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Machine Learning based Human Fall Detection System

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Abstract: ***Falls have become one of the reasons for death. It is common among the elderly. According to World Health Organization (WHO), 3 out of 10 living alone elderly people of age 65 and more tend to fall. This rate may get higher in the upcoming years. In recent years, the safety of elderly residents alone has received increased attention in a number of countries. The fall detection system based on the wearable sensors has made its debut in response to the early indicator of detecting the fall and the usage of the IoT technology, but it has some drawbacks, including high infiltration, low accuracy, poor reliability. This work describes a fall detection that does not reliant on wearable sensors and is related on machine learning and image analysing in Python. The camera's high-frequency pictures are sent to the network, which uses the Convolutional Neural Network technique to identify the main points of the human. The Support Vector Machine technique uses the data output from the feature extraction to classify the fall. Relatives will be notified via mobile message.***

Rather than modelling individual activities, we use both motion and context information to recognize activities in a scene. This is based on the notion that actions that are spatially and temporally connected rarely occur alone and might serve as background for one another. We propose a hierarchical representation of action segments and activities using a two-layer random field model. The model allows for the simultaneous integration of motion and a variety of context features at multiple levels, as well as the automatic learning of statistics that represent the patterns of the features.

Keywords: Fall Detection, Image Processing, Machine Learning, Histograms of Oriented Gradients, SVM

I. INTRODUCTION

A fall is defined as an incident in which a person accidentally comes to settle on the pavement, floor, or other reduced level. Across the world, falls have become a major issue. An estimated 600000 fatal falls occur each year, resulting as the next leading cause of inadvertent injury death, after road accident injuries. Over 79% of fall-related deaths are from economically developing countries, with regions of the Western Pacific and South East Asia. Death rates are highest in elderly people in all regions of the world. Each year over 38.4 million falls are tough enough to require adequate health care. According to the Centre's for Disease Control and Prevention (CDC), over 17,000 dies among 1,000,000 Americans due to slip and fall injuries.

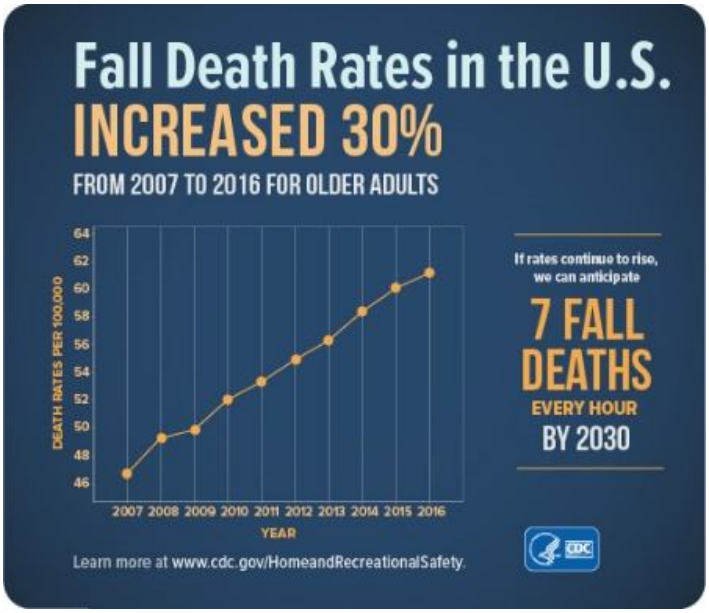

Fig. 1 Fall Death Rate

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The major causes for human fall are listed below:

A. Accidents

Accidents have become the predominant cause of falls in healthy adults. It may be by uneven ground, improper footwear, slipping from steady surfaces or stairs, dark surroundings.

B. Age

Injuries due to falling are higher in elder people than younger people. They are at risk due to dehydration, accidents, balance disorders, visual problems, sensory, motor and cognitive impairment, medications and alcohol consumption.
The below figure shows deaths from falls among elderly people.

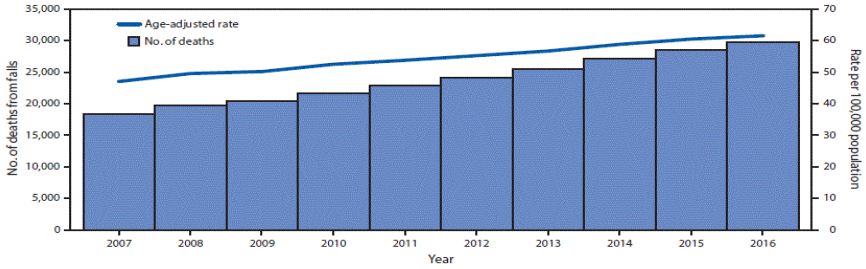

Fig. 2. Deaths from Falls

C. Sickness

Most of the falls occur due to the illness. Stroke experienced persons are at risk for falls due to gait abnormality, hypotonia. The other reasons for fall also includes adverse event of drugs, low Blood Pressure (BP), low blood sugar, reduced vision sight or loss of vision, loss of motion control including shivering and twitching, orthostatic hypotension, fainting, etc.

II. SCOPE

This work is focused on capturing and recognizing the human fall by video processing. The characteristics are retrieved using the Histogram of Gradients (HOG) method, and the fall is identified using the Support Vector Machine (SVM) classifier between Activities of Daily Life (ADL) and the fall.

III.LITERATURE SURVEY

A. Intelligent Fall Detection Using Statistical Features and Machine Learning

Hephzibah Thomas and Thyla B, [1] This article proposes a method of detecting a fall using combination of HOG, statistical features and machine learning concepts. They have used 10 fall videos and 10 non fall videos and SVM for classification. They have also used Gaussian Mixture Model (GMM) to extract the foreground features. This model generates an alarm when the fall is detected and an email is sent to the doctor with the captured image.

B. Fall Detection System by Machine Learning Framework for Public Health

Thiago B. Rodrigues, [3] This article proposes on applying a classification protocol from an IMU sensor using machine learning techniques. Shimmer sensor was configured to stream tri-axial accelerometer, gyroscope and magnetometer. They developed a multifunction MATLAB script. After testing the dataset, they selected k-Nearest Neighbor algorithm (kNN) due to its higher accuracy.

C. Machine learning in video surveillance for fall detection

Lesya Anishchenko, [2] This paper proposes a method of detecting a fall using Deep Learning and Transfer learning techniques. They used pre-trained CNN AlexNet. They used open database of video recordings provided by the Laboratory of Electronics and Imaging of the National Center for Scientific Research in Chalon-sur-Saone.

D. Real-time Detection of Human Falls in Progress: Machine Learning Approach

Gursel Serpen and Rakibul Hasan Khan, [4] This article presented the design of fall detection through body mounted embedded system. They collected data from two sensors namely, 3-axis accelerometer and 3-axis gyroscope. They placed the sensors at chest thigh and trained and tested SVM classifiers using three-fold cross validation.

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E. An Efficient Design of a Machine Learning-Based Elderly Fall Detector

L. P. Nguyen, M. Saleh, and R. L. B. Jeannès, [7] The proposed system of this article depends only on 3-axial accelerometer. In this article, the performance was analysed as a function of sampling frequency. They used three machine learning methods namely, SVM, K-Nearest Neighbour (KNN) and Multi-Layer Perceptron (MLP). The performance is evaluated and compared with the reference SVM-based Mezghani algorithm and the threshold-based Abdelhedi algorithm.

IV. REQUIREMENTS

A. Hardware Requirements

1) *Processor Type:* Pentium-1V
2) *Speed:* 2.4GHZ
3) *RAM:* 4GB
4) *Hard Disk:* 20G
5) *Camera:* IP Camera. An Internet Camera (IP) monitors the home using software that connects it to the internet. It's a form of digital recording device that uses an IP network to obtain control information and transfer image files.

B. Software Requirements

1) *Operating System:* Windows 8.1/10
2) *Programming:* Python/MATLAB2019

V. MODULES DESCRIPTION

A. Input Video

For the thesis work "Design and Implementation of an Open Architecture Framework for Video and Image Processing", in the framework that we have come up with in our thesis, we have created a part where a set of images or frames can be acquired from an .avi video format. The acquired images or frames can then be stored as any picture format.

B. Pre-Processing

Before being fed into the neural network, the camera's video will be pre-processed. The video will be converted into a series of RGB-imaged frames. The frequency at which sequential images called frames are projected on an active display is indicated in frames per second (fps).

C. Feature Extraction

Feature extraction is used in machine learning, pattern matching, and image recognition to create derived values that are meant to be useful and non-redundant, easing future learning and normalization phases and, in certain situations, helps in better human interpretations. When an algorithm's data set is too vast to analyse and is considered of being excessive, it can be condensed to a smaller collection of features. Feature selection is the process of choosing a subgroup of the initial features. To recognize objects using feature extraction, the Histogram of Oriented Gradients (HOG) is used. It has proven to be highly efficient in finding humans. It's a description that counts the gradient orientation in specific areas.

D. Classification

The Support Vector Machine (SVM) is a supervised learning method that is being broadly used to solve problems such as binary classification, factor analysis, and outer one detection. The SVM classification technique creates a model that can classify new data points into either positive or negative categories.

VI. IMPLEMENTATION

To build the human fall detector, dataset will be used for training and testing. Initially the video will be pre-processed before it is given to the frame enhancement. The video will be digitalized into RGB images and then transformed to its grey scale picture. The images will be resized using scale conversion and then interpolation will be done. The noise in the resized images will be removed by Gaussian filter. Histogram of Oriented Gradients (HOG) will be used to extract the required features from images as HOG is useful in detecting human. The classification between fall and ADL will be done by Support Vector Machine (SVM). This method will be implemented using Python/MATLAB.

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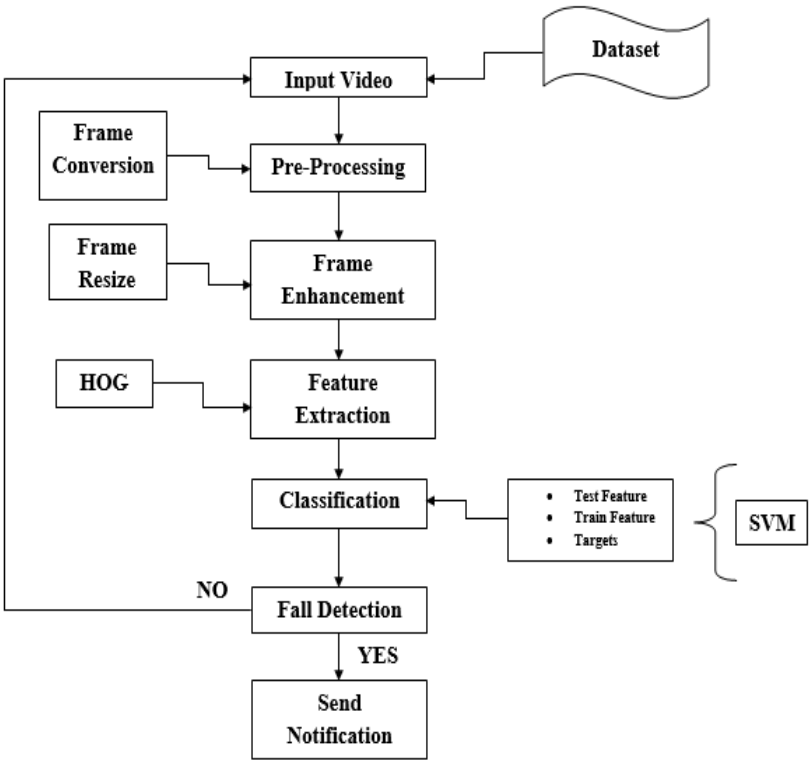

Fig. 3. Block Diagram

VII. RESULTS

The video is pre-processed and extracted using Histogram of Gradients (HOG). Then the video is classified between the fall and the Activities of Daily Life (ADL) using Support Vector Machine (SVM) classifier. If the fall is detected it creates an alarm and sends the notification to the family member.

Rather than simulating individual activities, we use both motion and context information to simultaneously model and recognize linked activities in a scene. This is based on the notion that actions that are spatially and temporally connected hardly occur alone and might serve as background for one another.

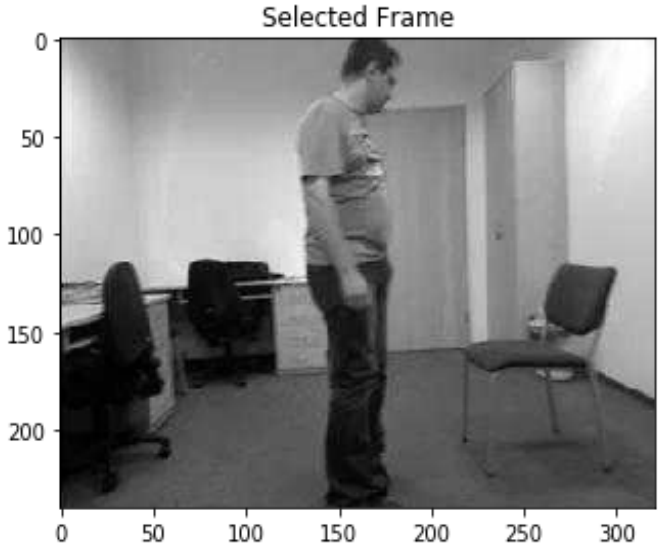

Fig. 4. Original Image converted to Grayscale Image

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Fig. 5. Image extracted using HOG

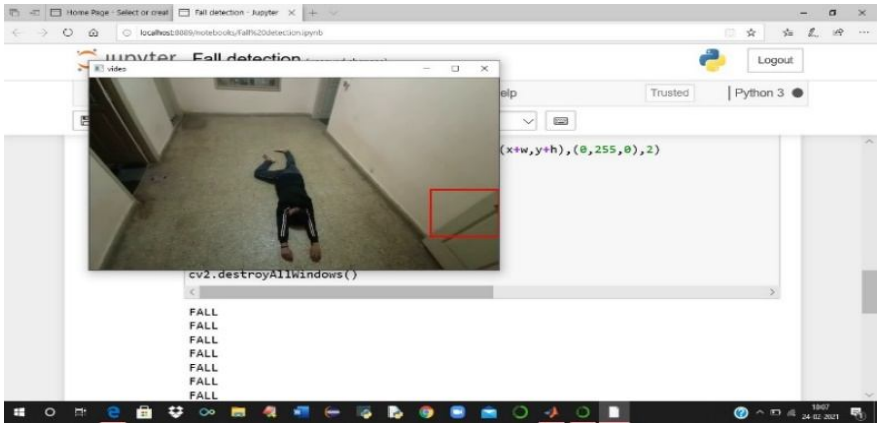

Fig. 6. Fall Detection

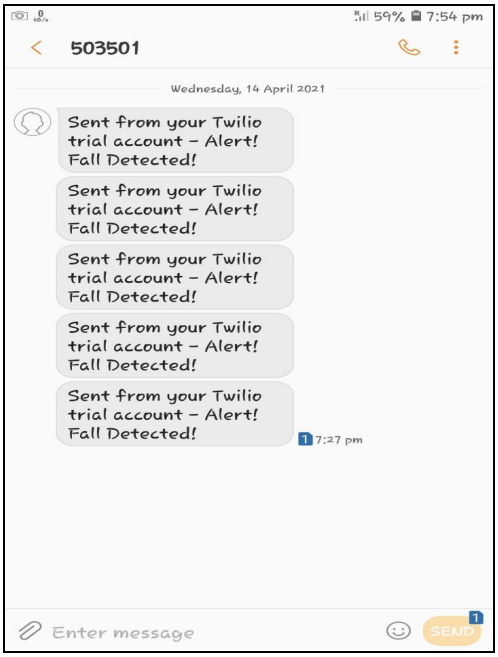

Fig. 7. Notification to the family member

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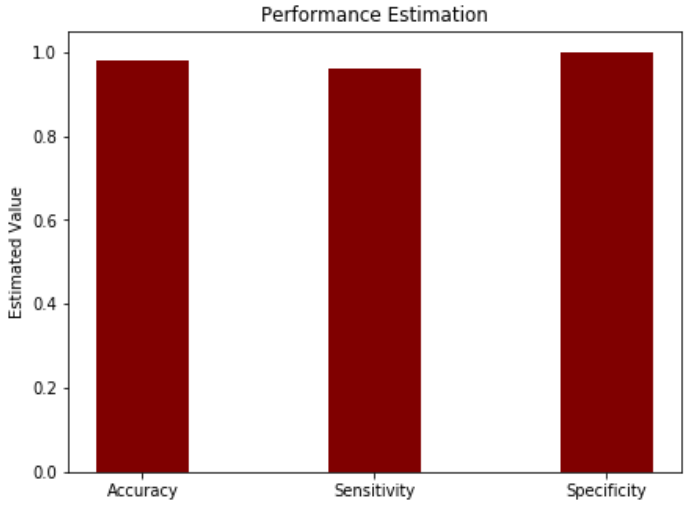

Fig. 8. Performance Estimation

VIII. CONCLUSION

Nowadays falls have also become one of the reasons for death. It is likely to be more among the elderly persons. Due to the public negligence or unawareness by the family, the victim may lead to death. This project proposal helps in avoiding this.
We proposed a multi-object tracking technique with spectral information and a confidence trajectory based on activity recognition in our work.

IX. FUTURE SCOPE

This idea can be extended by sending the information about the victim to the nearby hospital, so that the medical staff can reach the victim's place and give instant medication before taking to the hospital.

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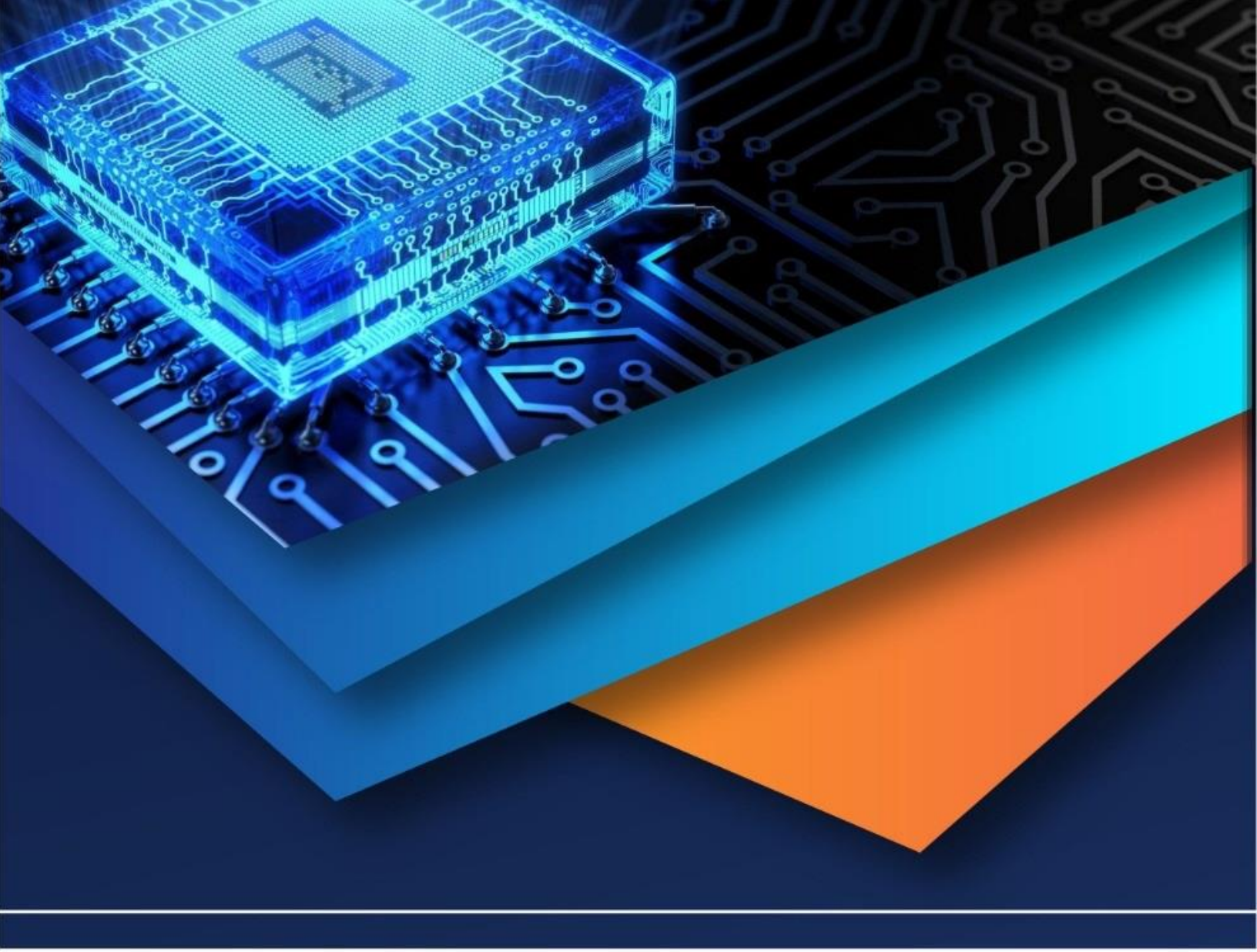

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