REAL TIME FALL DETECTION SYSTEM FOR ELDERLY SAFETY USING CNN

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Abstract- Elderly people who fall have considerable health risks that, if not treated right once, could result in fatalities or major injuries. Recent developments in deep learning methodologies have made it possible to create effective fall detection systems that use input video streams. This research uses deep learning techniques to present a revolutionary smart fall detection system for older people. The suggested system is made up of various essential parts. First, security cameras or wearable technology are used to collect input video data that shows the actions of senior citizens. Next, preprocessing methods are used to lower noise and improve the quality of the video streams. From the preprocessed video frames, feature extraction techniques are used to extract useful information and identify pertinent patterns suggestive of falls. For training and assessment, a large dataset with annotated examples of falls and everyday activities is used. Because convolutional neural networks (CNNs) are good at extracting spatial characteristics from picture input, they are used as the classification model. Using features that are extracted, the CNN model is trained on the dataset to determine which events are falls and which are not falls. In order to identify falls, preprocessed video frames are fed into a trained CNN model, which makes real-time predictions about the probability of a fall. When a fall event is detected, the right warnings or notifications can be sent to emergency services or caregivers, allowing for quick help and intervention. Results from experiments show how well the suggested deep learning-based fall detection system works at correctly identifying fall events while minimizing false alarms.
Keywords: Deep learning, Fall detection, Elderly care, Convolutional Neural Networks (CNNs), Video processing, Smart monitoring etc.

1. INTRODUCTION

Health and safety issues are becoming more pressing for the aging population, especially with regard to the danger of falls in the elderly. Serious injuries, a decline in quality of life, and even death, can result from falls. Elderly people's freedom and well-being depend heavily on the timely diagnosis and treatment of falls. Conventional fall detection systems frequently depend on ambient or wearable sensors, which aren't necessarily reliable or practicable for catching all fall incidents.

The development of deep learning techniques has transformed a number of industries, including pattern recognition and computer vision, in recent years. Convolutional Neural Networks (CNNs), in particular, are deep learning models that have demonstrated impressive performance in tasks like object recognition, picture classification, and video analysis. This research uses input video data to develop a unique Smart Fall Detection System for Elderly People by utilizing deep learning capabilities. The suggested method combines a number of essential elements to reliably identify falls in real time. Getting input video data from security cameras or wearable cameras is the first step in the process. Then, preprocessing methods are used to improve the video streams' quality, eliminate noise, and get the data ready for more examination. From the preprocessed video frames, pertinent patterns and information are then extracted using feature extraction techniques. These characteristics record temporal and spatial aspects suggestive of fall events.

The fall detection system is trained and assessed using a large dataset that includes annotated examples of falls and typical activities. The CNN model needs to be taught this dataset in order to properly distinguish between falls and non-fall events. In order to learn discriminative features for fall detection, a CNN model is trained on the dataset during the classification step. CNNs are ideally suited for this purpose since they are highly skilled at deriving hierarchical representations from visual input. After being trained, the CNN model can quickly and accurately predict possible fall events by classifying incoming video frames. The ultimate objective of the suggested system is to give senior citizens a dependable and non-intrusive fall detection solution, allowing for prompt aid and intervention in the case of a fall. This system seeks to improve the safety and well-being of the senior population by utilizing deep learning and video analysis, encouraging independent living and providing family members and caregivers with peace of mind.

2 LITERATURE SURVEY

[1] An Internet of Things (IoT) enabled geriatric fall detection model utilizing an optimum deep convolutional neural network was proposed by Thavavel Vaiyapuri et al. First, the input video is recorded by an IoT device. Next, three stages of preprocessing are applied to the input video: scaling, augmentation, and min-max based normalization. The Squeeze Net model is then used for feature extraction in order to extract helpful feature vectors for fall detection. [2] The double check approach combining a mobile robot and an Inertial Measurement Unit (IMU) sensor was proposed by Deok-Won Lee et al. A participant donning an IMU sensor repeats a number of movements at random, including walking, falling, standing, and sitting. The trained Recurrent Neural Network (RNN) based fall detection model is then fed the collected data sets, and the outcomes are tracked. The IMU sensor is used to track the user's movements in real time, continually. When a fall is identified, the robot uses the IMU sensor's location data to navigate to the appropriate spot.
[3] A multichannel convolutional fusion dense block technique for fall detection was presented by Xi. Cai et al. With its tightly connected layers, the dense block technique can compress a network with less processing and fewer parameters, which is advantageous for fall detection. It is also utilized to acquire rich information. This method's procedure is split into training and testing phases. In both phases, ten consecutive frames are input to utilize the spatiotemporal information.

[4] An RGB camera-based pose estimation-based fall detection technique was proposed by Yen-Hung Liu et al. The extremely unbalanced data set that was used reflects actual conditions. To extract the skeleton information from the photos, Open Pose is utilized. To aid the model in learning more efficiently, feature extraction and feature scaling are then carried out.

[5] A fall motion mixing model (FMMM) technique was presented by Chalavadi Vishnu et al. to describe both fall and non-fall events in human fall detection. The fall motion mixing model uses factor analysis to preserve pertinent characteristics of a given fall or non-fall video.

[6] A radar-based fall detection technique based on temporal frequency analysis and deep learning was proposed by Hamidreza Sadreazami et al. To identify the target range bin, the data is first pre-processed in a room setting. To obtain the spectrogram for various fall and non-fall activities, a brief Fourier transform is done to each return radar signal. [7] Doppler radar signals are split into windows by Khadija Hanifi et al., and each window is first preprocessed to filter. Following windows are further analyzed to extract and monitor the person's vital signs using the created algorithm when a window is recognized as a fall. When a significant movement is observed during vital sign monitoring, the system interprets it as a fall and notifies the caregiver by emergency contact.

[8] Diana Yacchirema et al. suggested an indoor fall detection system based on IOT and an ensemble machine learning algorithm. A 3D axis accelerometer is integrated into the wearable gadget to record senior citizens' movements in real time. An ensemble random forest (RF) mode is then used to process and analyze the acceleration readings.

[9] A fall detection system based on bone data from a Kinect v2 camera was proposed by Oussema Keskes et al. Graphs are used to represent the skeleton data. Graphs are used to represent the skeletal data. Therefore, to handle such data in its native form

and make the most of it, the Spatial Temporal Graph Convolutional Network (ST-GCN) technique is needed.

[10] An autonomous fall detector in a wearable gadget was proposed by Young-Hoon Nho et al. to lower hazards by identifying falls and notifying caretakers. A cardiac sensor and a triaxial accelerometer make up the wearable device. Using a combination of an accelerometer and heart rate sensor, a cluster analysis based user adaptive fall detection system was proposed. In this system, normal occurrences form the clusters, and any abnormality is interpreted as a fall.

III. EXISTING SYSTEM

The main concern, which becomes more pressing as one ages, is one's health. Consequently, caring for the elderly is a crucial duty. In this case, living aid is provided by technology, which benefits individuals. "Fall" is one of the main reasons elderly people's health deteriorates or passes away. This project suggests a machine learning-based fall detection system. By categorizing various acts into fall and non-fall categories, the system detects falls and, in the event of an emergency, notifies a family member or caregiver of the elderly person. Features are computed using the SisFall dataset, which includes a variety of activities from multiple people. SVM and decision trees are two machine learning methods that are used to identify falls based on computed features.

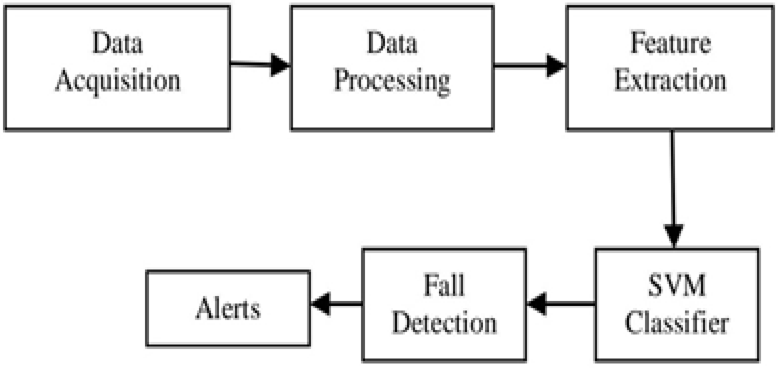

Fig. 1 Existing system

IV. PROBLEM STATEMENT

Older adults who live independently face a high risk of suffering falls-related injuries. Since no one is aware that the person is falling and there is a greater chance that they will sustain more severe injuries, falls that result in unconsciousness can be deadly. In the unlikely event of a falling incidence, swift action and rescue are essential. There are many devices available to help identify falls in the senior population. A webcam was utilized by one of the fall detection systems to monitor the movements of elderly people and detect falls. It can only be used indoors, and both installation and operation are quite expensive. Customers of fall detection devices that are currently on the market are required to wear a wireless emergency transmitter, like a bracelet, necklace, or pendant, most of the time. Wearable echnology has a drawback in that elderly people might not remember to wear it or might not be able to activate it after hey pass away. Thus, the need arises for a device that can detect falls and promptly signal for help without requiring a button push.

V. PROPOSED METHOD

The working of the proposed fall detection system relies on the integration of deep learning techniques, video analysis, and real-time classification to provide an effective and reliable solution for detecting falls among elderly individuals and ensuring their safety and well-being.

A. Block Diagram

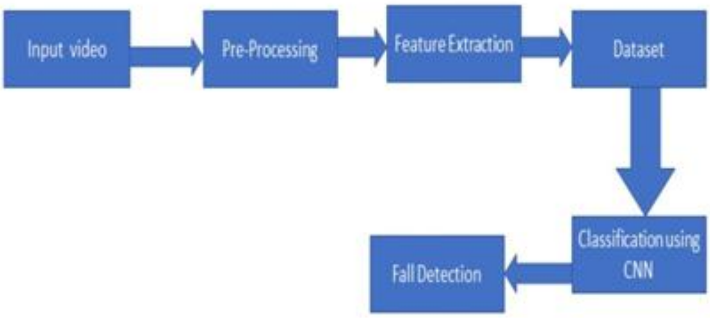

Fig. 2 System Architecture

1) Data Acquisition::
The system begins by capturing input video data using surveillance cameras or wearable devices equipped with cameras. These devices are strategically placed in environments where elderly individuals are expected to move, such as homes, assisted living facilities, or healthcare centers.

2) Preprocessing:
The acquired video data undergoes preprocessing to enhance its quality and prepare it for further analysis. Preprocessing techniques may include noise reduction, mage stabilization, and normalization to ensure consistency n the input data..

3) Feature Extraction:
Feature extraction methods are applied to extract relevant patterns and information from the preprocessed video frames. These features capture spatial and temporal characteristics that are indicative of fall events. Features may include motion patterns, shape descriptors, or texture Features extracted from key regions of interest in the video Frame.

4) Dataset Creation:
A comprehensive dataset is compiled, comprising annotated instances of falls and normal activities. This dataset serves as the training and evaluation data for the fall detection system, enabling the CNN model to learn to distinguish between fall and non-fall events effectively.

5) Training the CNN Model:
The dataset is used to train a Convolutional Neural Network (CNN) model specifically designed for fall detection. The CNN model learns to automatically extract discriminative features from the input video data and make predictions about whether a fall event has occurred in a given frame or sequence of frames.

6) Classification:
During the classification stage, the trained CNN model is deployed to classify incoming video frames in real-time. The model analyzes each frame and predicts the likelihood of a fall event based on the learned features and patterns. If the model detects a fall event with a high probability, an alert is generated to notify caregivers or emergency services for prompt intervention.

7) Optimization:
The system may undergo iterative refinement and optimization to improve its performance and reduce false alarms.

8) Deployment:
Once the fall detection system demonstrates satisfactory performance, it can be deployed in real-world settings, such as homes, healthcare facilities, or assisted living communities.

Continuous monitoring and feedback may be used to further refine the system and adapt it to different environments and user needs.

B. Methodology

1. Data Collection:

First, information collection is necessary. Since quantity and quality affect the overall performance of the system, this stage is critical. It is essentially a procedure for collecting information on specific factors.

2. Data Preparation:

The first step is collecting data; the next is preparing the data. It's a procedure that transforms meaningless data into knowledge that can help with decision-making. Data purification is another name for this methodology. Select a Model, when choosing a method to represent preprocessed data in a model, one goes with the CNN algorithm.

3. Train the Model:

Supervised learning is a technique in machine learning (ML) that trains a model to improve judgment or prediction accuracy. To assess the model, a few parameters are needed. The variables are determined by the stated goals.

4. Evaluate the Model:

It is also necessary to document how well the new model performs in contrast to the old one. To assess the model, a number of parameters are needed. The variables are determined by the stated goals.

5. Parameter Tuning:

At this stage, there may be initialization parameters, distribution, performance, learning rate, and the total number of training steps.

6. Making Predictions:

A prediction on the test dataset is necessary in order to evaluate the built model against the real world. The model can be used to provide more predictions if the result is consistent with the projections of experts in the field or experts who have a close link with the outcome.

C. Flowchart

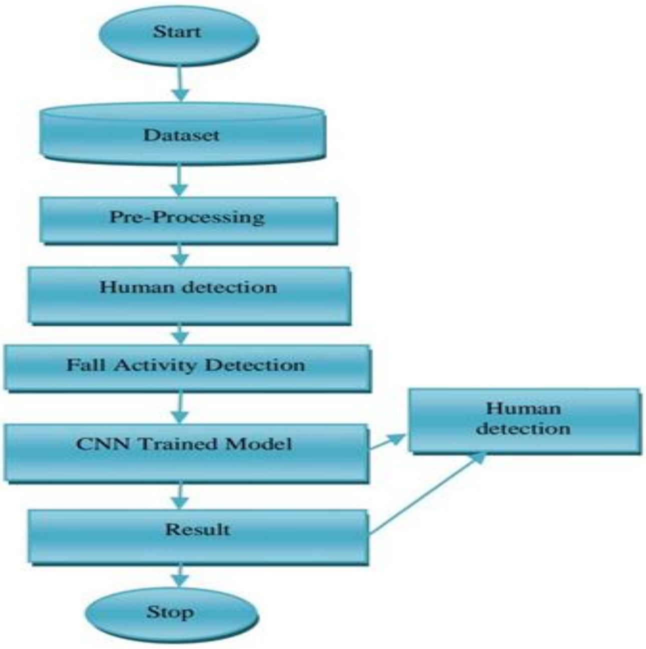

Fig. 3 Implmentation

The flow diagram is explained as follows:

- **Start:** The system begins.
- **Acquire Dataset:** Data containing instances of falls and normal activities is collected.
- **Preprocessing:** The acquired data is preprocessed to enhance its quality and prepare it for further analysis. Human Detection: Human detection algorithms are applied to identify human subjects in the video frames.
- **Fall Activity Detection:** Fall activity detection techniques are used to identify instances of falls among the detected human subjects.
- **Train CNN Model:** A Convolutional Neural Network (CNN) model is trained using the preprocessed data to classify fall and non-fall events.
- **Human Detection Result:** The result of human detection, along with fall activity detection, is obtained.
- **Stop:** The system ends.

Software Requirements:

Open CV:

An open-source software library for computer vision and machine learning is called OpenCV (Open Source Computer Vision Library). For real-time computer vision applications like object identification, face recognition, image and video processing, and more, it offers a broad range of functionalities.

Python Language and libraries:

Python is a high-level, general-purpose, open-source programming language. When compared to other programming languages, Python's syntax is straightforward and is known to be significantly simpler for non- programmers to learn. But Python's greatest advantage is that it comes with a vast standard library of modules that cover a wide range of topics, including business, finance, education, and more.

VI. SIMULATION RESULTS

The simulation results for the Deep Learning Based Smart Fall Detection System for Elderly People are obtained from Python script. First take the input video from the video obtain the frames, then do preprocessing removes the noise from frames and obtain the feature extraction and dataset of images by applying the CNN, finally obtained the fall activity detected images. The following figure 4 to figure 6 represents the image detection and fall activity detected images.

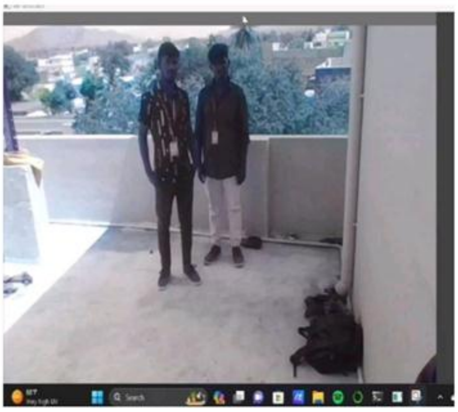

Fig. 4 Human Detection in position 1

Fig. 5. Human Detection in position 2

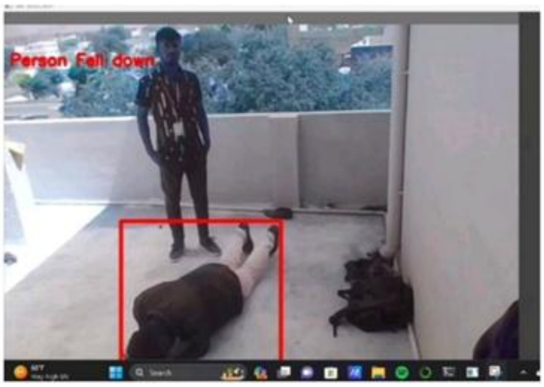

Fig. 6 Input image to Proposed Method

A Comparision Table

Table I Comparison of performance metrics

S.No	Method	Algorithm	Accuracy (%)	Training Time (S)	Prediction time (s)
		SVM	84.17	294.95	84.71
1	Existing	Decession	95.87	2.741	1.0
	Method	Tree			
2	Proposed Method	CNN	98.85	1.84	0.05

In Existig method the lgorithms are SVM (Support Vector Machine): This algorithm achieved an accuracy of 84.17% with a training time of 294.95 seconds and a prediction time of 84.71 seconds. Decision Tree: This algorithm achieved an accuracy of 95.87% with a training time of 2.741 seconds and a prediction time of 1.0 seconds. In Proposed method NN (Convolutional Neural Network): The proposed method, utilizing CNN, achieved an impressive accuracy of 98.85%. It required a relatively short training time of 1.84 seconds and an even quicker prediction time of 0.05 seconds. The table compares the performance of the existing fall detection methods with the proposed method.

It shows that the proposed method using CNN outperforms the existing methods in terms of accuracy, while also being more efficient in terms of training and prediction times. The CNN-based approach significantly reduces both training and prediction times compared to the existing methods, making it more suitable for real-time fall detection systems, especially for elderly safety.

B. Performance Comparision

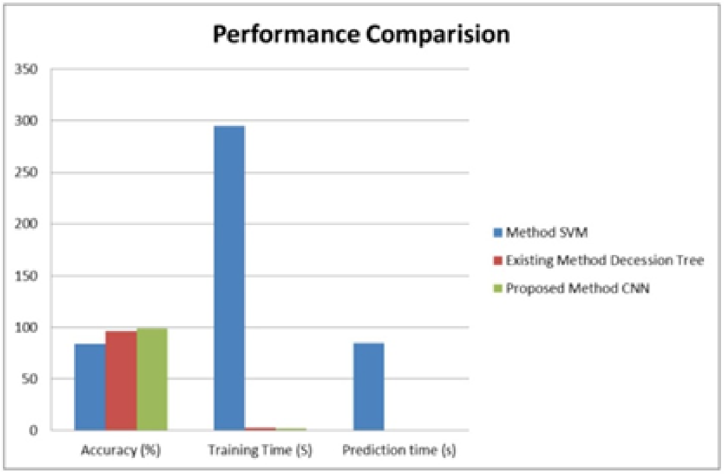

Fig. 7 Comparison Perfromene

VII. CONCLUSION

A potential answer to the pressing problem of fall detection among the elderly is the real time Fall Detection System for Elderly People. The suggested system offers significant advantages over conventional fall detection methods by utilizing input video data and advanced deep learning techniques, specifically Convolutional Neural Networks (CNNs). We have described the many elements and procedures involved in the creation and application of the fall detection system throughout this study. To achieve accurate and dependable fall detection in real-time, each step-from data collection and pre-processing to human detection, fall activity detection, and CNN model training is critical. Additionally, using CNNs makes classification reliable and efficient, which makes the system appropriate for implementation in a variety of contexts.

Future Scope

Future advancements can enable the fall detection system to not only detect fall events but also provide real-time monitoring and intervention capabilities. This may include automatically alerting caregivers or emergency services, activating assistive devices (such as automated emergency response systems or medical alert systems), and providing immediate assistance to the fallen individual.

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