Fall Detection for Elderly People Using Machine Learning

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Abstract:

Health conscious is the main subject of interest, its testability increasing with age. Thus, taking care of the elderly people is a very important responsibility. In such a scenario, technology helps people by providing life support. One of the main causes of poor health or old age is 'falling'. In this paper, a fall detection system is suggested based on machine learning. The system detects falls by classifying different activities into falling and non-falling actions and alerts parents or caregivers of senior students in an emergency. The SisFall dataset with diverse activities from many participants is used to compare the characteristics. SVM and decision tree machine learning algorithms are used to detect droplets based on computed features. The system obtains up to 96% accuracy by using decision tree algorithm.

Keywords: *Health, dataset, falling, accuracy, detect, Algorithms*

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1. Introduction

Now-a-days elderly people live alone at home because of poor conditions, different working cultures and due to many other reasons. According to World Health Organization (WHO) reports, falls causes many accidental deaths. Greatest number of fatal falls is seen in adults older than 65 leading to health problems, or injuries. Thus, elderly people require an attention at the times of emergencies at their residence because they cannot call for help due to lack of technology access in rural areas [1]. To improve quality of life of elderly aged people and to provide living assistance to them, automatic fall detection systems are in place. The risk of falling is high among older people, individuals with Parkinson's disease or patients in rehabilitation units. Main reasons for occurrence of falls are physical factors like of muscle weakness, vision, due to old age, or psychological factors or environmental factors. Falls are the major cause of injuries and hip fractures [2]. If immediate aid is not provided, it may lead to death. To Department of Electronics and Communication Engineering ensure proper treatment and care of the elderly people, fall detection system plays an important role. Various researches have been done on the fall detection system.

There are no fixed criteria on basis of sensors used or on calculated features or on algorithms used to classify. Image processing techniques are used after capturing images from camera to detect falls. Wearable sensors like accelerometer, gyroscope at knee, wrist, neck, and waist are used to get the data input. Features are calculated by using sensor readings to get some relevant data out of the raw data. Falls can also be detected by using ambient sensors like IR sensors, movement based sensors [3]. Major hurdle to develop precise fall detection system is false alarms i.e. alerting fall when there is a fall like activity but not exactly a fall. Most of the researches are focused on reducing false alarms and improving accuracy of the fall detection system [4]. The main aim of

studies is to detect falls in the daily life activity situations with high accuracy. To classify the activity into fall or not fall criteria, threshold based algorithms also can be used. But if sensor detects an unusual activity, then the probability of false alarm increase unlike machine learning based approach [5]. The fall detection system is proposed which monitors elderly people in real-time. The system uses open source available dataset SisFall which has recorded Gait data by using Tri-axial accelerometer [6]. By using machine learning algorithms, falls are detected after calculating various features. Two different machine learning algorithms, SVM and decision tree are implemented and compared for better accuracy and performance. The proposed paper explains eliminating the problem of contacting, providing protection, reducing deaths due to fall and Rapid detection of people.

2. Related Work

The World Health Organization's World Report on Health and Aging [1] presents a framework for action to promote quicker Healthy Aging, based on the novel notion of functional capacity. According to the World Health Organization, effectively focusing resources to prevent falls and related injuries necessitates a greater understanding of the scope and nature of the problem, as well as evidence of successful interventions [2]. In [3], an unattended fall detection system based on the elderly's auditory footsteps is shown. Source Separation (SS), Specific Frequency Coefficient (MFCC), and Layer Support Vector Machine were employed in this study (OCSVM). The system is defined by two major components: a wearable device and a cell phone, according to the [4] presentation. When the wearable device senses a fall, it sends a text message to the user's phone. It uses six activities of daily life (ADLs) to depict the decrease in [5].approaches for machine learning Support vector machines (SVM), Bayesian decision making (BDM), dynamic temporal warping (DTW), and artificial neural networks are examples of k-nearest neighbor (k-NN) classifiers (ANNs). In [6], a dataset of falls and activities of daily living (ADLs) is presented with commonly used feature extraction and a simple to use threshold based classification that achieves up to 96 percent fall detection accuracy.

3. Fall Detection for Elderly People using Machine Learning Algorithms

Decision Tree: Data is represented as a tree-like model with nodes and edges in the decision tree technique. The root node, internal nodes, and leaf nodes are the basic components of a tree, however with real datasets, additional features are added. The decision tree is a finite-number-of-classes classification algorithm. Once the tree has been prepared using training data, decision rules are drawn and classification judgments are made. The popularity of decision tree classification models is due to the ease with which they may be interpreted and the results obtained. Complex decision-making processes become simpler using the decision tree method, and issue solutions can be interpreted by decision-makers. The fall detection accuracy of these methods is compared. The accuracy of the models is calculated after they have been evaluated on 40,000 data samples. For further testing, the most accurate model is saved.

SVM: Support Vector Machines (SVM) and Decision Tree were the machine learning algorithms we employed. The SVM technique can be used for both classification and regression. To ensure good separation, SVM determines the hyper plane with the greatest distance from the nearest training data point of any class. Using the kernel function, it is feasible to find hyper plane to decide classification for non-linear datasets. Different classes of data points fall on each side of the plane [7].

Implementation Procedure:

Step 1: Upload Fall Detection Dataset: Using this module we will upload dataset to application.

Step 2: Features Calculation & Preprocess Dataset: Using this module we will read all features from dataset and then remove missing values and then normalize dataset using MIN-MAX scaler and the split dataset into train and test and we will use 80% dataset for training and 20% for testing.

Step 3: Run SVM Algorithm: Using this module we will train SVM on training dataset and then apply trained model on test data to calculate accuracy and prediction time.

Step 4: Run Decision Tree Algorithm: Using this module we will train Decision Tree on training dataset and then apply trained model on test data to calculate accuracy and prediction time.

Step 5: Comparison Graph: Using this module we will plot comparison graph between both algorithms

Step 6: Predict Fall from Test Data: Using this module we will upload new test data and then ML model predict ACTIVITY from that test data. Below is the test dataset screen shot which does not contains ACTIVITY column and ML model will predict it.

In this paper, there are some modules that can be used to construct an effective fall detection system for the elderly. The uploading of a fall detection dataset is the initial module. So, upload the dataset to the application here. The first row of the dataset screen provides dataset column names, whereas the next rows contain dataset values[6]. The first column of the dataset, ACTIVITY, represents numerous locations such as 0, 1, 2, 3, 4, and 5, with each value corresponding to the labels "Standing," "Walking," "Sitting," "Falling," "Cramps," and "Running." The fall dataset has seven columns: Activity, Time, SL, EEG, BP, HR, and Circulation, as well as rows with dataset values.

Table 1: Fall dataset

Activity	Time	SL	EEG	BP	HR	Circulation
0	12276.4	59742	-5101	56	249	2826
2	4059.12	2191.03	-1146.08	20	54	165
3	4722.9	4019	-1.60E+03	13	79	317
4	8271.27	9545.98	-2848.93	26	138	554

The second module involved preparing the dataset and calculating the features. Here, read all features from the dataset using this module, remove missing values, normalise the dataset using the MIN-MAX scaler, and partition the dataset into train and test, using 80% of the dataset for training and 20% for testing. For example, the total number of records found in the collection is 16382. Splitting Datasets for Training and Testing 13105 entries from the dataset were used for ML training, accounting for 80% of the total. In addition, 3277 dataset records were used for ML training, accounting for 20% of the total. The Run SVM algorithm module is the third module. We will use this module to train SVM on a training dataset and then apply the learned model to test data to determine accuracy and prediction time[5]. Run Decision Tree Algorithm is the fourth module. We will use this module to train a Decision Tree on a training dataset, and then apply the trained model to test data to determine accuracy and prediction time. The fifth and final module is the Comparison Graph. We will plot a comparison graph between the two algorithms in this module, and the last module will be Prediction Fall from the test data. We will upload new test data to this module, and the ML model will predict ACTIVITY from that data. The operating system we utilised was Windows 7 Professional, and the coding language we used was Python.

4. Result and Discussion

This paper represents for the purpose of detecting falls in the elderly people. We've gathered some fall detection data from the elderly. Table 1 displays the fall dataset. The information is not in a normalised format. We require normalised data to find accuracy, which we need to perform pre-processer. We retrieve the entire number of records accessible and partition them into testing and training in this pre-processor.

Table 2: Pre-processer dataset

Total records found in dataset	Training	Testing
16382	13105	3277

The SVM algorithm should be run after that. We'll obtain an SVM's accuracy, testing time, and training time here. The time is measured in microseconds.

Table 3: SVM data

Accuracy	Test Time	Train Time
0.35	17.31	32.55

We attained 0.35 % accuracy using the SVM method, with a train time of 32 milliseconds and a test time of 17 milliseconds.

The decision tree algorithm is the next step. It works in the same way as the SVM algorithm.

Table 3: Decision Tree data

Accuracy	Test Time	Train Time
0.965	0.027	0.32

We achieved 0.96 % accuracy using the Decision Tree approach, with a train time of 0.32 milliseconds and a test time of 0.02 milliseconds. Compare and contrast the two algorithms now.

Table 4: Comparison of Algorithms

Algorithm Name	Accuracy	Test Time	Train Time
SVM	0.35	17.31	32.55
Decision Tree	0.965	0.027	0.32

Based on the comparison, we find that the decision tree algorithm has a higher accuracy value than the SVM algorithm and that the test and train times are shorter.

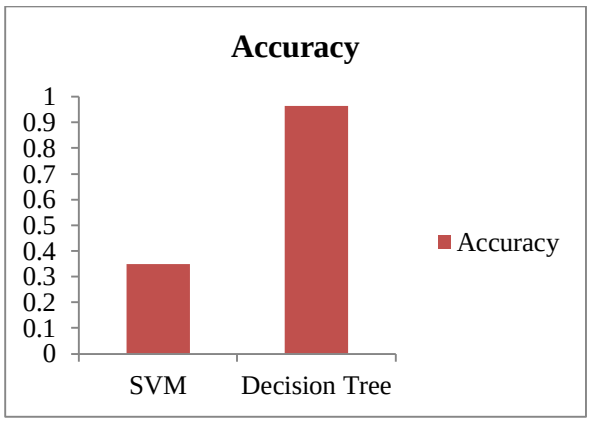

Figure.1 Accuracy Comparison for both Decision tree and SVM Algorithms

Based on the figure 1, we may conclude that Decision Trees are superior to SVM. Then we have a prediction fall from the test data to predict the fall. The test results are displayed in square brackets, and the predictions are things like sitting, standing, walking, and falling.

To acquire the desired outcome, double-click the 'run.bat' file to bring up a screen. To upload the dataset, go to that screen and click the 'Upload Fall Detection Dataset' button. The 'falldetection.csv' dataset should be uploaded there. The dataset will be loaded, and since it isn't in a normalised format, we'll have to process it before we can generate a graph. Close above graph and then click on 'Features Calculation & Pre processer Dataset' button to process dataset. x-axis represents ACTIVITY such as standing, walking, or falling in integer code, and y-axis represents number of records available in dataset for such activity. We can see that the dataset has been normalised and that it comprises a total of 16382 records. The application then separated the dataset into train and test, with 13105 records used for training and 3277 records used for testing, and the dataset is now ready. Then, to train SVM and calculate accuracy, click 'Run SVM Algorithm.' We attained 0.35 % accuracy using the SVM method, with a train time of 32 milliseconds and a test time of 17 milliseconds.

To train a decision tree, run the Decision Tree Algorithm. We got 96% accuracy with Decision Tree, and the train time was 0.32 milliseconds and the test time was 0.02 milliseconds, proving that Decision Tree is superior to SVM. Now when compare both algorithms, we get a graph where the x-axis represents algorithm names and the y-axis indicates algorithm accuracy, and both Decision Tree algorithms have high accuracy. We should upload test data and get a prediction to predict the fall. We're using the 'testData.csv' file for this. We can see test values there, and after the square bracket, we can see PREDICTION results from that test record, such as 'Standing, walking, falling, and so on.'

5. Conclusion:

This paper describes a wearable sensor-based fall detection system that is appropriate for the elderly. Machine learning techniques are used in the proposed method to identify falls from a set of daily living activities. Machine learning techniques have been found to be superior to threshold methods, as they produce fewer false

alarms as a result of pre-trained gait patterns.

The decision tree has a greater level of accuracy than SVM since it can properly define and categorize each characteristic to each class. In addition, the prediction time of SVM is longer than that of a decision tree, resulting in a slower system. Sensitivity, specificity, accuracy, and the confusion matrix are all used to evaluate the models. Falls are correctly identified utilizing a decision tree algorithm that has a 96 percent accuracy rate. The accuracy of the models can be improved further by training them with a big dataset and selecting the best characteristics.

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