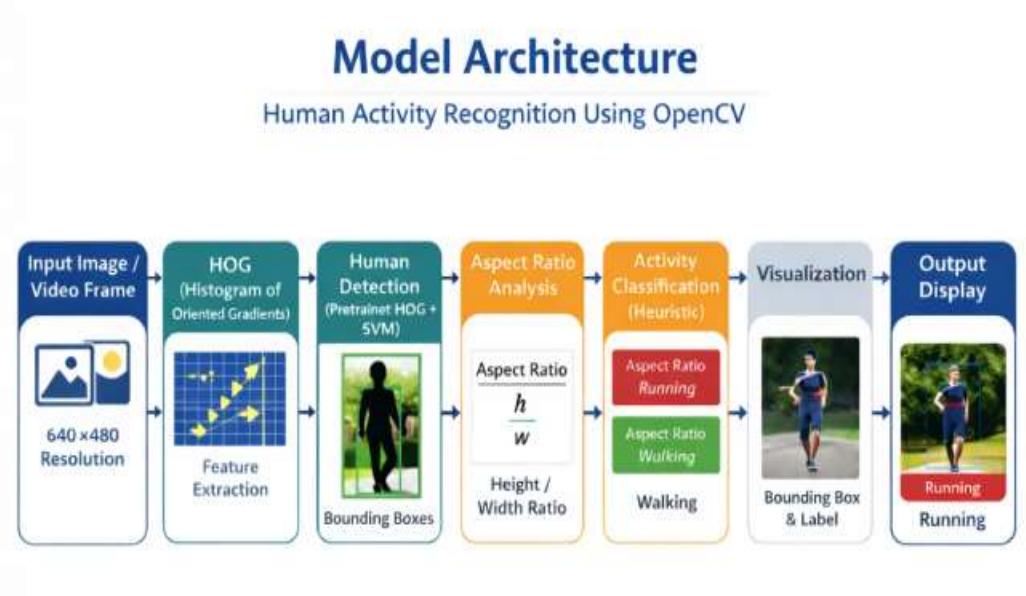
- Real-time activity recognition
- No need for wearable devices
- Improved accuracy using ML/DL models
- Ability to recognize multiple activities
- Robust to environmental variations
- Scalable and efficient system
- Useful for multiple applications

IV. Methodology (11–12 lines)

The methodology begins with capturing video data using a camera. Frames are extracted from the video stream using OpenCV. Preprocessing techniques such as noise reduction and resizing are applied. Background subtraction is used to detect moving objects. Feature extraction techniques analyze motion and posture. The dataset is divided into training and testing sets. Machine learning or deep learning models are trained for classification. The model is evaluated using accuracy, precision, and recall. Real-time processing is implemented for live detection. The system predicts activities based on input frames. Results are displayed through a user interface. Continuous learning is implemented by updating the model with new activity data over time. Alerts or notifications can be triggered for specific activities (e.g., fall detection in healthcare).

System Architecture

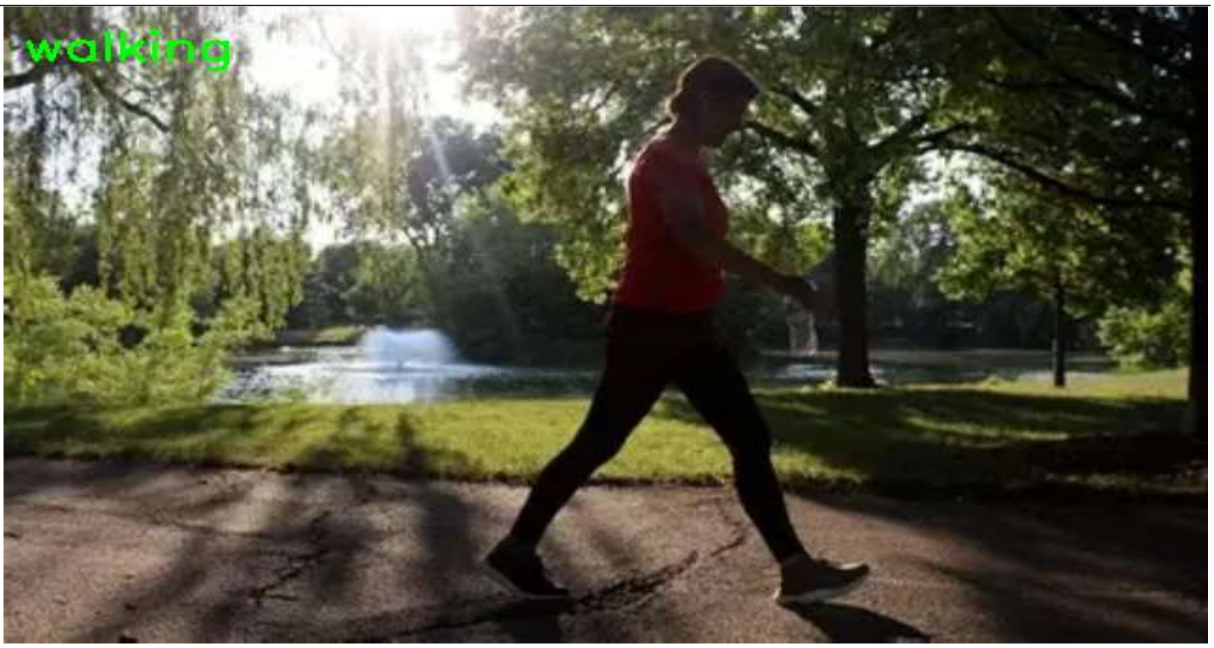
The system architecture consists of several layers. The video input layer captures live or recorded video. The preprocessing layer enhances frame quality. The detection layer identifies human subjects. The feature extraction layer analyzes movement patterns. The model layer uses ML/DL algorithms for classification. The prediction layer determines the activity. The database layer stores data and results. The user interface displays detected activities. The feedback layer updates the model with new data. All components are integrated into a unified system. The system supports real-time processing. Overall, the architecture ensures accurate and efficient activity recognition.



V. Result and Output


sleeping


standing



VI. Conclusion

The proposed Human Activity Recognition (HAR) system using OpenCV presents an effective and computationally efficient approach for detecting and classifying basic human activities such as walking and running. The system leverages Histogram of Oriented Gradients (HOG) for extracting meaningful shape and edge-based features from input images or video frames, which are then processed using a pre-trained Support Vector Machine (SVM) for reliable human detection. A simple yet practical aspect ratio–based heuristic is employed to classify activities, allowing the system to differentiate between walking and running with minimal computational overhead. The results are visually presented by displaying activity labels on the output frames, making the system intuitive and easy to interpret. Due to its lightweight nature and low processing requirements, the system is well-suited for real-time applications, even on devices with limited computational resources. However, the reliance on a basic rule-based classification limits its ability to recognize complex or subtle human activities under varying conditions. To overcome these limitations, future improvements may include the integration of advanced deep learning techniques such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), or Long Short-Term Memory (LSTM) models, which can significantly enhance accuracy, robustness, and scalability for real-world deployments.

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