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Fall Detection for Elderly People Using Machine Learning

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Abstract: Falling down is among the most common causes of medical attention required by the elderly people . Elderly people often injure themselves from falling down more especially when they are living alone. After a fall occurs, medical attention needs to be provided promptly in order to reduce the risk of victim . Several technologies have been developed which utilize webcams to monitor the activities of elderly people. However, the cost of operation and installation is expensive and only applicable for. Fall is one the major cause of death for older people. Detecting the fall plays a major role in saving lives. There are three different types of fall detection commonly used , such as wearable, ambient sensor and vision-based methods.If elderly people falls then it will put severe effect on their health and technology is helping humans in every aspect of their life and in this paper author is using machine learning algorithm to predict FALL scenarios by analysing their movements. In propose paper author has used SVM and Decision Tree algorithms to train SISFALL dataset and this trained model can be used to predict fall scenarios from new test data. Sensors will be embedded with elderly people's body and this sensor will record their movement such as Heart Rate, EEG and circulation and then give this input to ML model and ML model will predict current scenario or posture and alert to elderly people.
Keywords: SVM, Decision Tree

I. INTRODUCTION

Falls by an older person are a significant public health issue because they can result in disabling fractures and cause severe psychological problems that diminish a person's level of independence. Falls can be fatal, particularly for the elderly. According to one study,falls are the leading cause of injury-related death for seniors aged 79 or over and the second most prevalent cause of injury-related (unintentional) mortality for adults of all ages. A person's quality of life (QoL) is influenced by their intellectual ability, which has been documented to be impaired when elderly persons become bedridden after falls. A fall detection system is an aid with the main purpose of generating an alert if a fall has occurred. They show great promises of mitigating some of the detrimental impacts of falls. Fall detectors have a substantial impact on how soon assistance is provided after a fall as well as decreasing the fear of falling. Falling and being afraid of falling are related: being terrified of having fallen may increase the likelihood that a person will suffer a fall. Numerous studies have been done to create strategies and methods for improving the functional abilities of the elderly and ill. Some systems use cameras, sensors, and computer technology. Such systems for older persons can both improve the capacity for independent living by enhancing their sense of security in a supportive environment and reduce the amount of physical labor required for their care by reducing the need for nurses or other support employees.The objective of this paper is to document the currently available systems for fall detection and their outcomes, which we hope will be a basis for future research and development of fall detection systems.

II. LITERATURE SURVEY

Falling is among the most damaging event elderly people may experience. With the ever-growing aging population, there is an urgent need for the development of fall detection systems. Thanks to the rapid development of sensor networks and the Internet of Things (IoT), human-computer interaction using sensor fusion has been regarded as an effective method to address the problem of fall detection. In this paper, we provide a literature survey of work conducted on elderly fall detection using sensor networks and IoT. Although there are various existing studies which focus on the fall detection with individual sensors, such as wearable ones and depth cameras, the performance of these systems are still not satisfying as they suffer mostly from high false alarms. Literature shows that fusing the signals of different sensors could result in higher accuracy and lower false alarms, while improving the robustness of such systems. We approach this survey from different perspectives, including data collection, data transmission, sensor fusion, data analysis, security, and privacy.

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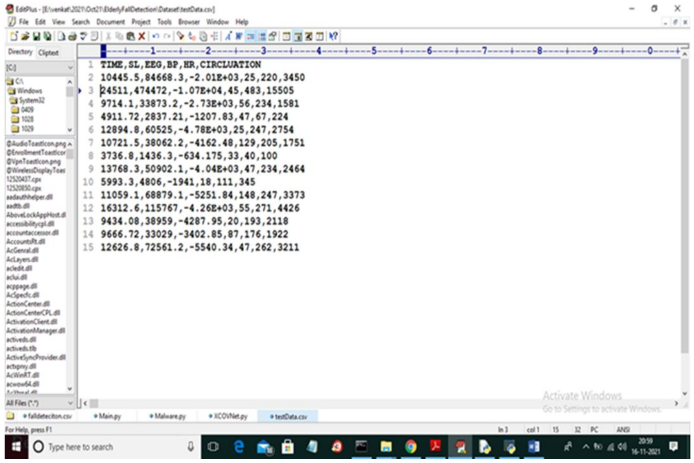
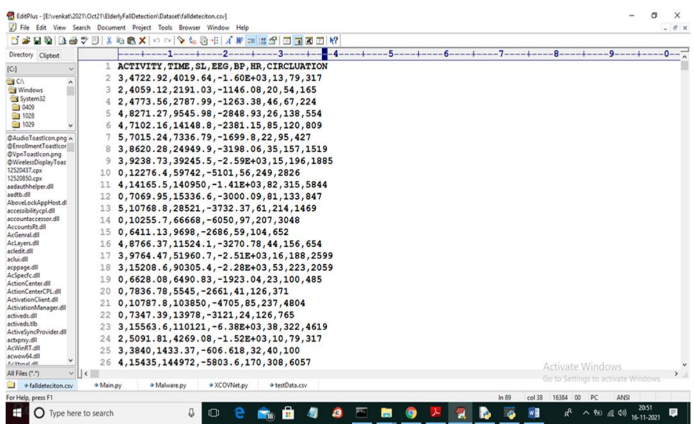
We also review the benchmark data sets available that have been used to quantify the performance of the proposed methods. The survey is meant to provide researchers in the field of elderly fall detection using sensor networks with a summary of progress achieved up to date and to identify areas where further effort would be beneficial.

A. Data Sets Descriptions



1) In Fall detection dataset screen first row contains dataset column names and remaining rows contains dataset values and in above dataset first column called ACTIVITY represents various positions such as 0, 1, 2, 3, 4 and 5 where each values correspond to below names
2) 'Standing', 'Walking', 'Sitting', 'Falling', 'Cramps', 'Running'
3) In above names 0 means Standing and 1 means Walking etc.
4) Remaining values are the sensor data about elderly people movement.
5) In Test data you can see we don't have ACTIVITY column and we have only sensor data and ACTIVITY column will be predicted by ML model.



B. Pre-processing

1) *Temporal Alignment:* Ensure proper synchronization of time-series data to account for any time lags in sensor readings, especially if using multiple sensors.
2) *Filtering and Smoothing:* Apply signal processing techniques like filtering to remove noise from accelerometer and gyroscope readings, providing cleaner input for the model.
3) *Feature Extraction:* Extract relevant features from sensor data, such as peak accelerations, spectral features, or statistical measures, to capture essential information for fall detection.
4) *Data Balancing:* In some datasets, the number of fall events may be significantly smaller than the number of non-fall activities. This imbalance can bias the machine learning model towards the majority class, reducing its accuracy in detecting falls.

Fig3: Disease prediction and K-means Image Segmentation of disease detection apple

C. Model Evaluation Metrics

1) *Accuracy:* Accuracy is the most fundamental metric, representing the proportion of correctly classified events. It is calculated as the total number of correct predictions divided by the total number of events.
2) *Sensitivity:* Sensitivity measures the model's ability to correctly detect falls, also known as the true positive rate (TPR). It is calculated as the number of correctly identified falls divided by the total number of actual falls.
3) *Specificity:* Specificity measures the model's ability to correctly identify non-fall activities, also known as the true negative rate (TNR). It is calculated as the number of correctly identified non-fall activities divided by the total number of actual non-fall activities.
4) *Precision:* Precision indicates the proportion of detected falls that are true falls. It is calculated as the number of correctly identified falls divided by the total number of events classified as falls.

III. PROBLEM STATEMENT

Fall detection is a technology that can detect when someone has fallen and alert emergency services or caregivers. It is especially useful for older adults who are at a higher risk of falling. According to the Centers for Disease Control and Prevention (CDC), one in four Americans age 65 or older experiences a fall each year, and an older adult is seen in an emergency department for a fall every 11 seconds. Fall detection devices use sensors and algorithms to detect changes in motion or orientation that indicate a fall has occurred. When a fall is detected, the device sends an alert to emergency services, family members, or caregivers, enabling them to respond faster and achieve better outcomes.

IV. METHODOLOGY

Fall detection system consists of the following steps as

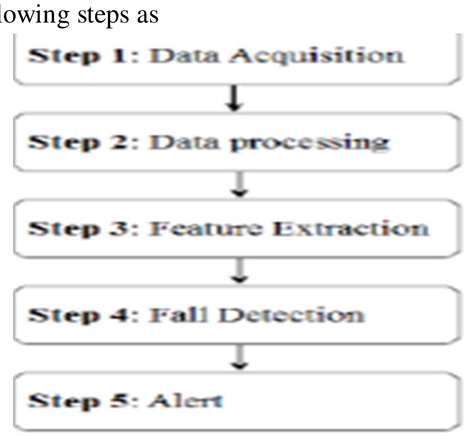
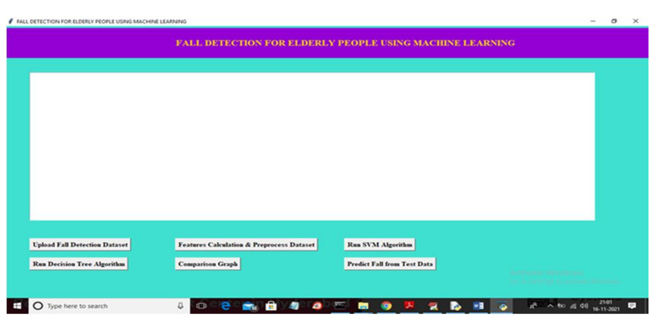
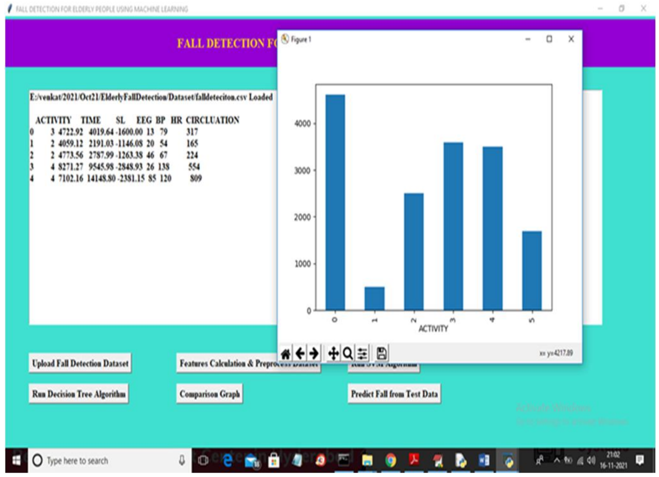


Figure 1 System flow

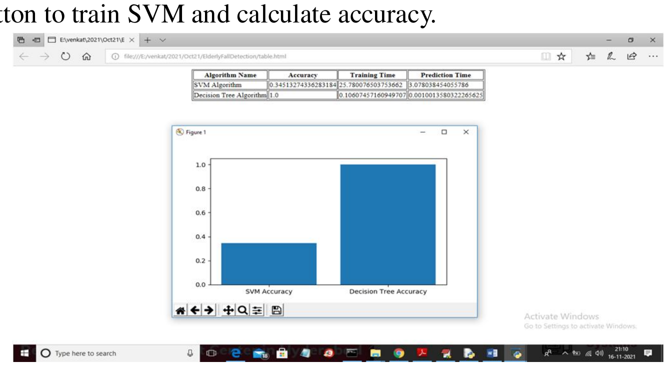
V. EXPERIMENTAL RESULTS

1) In screen click on ‘Upload Fall Detection Dataset’ button to upload dataset.
2) In screen we can see dataset loaded and dataset is not in normalized format so we need to process and in above graph x-axis represents ACTIVITY such as standing, walking of falling in integer code and y-axis represents number of records available in dataset for that activity and now close above graph and then click on ‘Features Calculation & Preprocess Dataset’ button to process dataset





In above screen you can see dataset normalized and we can see dataset contains total 16382 records and then application split dataset into train and test where 13105 records are using for training and 3277 records for testing and now dataset is ready and now click on 'Run SVM Algorithm' button to train SVM and calculate accuracy.



In above graph x-axis represents algorithm names and y-axis represents accuracy of those algorithms and from both Decision Tree got high accuracy and in above screen we can see comparison table of train and test time for both algorithms and now close above graph and then click on 'Predict Fall from Test Data' button to upload test data and get prediction.

- In screen selecting and uploading 'testData.csv' file and then click on 'Open' button to get output.
- In screen in square bracket you can see test values and after square bracket you can see PREDICTION result as 'Standing, walking, falling etc from that test record.

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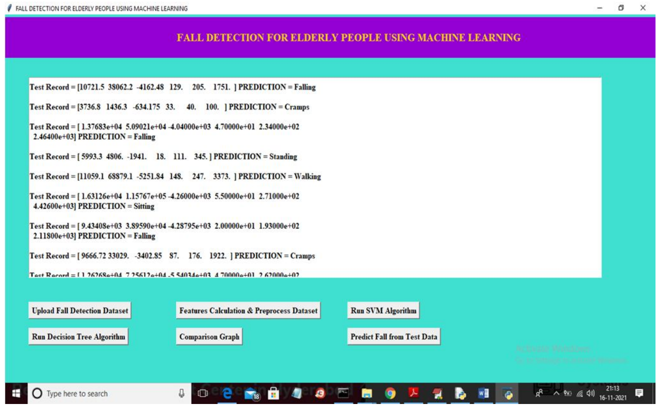

In above screen in square bracket you can see test values and after square bracket you can see PREDICTION result as 'Standing, walking, falling etc from that test record.

VI. CONCLUSION

This paper presents fall detection system, which are suitable for elderly people. The proposed method uses machine learning algorithms to detect falls from a set of daily living activities. Machine learning technique are found better than the threshold method, as it gives less false alarms due to pre-trained Gait patterns. The decision tree gives higher accuracy than SVM as decision tree has the ability to define and classify each attribute to each class precisely. Also prediction time of SVM is greater than decision tree which leads to a slower system. The models are evaluated by using parameters such as: sensitivity, specificity, accuracy and confusion matrix. Falls are appropriately detected using decision tree algorithm with an accuracy of 96%. Further improvement in accuracy can be obtained by training the models with large dataset and by identifying optimal features.

VII. FUTURE ENHANCEMENT

One future enhancement could be incorporating advanced artificial intelligence algorithms to better distinguish between normal movements and potential falls. Using a combination of sensors like accelerometers, gyroscopes, and maybe even depth-sensing cameras could provide more accurate data for analysis.
Additionally, integrating machine learning models that learn from individual movement patterns over time could enhance the system's ability to tailor fall detection to specific users. This way, it becomes more personalized and adaptable to each person's unique behavior.
Of course, privacy and user consent would be crucial considerations in implementing such enhancements. It's important to strike a balance between providing assistance and respecting the autonomy of the elderly individuals using the technology.

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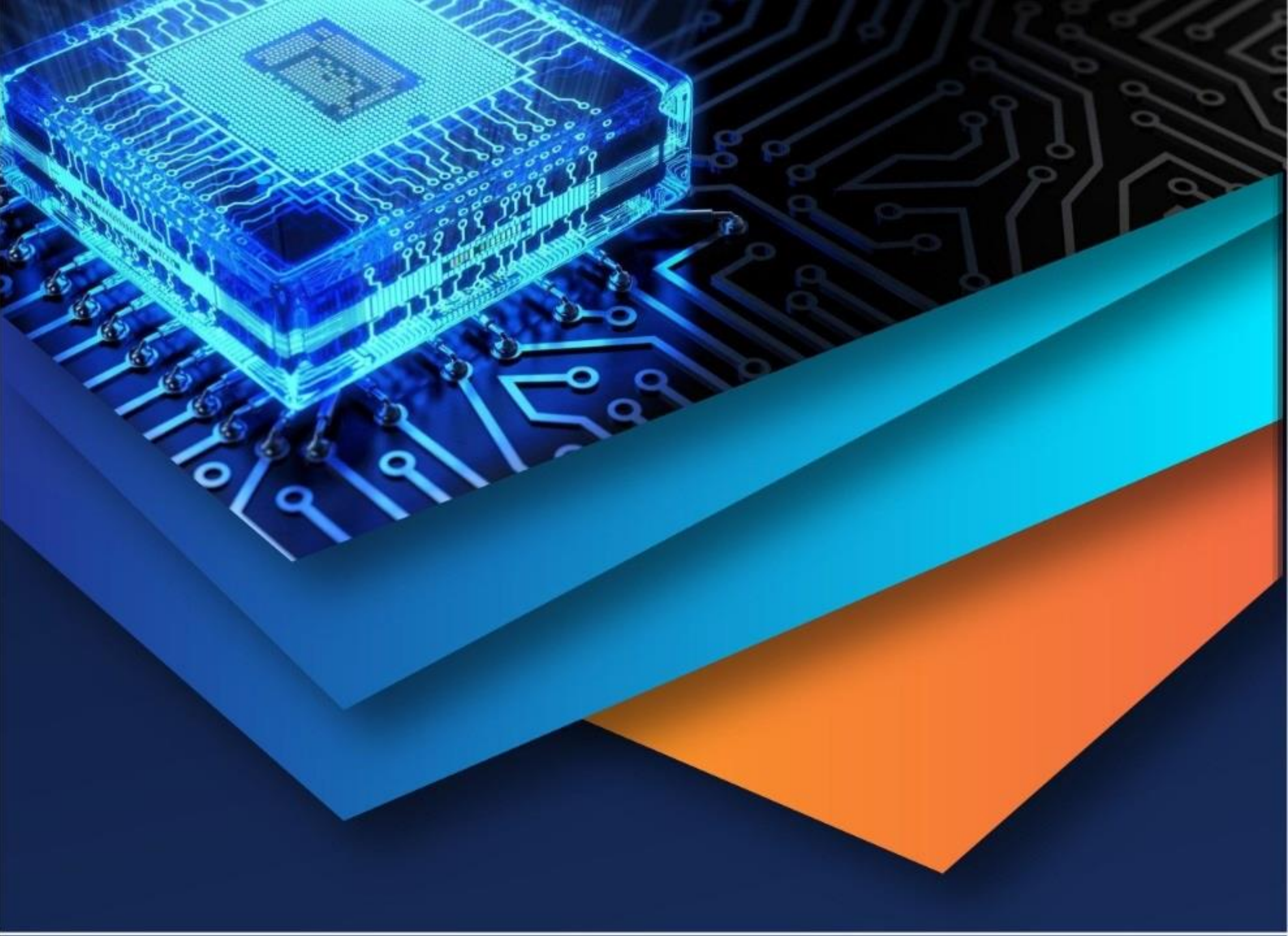

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