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Human Fall Detection System Using IOT and ML

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ABSTRACT: Falls are the major barrierfor the people. Elders are hugely impacted due to the fall. Patients most have problem to control the balance of the body & fall. So falls must be tracked and watch must be kept to avoid major injuries. In this review paper, a fall detection system is proposed based on IOT and machine learning. The system does the image processing in the preprocessing part and then gathers input to be applied on CNN algorithm and if falls are detected caretakers will be notified. Machine learning algorithm CNN will be used in our system.

KEYWORDS: CNN, IOT, Machine Learning

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I. INTRODUCTION

Emergencies could happen suddenly and without warning. As per the report of WHO Falls are the secondmosts leading cause of unintentional injury deaths worldwide. Each year an estimated 684 000 individuals die due to falls globally of which over 80% are in low- and middle-income countries. Adults older than 60 years of age suffer the huge number of injurious falls.
37.3 million falls that are fatal enough to require medical attention occur each year. Prevention strategies should emphasize education, training, creating safer environments, prioritizing fall-related research and establishing effective policies to avoid risk. A fall is termed as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level. Fall-related injuries may be sever though most are not sever. Most of the falls do not cause injuries. But one out of five falls does cause a sever injury such as a broken bone or a head injury. These injuries can make it a problem for a person to get around, do everyday activities, or live on their own.

In this work, a fall detection system is proposed. The system uses open source available dataset.. Machine learning algorithm, CNN is implemented and compared for better accuracy and performance.

This review paper seperates the section 2 for the evaluation of the past work in the configuration of a literature survey, and section 3 provides the proposed system. Finally, section 3provides the conclusion with the future work.

II. RELATED WORKS

YangsenChen ,Rongxi Du, Kaitao Luo, Yuheng Xiao [1] proposes a methodology based on pose estimation and the auxiliary detection method based on yoloV5. First, get video frames from different falling video sequences to form a data set; then, input the training sample set into the good network for training until the network converges; At last, test the category of the target in the video according to the optimized network model and locate the target.Activities of Daily Living (ADL) events in each frame of the image and give real-time results. The detection of falling behavior in the video further verifies the usefullness and efficiency of the recognition method based on our deep learning methods.

Hadir Abdo [2] proposes framework depends on RetinaNet for detecting humans with less computing time and moreaccuracy compared with the traditional human detection methods. Then, the proposed framework relates on

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handcraftedfeatures to represent shape and size and motion properties of the detected human. The proposed framework extracts aspect ratioand head position as shape features and motion history picture as a motion feature of the detectedhuman to create thefeature map. This feature map is used in training MobileNet network to distinguish the human motion into fall or not-fall.
The proposed framework is evaluated using UR and FDD datasets and the experimental results give the efficiency ofthe proposed framework achieving.

Mahesh Bundele, Harish Sharma [3] proposes conceptual technique, we have collected the Microsoft Kinect depth pictures of elderly fall event. After collecting the needed depth images the background subtraction algorithm has been used to remove the background and retain the subject. Segmentation and feature selection process is applied on various daily activity to train the fall detection model. The model is trained using decision tree. To ensure the fall confidence, ground truthing technique is used.

PrakrankiatYoungkong, PhD [4] Previously, a pressure sensor-based system called "NEF" was developed to monitor on-bed movements and send out alarming notifications to end-users when undesired events happened. The system used only one pressure sensor that was situated on the bed or mattress. On-bed positions and patterns were classified with more accuracy. However, the fall event is actually very active. Movements outside the bed must be included. In this paper, a novel double pressure sensors-based system is proposed. Applying different machine learning techniques, random forest yielded the better fall detection model

Sunah Min, Jinyoung Moon Lt [5] introduce an attended memory reference network that detects a current action online for a given video segment including of past and current frames. To integrate contextual information used for detecting a current action, we propose a new recurrent unit, known as attended memory reference unit, which gets input information based on visual memory attended by current knowledge. In an experiment using a fall detection dataset obtained from the abnormal event detection dataset for CCTV videos publicized by AI Hub, the proposed method surpass state-of-theart online action detection methods.

Chalavadi Vishnu, Rajeshreddy Datla, Debaditya Roy [6] proposed an approach to efficiently model the spatio-temporal features that used fall motion vector. First, we construct a Gaussian mixture model (GMM) called fall motion mixture model (FMMM) using histogram of optical flow and motion boundary histogram features to implicitly capture motion attributes in all the fallen and not-fallen videos. The FMMM contains both fall and nonfall attributes giving in a high-dimensional representation. In order to extract only the important attributes for a particular fall or non-fall videos, we perform factor analysis on FMMM to get a low dimensional representation called fall motion vector. Using fall motion vector, we can efficiently identify fall events in varieties of scenarios, including the narrow angle camera (Le2i dataset), wide angle camera (URFall dataset), and multiple cameras (Montreal dataset).

Yuya Ogawa [7] proposed a fall detection method that used IR array sensors. The method allows for fall detection that is not expensive and capable of providing security in a non-wearable form. Also, we analyze temperature distributions using machine learning to enablefast and mostcorrect fall detection. We evaluated multiple algorithms of machinelearning to select best and required algorithm. Then, classifiers are created upon these algorithms. We calculate and compare thecorrectness of these classifiers. One of the learning data is a line of temperature distribution data for 2 seconds. Onetemperature distribution is used every 0.1 seconds by IR array sensors located on a ceiling.

Laavanya Rachakonda, Saraju P. Mohanty [8] It is important to be able to reduce the frequency of elderly falls and their hazardous effects. Good-Eye proposes an edge device which predicts or detects falls based on picture orientation and physiological sensors using the Internet-of-Medical-Things (IoMT). Using LED lights, the user is notified with the decision of fall prediction and detection if the observed change is more than a set threshold. Along with a camera attached to the wearable device.

Xue Yang ,Shiping Tang, Tiankeguo , Kesheng Huang , Jiaxiong Xu [9] Intelligent video surveillance system is implemented in this research. CMOS camera transmits the collected video to the video processing model based on ZYNQ(ARM+FPGA). CNN (Convolutional Neural Network) image classification algorithm and hardware acceleration technology are used to process images in real time and detect whether the elderly have fallen.

Sejal Badgujar , Anju S. Pillai [10] a fall detection system was proposed based on machine learning. The system detects falls by classifying different activities into falled and not-falled activities.
The dataset SisFall with various activities of multiple participants is used to calculate features. Machine

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learning algorithms SVM and decision tree are used to detect the falls using of calculated features.

III. PROPOSED SYSTEM

CNN algorithm will be used to train our system and if fall is detected by our system notification will be sent to caretaker. When if person enters in camera range we will detect him and will start focusing on him.

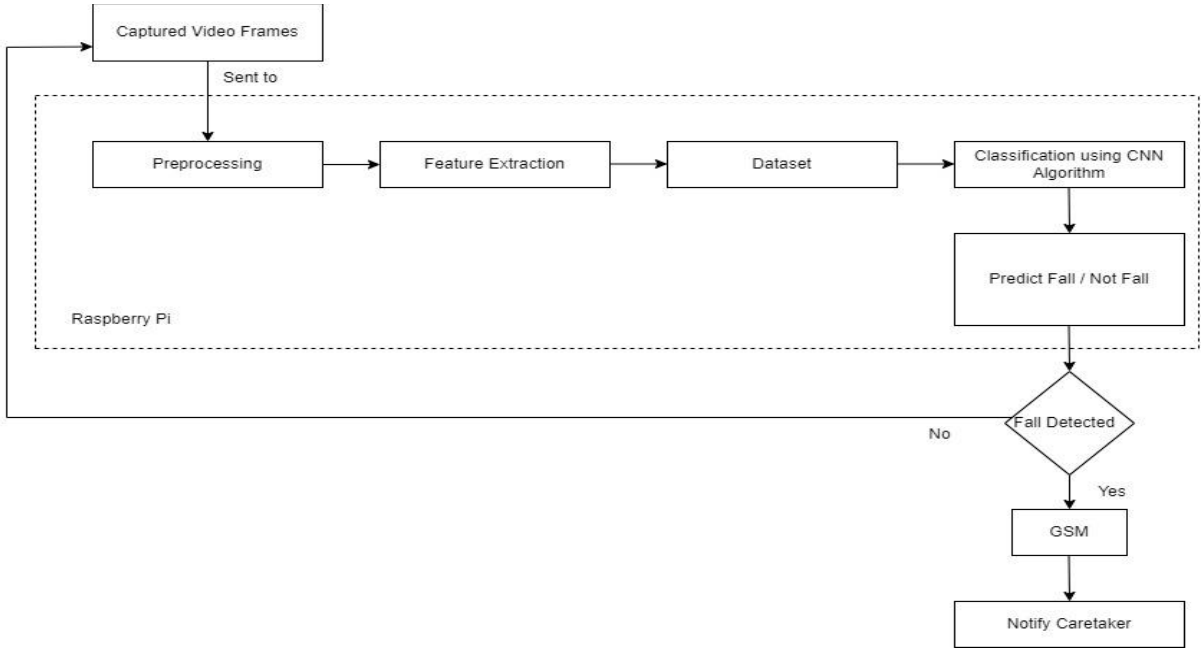

Fig 1.1 Architecture Diagram

3.1 Internet of Things: The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transmit data over a network without requiring human-to-human or human-to-computer interaction. IOT devices shares the sensor information they collect by connecting to an IOT gateway or other edge device where data is either transfered to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another device.

3.1.1 Raspberry Pi : Raspberry Pi (RPi) defines as a series of single-board computers that are now expanding being used to connect IoT devices. RPi can be plugged toa monitor. It is a capable little device that makes people to explore computing and learn how to do programming in languages. It is also capable of performing everything with users excluding from a computer. Raspberry Pi has ability to interact with the outside world. It is being used in variety of areas of digital maker projects, including music machines, parent detectors, weather stations and many more

3.1.2 GSM:A customised Global System for Mobile communication (GSM) module is discovered for wireless radiation monitoring through Short Messaging Service (SMS). This module is able to gather serial data from radiation monitoring devices such as survey meter or area monitor and transmit the data as text SMS to a host server.

3.1.3 Camera: Camera is used to capture the video required in oursystem .Usingcamera we are going to take the video input for our system.

3.2 Machine Learning: Machine learning (ML) is a type of artificial intelligence (AI) that allows software applications to become most accurate at predicting outcomes without being definite programmed to do so. Machine learning algorithms use historical data as input values to predict new output values.

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3.2.1 Convolutional Neural Network (CNN):

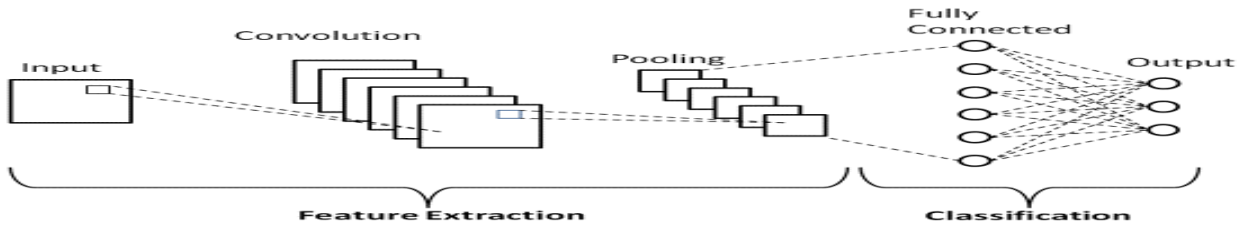

Fig 1.2 Convolutional Neural Network Diagram

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign priority (learnable weights and biases) to various aspects/objects in the image and be able to distinguish one from the other.

The architecture of a ConvNet is related to that of the connectivity pattern of Neurons in the Human Brain and was motivated by the organization of the Visual Cortex. Individual neurons counter to stimuli only in a restricted region of the visual field called Receptive Field. A collection of such fields overlay to cover the total visual area

Three layers in CNN algorithm:

1)Input Layer: It's the layer in which we provide input to our model. The number of neurons in this layer is uniform to total number of features in our data.

2)Hidden Layer: The input from Input layer is then provided into the hidden layer. There are many hidden layers depending upon our model and data size. Each hidden layers can have different numbers of neurons which are generally more than the number of features. The output from each layer is calculated by matrix multiplication of output of the previous layer with learnable weights of that layer and then by incorporation of learnable biases followed by activation function which makes the network nonlinear.

3)Output Layer: The output from the hidden layer is then provided into a logistic function which converts the output of each class into probability score of each class.

IV. OUTCOME ANDDISCUSSION

To assess various trained models and to compute the efficiency of algorithms, different parameters including confusion matrix, sensitivity, specificity, accuracy, training time and prediction time are computed.

Sensitivity acts for the actual positive cases which get predicted as positive, Specificity represents the true negatives, that get'spredicted as the negative. Accuracy is ratio of predictions our model got right which is calculated by taking average of sensitivity and specificity. Also confusion matrix is used to acquire true positive and true negative values. The accuracy is planned with selected features.

Table I. Performance of ML algorithms

Algorithms	It's Accuracy	It's Training time	It's Prediction time
SVM	84.16%	294.94 sec	84.70 sec
CNN	97.69%	27.78 sec	3.05 sec

The performance of CNN algorithm is found to be better as compared to the SVM algorithm for the considered information. Several factors were taken into account for comparison and one among them is the ability to define and

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classify each attribute to each class. The computing time of CNN is found to be lowas compared to the SVM. SVM works better out of the box, but CNN gives more perceptiont into how the model works. CNN are great for their simplicity and interpretation, but it has limitations in learning complicated rules and to scale to large information sets.

V. CONCLUSION

Our review paper presents IOT and Machine Learning based fall detection system. Thereforeafter studying and implementing we came to the conclusion that compared to the algorithm in the existing systems, our proposed system works more efficiently on CNN algorithm and provide best accuracy as compared to SVM. In addition to the proposed system, when the fall has been detected notification can be sent to the caretaker.

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