A SURVEY ON DIFFERENT APPROACHES USED IN DETECTING AND MONITORING THE ELDERLY PEOPLE FROM UNDETECTABLE FALLS

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Abstract- The fall-detection systems are used to create a reliable surveillance system for elderly people. Falls are a major problem for the elderly people leading to injury, disability, and even death. By utilizing information gathered from an accelerometer, cardio tachometer, IR sensors, MAX 30205 the impacts of falls can be logged and distinguished from normal daily activities. In the existing system, the normal activities of the elderly people will be captured which will lead to confusion. Our aim is to find only the unpredicted fall such as falling due to obstacle, fainting etc. By using accelerometer the rate at which the person is walking can be detected. Cardio tachometer is used to find the heart beat rate. MAX30205 sensor is used to detect the body temperature of the user. Microsoft Kinect is a sensor usually used to detect the obstacles that are present on the way. This sensor is used to help the visually challenged people and prevent them from falling. In this survey, an effective solution for detecting the unpredicted fall of the elderly people who are staying in the home alone has been made.

Keywords – Fall Detection, Wearable based, Ambience based, Vision based, Long Lay detection, accelerometer, cardiotachometer

I.INTRODUCTION

In today's worlds, Falls are a normal part of the human development life cycle. During the process of standing, walking, climbing, running and pursuing other activities, falls occur. Similarly, for aged people, falls also become part of our life experience. Most of the falls are of little consequence in which the frequency and impact of falls increase dramatically with age. Falls are part of most of the human, that we often underestimate the impact that they have on individuals and society. The report revealed that the fall detection problem affect 28- 35% people around 65 years of age and 32-45% for those over 70 years[1]. The World Health Organization (WHO) reports that,in todays world falls cause over 37.3 million severe injuries and 646,000 deaths per annum. They place a significant burden on health systems, both in terms of in-patient and long-term care, falls also can result in indirect psychological effects including reduction or avoidance of physical activity for fear of falling. From an economic perspective, any increased burden on health system results has a direct financial cost to society. Unsurprisingly, the frequency and impact of falls, the risk of death, healthcare costs, and economic productivity have driven research and innovation in the area of fall detection. Earlier experiments that are carried out on fall detection were environmental sensor-based, which monitored the local person in that location and collected relevant information. These systems had inherent location-based limitations. A fall detection system is an useful experiment whose principle objective is to notify when a fall event has happened. [2].

Most recently, as part of the so-called Internet-of-Things(IoT), the growth and widespread adoption of cloud computing, mobile technology and big data analytics, coupled with developments in low cost sensing technologies, has accelerated research into mobile health monitoring. To children and adults of ages, wearable devices to health monitoring are common place; they can be specialized wrist-worn devices built with smart phones or smart watches. Wearable fall dedection system have significant advantages over fixed location fall detection system in previous generations. They are location-agnostic, track the focal party on an ongoing basis, detect not only the falls but also any predefined anomalous or predictive activity, and can notify the third party to interfere before or after a crash, thus remediating effects. Although advancements in in cloud and mobile computing have allowed ongoing surveillance developments in data science allow fall detection. This survey focuses on the fall detection and addresses calls for more research on the use of deep learning analysis in healthcare.

II.AMBIENCE BASED APPROACHES

Ambient-based fall detection systems are based on the use of proximity and floor sensors to gather data from daily living activities. This data is used for detecting fall The research work discussed in uses several sensors that are designed to gather human data when a person gets near. Moreover, atmosphere-based devices aim to integrate sound and visual knowledge and recognize the potential by information about vibrations[3]. Ambient-based methods are the easiest strategies to diagnose a dropping case, since they do not use any wearable device and only use sensors for orientation, light and sound.

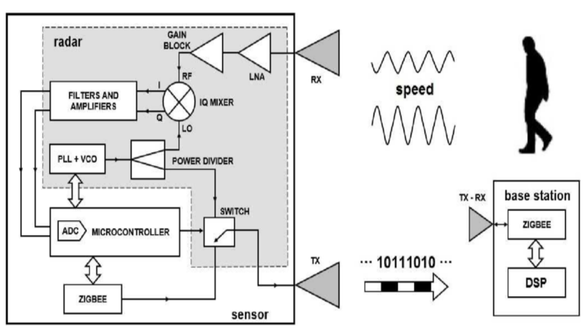

Fig.2 An example of the usage of ambient sensors in monitoring activity patterns

A.Audio and Visual

Ambient-based models tend to be based on a cumulative judgment associated with audio-visual signals along with some other specific information like vibrational floor data or even microphone inputs through the ambient sensor array. Toreyin et al[6] used the audio and video data to track a person's collapse and try to separate the fall from walking and sitting using wavelet analysis and Hidden Markov

(HMM) models. In another study, Toreyin et al used an HMM model to detect a dropping using vibrational data using audio data and passive infrared (PIR) sensors Event sensing.

B. Vibrational Sensing

The identification of events and the use of vibrational data can be important in any context, such as surveillance, tracking and localization, etc.[3] Alwan and Majd [4] et al are working on a fall-detection system dependent on floor vibration. The daily activities of peoples are continuousy monitored. The device uses floor vibration patterns to track dropping events and fits vibration pattern technique. Yazar et al[5] used PIR and vibration sensors and the Winner-takes-all (WTA) judgment algorithm used to differentiate drops from the normal daily activities. Alwan and Majid further disclosed that this environmentally based solution leads to high false alarm levels, low accuracy and high installation costs[4].

III.VISION-BASED APPROACHES

In an indoor environment, the vision-based approach uses single or multiple cameras to monitor a person's movements and body shape over the entire dropping duration[8][9][10]. Anh Nguyen et al.[10] introduced a single camera-based fall detection system, and the system works by monitoring the characteristics of motion and body shape throughout the falling duration, not at a certain particular point in time. Zhen-Peng Bian et al[9] proposed single depth camera based fall detection system. The present system is independent of illumination of lights, and the system can also work in the dark room. Yu et al [11]proposed a fall detection system using vision-based technique by using background subtraction technique. Various methodologies have been proposed for the examination of images including spatio temporal features and analysis of the 3D head position[3].

A.Spatio-temporal

Modeling the form using spatio-temporal features provides important data to human activities which are used to detect various events. Foroughi et al.[12] suggested a method for the detection of dropping by combining the approach to proper space with integrated time motion images (ITMI). Time of movement event and information about motions found in the spatio-temporal database can be defined as ITMI.Using the Eigen space technique and the neural network classifier used to identify fall occurrences, feature reduction is applied.

B.3D head position analysis

Assessment of the head position relies on the monitoring of the head which controls the event of large motion within the video series. Different state models are used for tracking the head based on information about the magnitude of the motion[3]. Auvinet et al.[8] listed a variety of approaches to the technique using an occlusion-resistant algorithm and a VVDR[13]. Multi-camera system downside needs to be adjusted, and video sequence from different camera needs to be coordinated as well. The process makes it more difficult and expensive to implement a system[14].

IV. WEARABLE DEVICE BASED APPROACHES

The wearable device-based methods allow the subjects to dress in certain devices or clothing with embedded sensors such as magnetometers, gyroscopes and accelerometers to track the movement of the body or posture of the person, the data collected by the inertial sensors are used as motion signals to evaluate the movement status.

Accelerometer

The accelerometer is a tool used to measure the acceleration, location shifts, and velocity. It is the most commonly used methods used to assess the physical activity and detect patterns of activity**.**

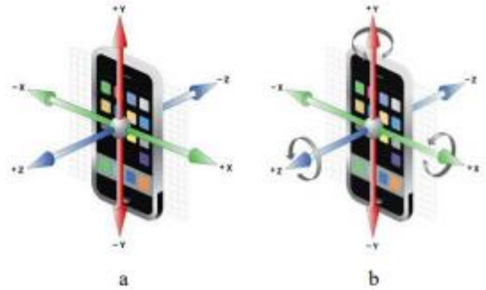

Fig3.Three axis accelerometer(a) and gyroscope(b) in a Smartphone device

Gyroscope

A gyroscope is a tool used to measure directional shift and rotational velocity.

Magnetometer

A magnetometer is an instrument measuring a magnetic field. The inertial sensor data are either generated by the sensor attached to the body or embedded in a smart phone.

Cardiotachometer

A heart rate measuring instrument. It is used to count heart beats, typically showing the number of beats per minute. Its electrical activity produced by depolarization of the heart muscle that propagates to the skin through pulsating electrical waves.

MAX 30205

The temperature sensor MAX30205 reliably calculates temperature and produces an alarm / interrupt / shutdown output over temperature. The MAX30205 converts temperature measurements to digital form using a high-resolution, sigma-delta, analog-to-digital converter (ADC). When soldered on the final PCB, precision follows the clinical thermometry requirements of the ASTM E1112.Communication is through an I^2C-compatible, 2-wire serial interface.

IR Sensor

An infrared sensor (IR sensor) is an electronic sensor that detects infrared (IR) light that are radiated from the objects. They are most widely used in motion-detectors based on IR. IR sensors are widely used in safety alarms and automatic lighting.

IR sensors detect general motion, but don't provide information about who or what moved. An active IR sensor is required for that reason.

IR sensors detect general movement of the person. Inorder to check this, an active IR sensor is required.

A. Wearable Device attached to the body

The sensor was connected to various parts of the individual's body to collect the data during the fall. Huynh y al. Its used accelerometer-and gyroscope-based wireless sensor system (WSS) and the senor is connected to the human body at the center of the chest to capture real-time fall data. Lai et al. have incorporated various sensor systems such as, tri-axial acceleration for joint monitoring of damaged body parts when there is an accidental fall. The model transmits the sensor-encouraged data which is distributed over different parts of the body.

B. Wearable Device Built-in Smartphone

A rich range of embedded sensors, namely an accelerometer, digital compass, gyroscope, GPS, microphone, and camera, are accompanied by smart phones today. Today, many researchers use the advantage of this reality to create fall detectors based on Smartphones. For example, Bai et al. demonstrated GPS-based smartphone with a 3-axis accelerometer sensor for detecting falls. Andò et al. developed an ADL and fall detector system based on smartphones through the use of an accelerometer sensor.

V. CLASSIFICATION ALGORITHM BASED ON WEARABLE APPROACH

The classification algorithm is used to classify daily living behaviors, as well as several fall events. A wearable based fall detection algorithm can be classified into two methods, namely Fall-based and machine-based learning, according to our literature review.

A.FALL DETECTION ALGORITHM

Existing studies on the human body from the fixed accelerometers will determine whether a fall occurred by measuring the values of accelerationx, y, and z. A fall can be detected if the accelerometer shows that the body is rapidly moving downward and in the vertical direction above a certain limit.Since the current approach involves the use of an external tool to recognize that a senior has dropped, however, it is difficult to implement such a program. The approach proposed in this report, however, can easily identify whether a fall has occurred by using only a smartphone without any additional tool.

The approach used in this study analyzes the signal vector magnitude (SVM) to detect a fall regardless of the direction the smartphone accelerates. The total SVM is defined as follows

$$\mathrm{SVM} = \sqrt{(A_x)^2 + (A_y)^2 + (A_z)^2}$$

where Ax, Ay, and Az are the acceleration (g) in the x-, y-, and z-axes, respectively. When there is a movement by the senior, the SVM value changes. If the movement is large and fast, the SVM value increases.. If the senior falls, the change in the value is very large, and since the change can be discriminated from other changes due to everyday living, it is possible to detect a fall. In addition, the critical point to determine that a fall has occurred can be controlled by combining sensor data at the time of a fall. As a result, the fall would not be misjudged. In this way, a fall can be observed without the smartphone being set. In other words, the senior should hold a smartphone in the pocket of their pants as it is possible to detect a fall without fixing the smartphone in a particular direction. At this time, the slope sensor plays an auxiliary role in detecting the fall and helps improve the accuracy by preventing a fall from being detected incorrectly.

B.MACHINE LEARNING BASED ALGORITHM

In Machine-based learning approach, a learning algorithm trains different types of falls and ADL patterns and then classifies the case by classification algorithm. The machine learning algorithm includes Hidden Markov Model (HMM), Decision Tree, Support Vector Machine (SVM). Tong et al suggested a low-cost monitoring and protection method using HMM and tri-axial, and the results of the experiment showed that 200–400 ms earlier the accident could be expected to fall and could also be accurately detected from other regular activities. Using acceleration data and Hidden Markov model (HMM), Cao et al suggested fall detection system, and data collected by a tri-axial accelerometer built into a wearable device. A guiar et al suggested a smartphone-based detection system using the device's embedded accelerometer sensor and tested three machine learning algorithms, such as Decision tree, k-nearest neighbor (K-NN), and Naive Bayes, but Decision Tree appears to be good performance among those algorithms. Pierleoni et al suggested use of accelerometer and magnetometer sensors to support vector machines (SVM) powered fall detection system.

C.HYBRID CLASSIFICATION ALGORITHM:

The purpose of this paper is to reduce fall-related issues by developing a new fall detector that we call fall detector Tesodev. Additionally, there is a proper algorithm and a wearable electronic device that attaches the sensor to the clothes of the patient. The electronic device is an IOT device capable of sending and receiving data wirelessly, which means the device can inform medical centers in order to improve the time of medical attention. This system is also versatile and makes other medical data such as blood sugar, anxiety, heart rate, SPO 2, response, error rate and precision of classification in this analysis are 89.8%, 23.4%, 76%, respectively.

D.THRESHOLD ALGORITHM:

Threshold based fall detection algorithms use dara from accelaration sensor that are part of the smart phone technology. The evaluation was done with sampled fall records where young people simulate falls. A further record set of Daily Living Activities(ADLs) from elderly people was used to check the false positive rate of the algorithms. The finding are very positive and show that smart phone sensors are appropriate for detecting drops.This will offer a new opportunity to assist elderly people in their daily lives and increase their self-determined life span.

Reference	Proposed approach	Contributions	Challenges
1	PerFallD: A Pervasive Fall Detection system using mobile phones	Uses Android G1 phone mobile platform to conduct fall detection, the system automatically and iteratively calls and/or texts emergency contacts according to priorities on fall detection, available in both indoor and outdoor environment	Mobile phones limited battery and affordability, false alarms, integrating the system with some extra protection devices, e.g., airbag to reduce fall impacts
2	Wearable fall detection monitoring system for the elderly	Distinguishes between fall and non-fall events, provides visual, audio, and tactile fall alerts	Some actions have not been successfully distinguished to be falls/non-falls, as a wearable device, old people tend to forget wearing it, produces false alarms
3	Wearable fall detection monitoring system based on TEMPO 3.0 sensor nodes	Applies both tri-axial accelerometers and gyroscopes, improves fall detection accuracy, reduces both false positive and false negative alarms	Facing difficulties in differentiating actions that need context information
4	WAMAS: Wearable Accelerometric Motion Analysis System	Measures head motion via 3-axis sensors attached to both corners of eyeglass frames and two more above the hips at the waist, warns the wearer of prefall behavior	As a wearable device, old people tend to forget wearing it, needs lighter weight, digital input, voice output improvements
5	Vision-based fall detection system for the elderly	Models human motion and audio track of the video using HMMs, avoids false alarms via using the impact sound of a falling person	Hard to estimate moving object trajectories, inaccurate detection depending on the relative position of the person and camera, occluding objects, requires using omni directional camera

Figure 1.1 Comparison of various approaches and their challenges

CONCLUSION:

The Internet of Things is a new paradigm that helps the adult population improve their quality of life by promoting a more personalized and omnipresent mode of treatment. This study introduced the IoTE-Fall system, an IoT framework for the identification of elderly people in indoor environments, based on a Big Data model using techniques for the analysis of machine learning based on ensemble-RF. Four machine learning algorithms were developed and tested to identify falls and differentiate them from the ADLs. We selected the best suitable algorithm to achieve this objective by comparing the classifiers ' efficiency, computational requirements and the area under the receiver operating characteristic (ROC) curve. We have built and tested the classification models based on historical information from a publicly accessible dataset of falls and ADLs performed by elderly people by using five-fold cross validation.

The purpose of this survey is to help people know about the fall of the elderly people and to reduce the by using various approaches such as vision based, wearable based and ambience based. The knowledge will be stored in the cloud that will be compared to normal data about human beings. If any anomalies are detected then the warning message is sent to the registered mobile number. Thus the survey was carried out to predict the decline of the elderly, and the fall can be minimized by continuously monitoring the elderly.

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