Usage of Energy Efficient Sensor Nodes on Wearable Device for fall and Child Abduction Detection

M.Rajeswari, Satheesh Kumar R, Chidambaranathan, Nasiya PM

Abstract*: *Falling is the most hazardous occasions that frequently occur among senior individuals, patients which requires medicinal consideration in time. Fall discovery frameworks could support senior individuals and patients to live autonomously. A programmed continuous fall discovery framework may discover fall occasions among old individuals in time that lessen the general setback rate. This device also helps to find the location of child when kidnapped which makes anyone to find out the child from kidnappers easily. The proposed framework utilizes the accelerometer and tilt sensors to structure an ongoing fall recognition framework additionally to recognize up to 4 various types of fall occasions (forward, in reverse, rightward and leftward), and compact ,wearable, ease and with high exactness rate. Machine learning algorithm is applied to predict if fall has happened or not ,so it is easy to avoid the false events effectively. Since the midriff is the focal point of gravity in the human body, the framework is progressively helpful when put at the midsection. The framework incorporates a programmed ongoing fall recognition gadget, energy utilization of sensor nodes in an IoT-based fall discovery framework and displays a structure of an altered sensor nodes and GSM texting capacity which can issue fall alert, send emergency help message.

Keywords* : *Wearable device, fall detection, Child kidnapping, IoT, Machine learning

I. INTRODUCTION

Falls are the most residential mishaps among the patients, older individuals and incapacitated people. In many cases, fall injuries will result in noteworthy restorative expenses. Besides, it every now and again happens that older individuals, who have recently encountered a fall, dread another fall and sink step by step into latency and social segregation. In this way, it is imperative to identify fall which requires someone to send crisis help alert. Also, if a fallen individual is oblivious and incapable to call for assistance it can prompt even passing. Thusly, a fall discovery framework, which can consequently identify the fall and call for assistance, is significant for older individuals, particularly for those living alone. With wearable sensors appended to the human body, falls can be naturally recognized. Alert messages can be created and conveyed to the appropriate contacts. Subsequently there is a need of programmed fall locators that is equipped for setting off an alert consequently with no bogus cautions and delivering this data to the overseers to get quick restorative assistance.

The primary objective, of the proposed framework is to build up a programmed fall location framework, which help old individuals. The fall indicator will create in an ongoing framework, utilizing accelerometer and tilt sensor. It will be consequently identifying different body falls and sending an alert to the caretakers. The client can physically produce the caution signal, if there should arise an occurrence of need or, conversely. Also, he/she can cancel a consequently produced alert, if there should be an occurrence of false fall recognition. It will comprise of GSM Technology joined with this system, sending the continuous status used for finding the situation of the client. The focal point of gravity is the equalization point. The body's focal point of gravity is close to the midsection, when individuals are holding up. Another motivation behind why we are not wearing it on a hand or a foot is that on the grounds that the increasing speed would change too seriously in the event that we set the accelerometer there..

II. WEARABLE SENSORS USED IN FALL DETECTION

Many sensors use for fall detection as accelerometer sensor, Gyroscope sensor etc.

A. Accelerometer

Increasing speed is the estimation the adjustment in speed, or speed separated by time. Increasing speed is estimated in (m/s)/s. This edge is extremely valuable to distinguish fall. A three dimensional (3D) accelerometer is an electromechanical gadget which could quantify a unique speeding up and a static increasing speed in three dimensions such as x, y, and z in fig1. Dynamic speeding up is direct increasing speed when the accelerometer functions, while the static quickening is a dormancy quickening. The inactivity quickening is called G-Force (G), 1G = 9.80665 m/s2. This sensor is accustomed to estimating direction of a human body by ascertaining the latency increasing speed on every hub. Consequently, the yield from the 3D accelerometer can be utilized to figure the estimation of pitch, roll and yaw of anyone.

X, Y, Z are the three hub of the accelerometer to identify the

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movement and area of the body of the subject. In the event that the negative speeding up is all of a sudden increased, then A fall is distinguished. At the point when change in direction from upstanding to lying position.

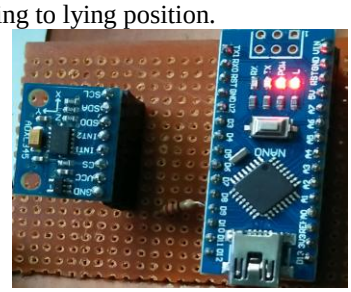

Fig 1.ADXL and Arduino nano

Pitch, Roll and Yaw

Any developments in the x, y and z directions estimated as an edge. The move, pitch and yaw are rotaries development of the x-pivot, y-hub and z-hub to the plane appeared in figure2.

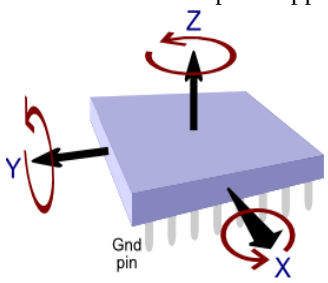

Fig 2.Axis Gyroscope Sensor

At that point, discover the edge estimation of pitch and move of the human body utilizing the 3-D accelerometer with the accompanying trigonometric condition:

$$\varphi = \tan^{-1}\left(\frac{Ay}{\sqrt{Ax^2+Az^2}}\right),$$

$$\theta = \tan^{-1}\left(\frac{Ax}{\sqrt{Ay+Az^2}}\right)$$

where φ is a roll value and Ax,Ay, Az are acceleration of the x-pivot, y-hub and z-hub respectively. where θ is a pitch esteem.

Alpha

The estimation of alpha (α) is the size vector speeding up from the yield of 3-D accelerometer. The condition [7] of size the estimation of alpha (α) is the total of squares direct quickening in the x, y, and z hub of the accelerometer sensor with the accompanying condition:

$$\alpha = \sqrt{Ax^2 + Ay^2 + Az^2}$$

.

This value is utilized as the limit to decide the body direction and fall of old people.

Gyroscope Sensor

Gyro sensors give angular velocity shown in fig.2. Angular velocity is the change in rotational point per unit of time. Unit of precise speed is represented as degrees per every second. Utilizing recreated falls accomplished by youthful volunteers under directed conditions onto crash mats and ADL made by old people; completed by setting edges for the gyrator. From the gyroscope pitch and roll precise speed are determined, on the off chance that these qualities surpass the limits, at that point a caution is activated to caution of a fall. This framework has got high precision for fall identification.

III. ARCHITECTURE FOR FALL DETECTION USING IOT SYSTEM WITH MACHINE LEARNING

The framework design, appeared in Fig. 3, comprises of three fundamental phases: sensor hubs, a door with a mist layer unit and a back-end framework depicted as pursues: A sensor hub comprises of at any rate three essential segments: 3D accelerometer sensor, smaller scale controller and remote correspondence module. Information is assembled from the triple hub accelerometer with arduino nano module. Contingent upon specific fall location frameworks, the gathered information can be pre-processed using examinations from sensors that are moving to AI calculation as support vector machine (SVM).

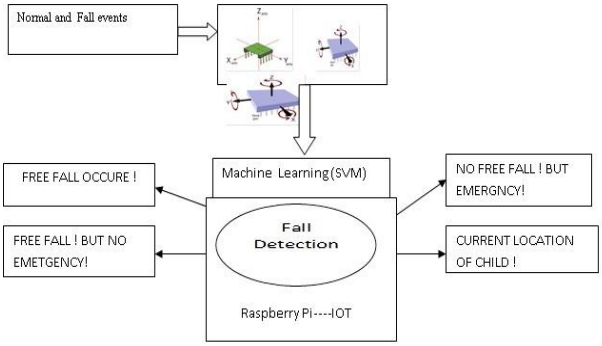

Fig 3. Nasi's architecture for Free fall detection

Support Vector Machine (SVM) is a sort of managed learning strategy that all the while limits the observational arrangement mistake and boosts the geometric edge. Informational collection for fall discovery is extracted from kaggle. In this arrangement strategy ,informational index of training model that have a place with one of two classifications, finally SVM predicts that new model fall into which classification.

It is noticed that support vector machines (SVM) are superior to anything other than edge based strategies. The Nasi's fall identification framework utilized a wide assortment of fall and every day movement situations to more exactness of our SVM calculation over a mix of changing lead times and window sizes, utilizing a tri-hub accelerometer and gyroscope. The framework gave in any event 95% affectability and in any event 90% particularity for blends of window size from 0.125-1 s and lead time from 0.0625-0.1875s. By exhibiting experimentation technique, lead times 0.25 s or more prominent, affectability and explicitness differed significantly with decision of window size, demonstrating poor power of the grouping execution. Hence, the utilization of an objective lead time around 0.1875 s or less, and window size 1 s or less for robust pre-impact fall detection [1].

Raspberry Pi v3 is utilized which is a charge card measured smaller than normal PC, it functions extraordinary stage for constructing internet of things(IOT) [10] as it is outfitted with a convincing 4-center 1.2 GHz CPU, 1 GB. RAM and extensible stockpiling ensure that mind boggling calculations run easily with low latencies. Moreover, Bluetooth classic, Bluetooth low vitality, and Ethernet are promoted which gives individuals to machine and machine to individual's correspondence.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

In this section, given device was evaluated when it is utilized in an ordinary situation and while falling. The implementation of device was carried our when an old is falling which is summarized in Table 1. This device discovers elderly fall forward which is 95% and the same is recorded only 75% in fall backward successfully. It allows anyone to develop their individual hardware and disseminate the details over internet using smartphone application like telegram instant messaging. Telegram Bot API was used for message dissemination between people and Raspberry Pi platform. Nasi's protocol for wearable device is shown in fig.4.

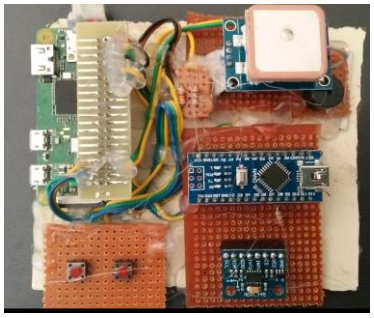

Fig.4.Nasi's protocol for wearable device

Table 1. The threshold values when anybody falls

Parameter	Fall Forward	Fall Backward
T1	-	-
T2	-	-
T3	T3 ≤ -0.5	T3≥-0.5
Pitch	pitch≥45	pitch≤-45
Roll	45≤roll≤45	45≤roll≤45
Alpha	alpha≥0.8	alpha≥1.0

There are four types of telegram messages are send.

Free fall occurs!

When negative acceleration suddenly increases, buzzer produces an alarm up to 10 sec, indicates patient is in unconscious state, and need emergency help. It automatically sends emergency help message to appropriate caretaker's mobile phone via telegram message with current location from GPS module fig 5.

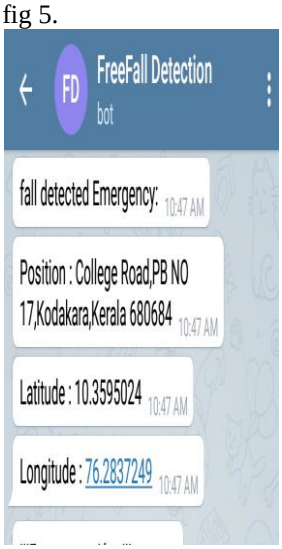

Fig.5.Free Fall occurs!

Free fall, but no emergency!

If free fall occurs and alarm is produced while patient does not need any help, then he or she can press the stop button (two type of button-stop and emergency button) within 10 second for sending message as free fall occur, but no emergency with location fig 6.

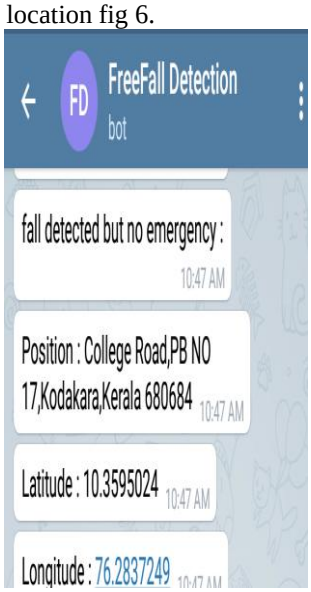

Fig.6.Free Fall

No free fall, but need emergency help!

When free fall has not occurred ,but patient needs help as well as if child abduction is done, when the child needs help from his/her parent, then he can press the emergency button which automatically sends emergency help message to the caretakers with current location including latitude and longitude fig.7.

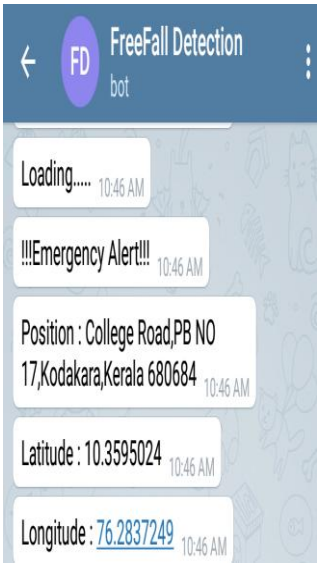

Fig.7.No Free Fall, But need Emergency

Location of the child

Now a day's child snatching increase, it requires alternative type of messaging which is used to understand the current location of our child as well as old people. If any child has been kidnapped, then his/her parent needs to know the current location to rescue him/ her. It is desirable to understand that if the child wears this belt, the parent can send message like "/location" to that device which makes the device to send back the current location fig.8.

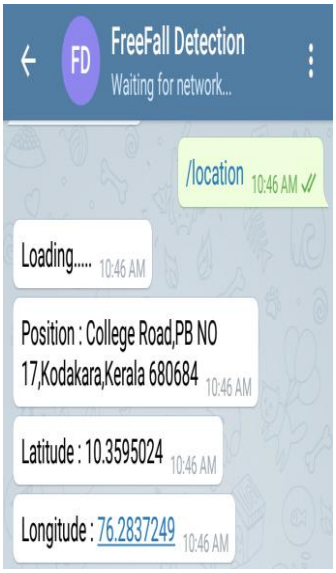

Fig.12. Getting current location of child!

V. CONCLUSION

There are different fall location frameworks which function well for the recognition, yet not reasonable for kid snatching framework in the real life, because of the bigger number of sensor nodes connected to human body with awkward wearing condition. The proposed framework is made to be convenient, wearable gadget set on the midriff of client, having sensors comprising of accelerometer and tilt sensors and a basic calculation utilizing posture recognition fall detection. In this paper, the energy utilization of remote sensor nodes in fall identification was discussed. IoT-based framework for identifying an energy effectiveness technique for planning those sensor nodes was defined. Also, elaborated a straightforward modified sensor hub for accomplishing a significant level of energy consumption. Contrasted with essential energy utilization of a few sensor hubs dependent on this along with different plans presumed that sensor hub is energy efficient. The sensor nodes can function as long as 35 hours, when using an 1100 mAh battery. In addition, Messenger notification service can improve the quality of healthcare services.

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