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Internet of Things based Fall Prediction and Alerting Device

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***Abstract* - Mostly, the older people are living their own life alone or being separated from their younger ones due to many factors. As they live alone, they tend to fall. This fall leads to various health related problem and even lead to death. In this work, an Internet of Things (IoT) based fall prediction and alerting device plays a major role in helping these older peoples, as it is difficult to look after continuously. Further, the proposed device is designed in a way that whenever the patient is about to fall, the buzzer gives alarming sound by sensing the value from the accelerometer and gyroscope sensor and comparing with the threshold value in order to indicate the patient. Also, the device sends the alerting messages to their guardian once they fell. Result demonstrates that the message alerts the patient guardian and makes the patient to get help in time. By this way, the special care is ensured to take care of those people and can avoid these problems.**

Keywords: Internet of Things (IoT), fall detection, wheelchair, Raspberry Pi, accelerometer and gyroscope sensor, threshold.

INTRODUCTION

Now-a-days as the population of older people increases, they get vulnerable to different problems mostly medical and health issues. Rural areas still lack in the facility for appointing a caretaker or a nurse for patients. This means there may be no one to help the patient if any accident happens. This kind of situation leads to more complication of health. If the person is a wheelchair ridden patient. The difficulties faced by the patient who is aged and also a wheelchair ridden may increase, if they fall from a wheel chair. A patient's fall with wheelchair may cause more complication when compared to the patient's fall without the wheelchair. In any case if the patient had a fall from wheel chair, they need some emergency help. or else, lying on the floor for long period of time may also leads to dehydration of the body, damages in muscle and bones and also this may lead to death in severe cases [1].

The technology used in building a wheelchair with fall prediction and fall detection is IOT (internet of things). IOT is nothing but a communicable pathway which is embedded with sensors, software's and other technologies. This helps in connecting the devices and also in exchanging data from one device to other with the help of internet. IOT is an advanced helping hand for humans. This helps in innovative creation around the technologies to make the human's life style easier and more comfortable. According to the survey 20 billion smart devices are used by 7.2 billion people present on the earth. IOT plays major role in fall detection and prediction device as the patient cannot be monitored by the supervisor continuously. If there is no correct guidance in such fall cases the user may end up in critical health situations, for this purpose IOT (internet of things) is incorporated with this device to monitor the patients continuously without the help of supervisors**.** Vaiyapuri et al., [1] (2017) have suggested connecting the smart phone and deep learning so that it activates and alert the guardian when the patient faced any fall in their home. Bhoi et al., [2] (2018) have described the use of accelerometer and gyroscope sensors to receive the accurate values of acceleration as well as angular orientation of the patient in-order to identify a fall event. Luna et al., [3] (2019) have described the studies on performance of recurrent neural network algorithm in the fall detection application. Shaheen et al., [4] (2019) have described the sensors that are incorporated in this system monitors the sensor values such as acceleration and angle orientation of the subject and reports it to the guardian when there is a sudden or abrupt changes in the sensor values. Saadeh et al., [5] (2019) have used the Patient-Specific (PS) prediction and detection of fall event. This uses single tri-axial accelerometer which is being attached to patient's thigh region so that it distinguishes between Activities of Daily Living (ADL) and also fall events. Moulik and Majumdar [6] (2019) have designed the "FallSense" that generates the value between 0 and 1, that differentiates the fall from daily activities and it works with the help of input from multiple sensors. Sumi et al., [7] (2019) have designed this system to monitor the patients such as physically and intellectually disabled people who need constant monitoring. This system uses accelerometer threshold algorithm to detect a fall, and alerts. Bernadus et al., [8] (2019) have designed the elderly care taking system that

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detects the fall from wheelchair. Abnormal health conditions pay way to generate message automatically and sent through notifications to their families. Liu et al., [9] (2020) have proposed a fall detection system that operates with the help of infrared sensor arrays which can be implemented as a real-time, non-contact fall detection method. Singh et al., [10] (2020) have provided a in-depth technical perception to the available fall detection systems. Nho et al., [11] (2020) have demonstrated the merits of the user-adaptive approach using the signals from the combination of heart rate sensor and acceleration sensor in-order to detect the fall events. La Blunda et al., [12] (2020) have designed a wearable device to detect the patient's fall. This system does not depend on any sensor or network units which is located within a building structure. L. Minh et al., [13] (2021) have classified the available fall detectors into three types of fall detectors namely, wearable sensor-based, ambient device-based and computer vision-based approaches. Wang et al., [14] (2021) have proposed the use of fine-grained indoor fall detection method instead of coarse-grained Wi-Fi signal systems and it has flexible threshold systems that accounts to the adaptability of this system to different surrounding environments. Even though day by day the medical resources and facilities are expanding, the suffice level is still not acquired. Nearly, 28%-35% of people falls each year in which mostly aged people's ratio is high [15].

The objective of this work is to design an IOT based fall prediction and alerting device that alerts the user that they are going to fall. To achieve this, firstly the accelerometer and gyroscope sensors values are recorded to alert the patients when they are about to fall. The second step is to design a device that conveys the fall message of the patients to their closed ones.

METHODOLOGY

I. Proposed System

The present models do not have a snooze button to prevent the false alarm and there is no option to alert alert the deaf people. Time limit for receiving alert message takes time. Most of the present models are designed as wearable device, that can cause discomfort to the user. The present models are mostly designed with Arduino boards, which is comparably slow than Raspberry pi.

The proposed system has the following advancements when compared to the existing models:

- The proposed model is designed with snooze button to prevent false alarm.
- This model is helpful in alerting deaf people as it is designed with LED.
- The usage of "Twilio" ensures the alert message is delivered on time.
- The Proposed model is a wheelchair embedded device, that cannot cause any discomfort to the user.
- It is designed with raspberry pi 3 model B+ which is faster and more accurate.

Figure 1 represents the block diagram of this proposed model which contains both the fall prediction as well as alerting system.

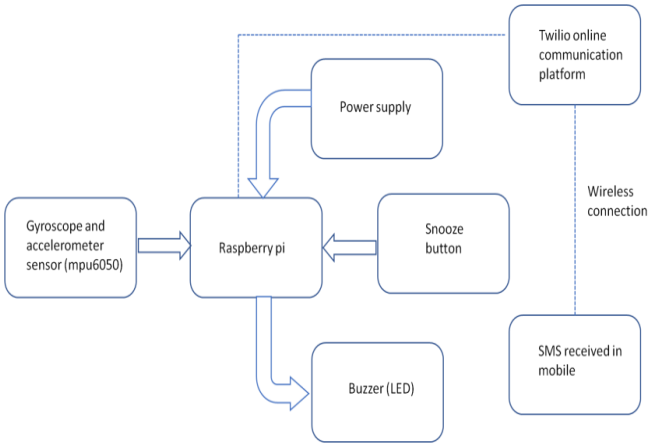

Fig.1. Block diagram of the proposed system

There are several components used in this work such as raspberry pi 3 b+ model, accelerometer and gyroscope sensor (MPU6050), active buzzer, push button, resister etc. This device works based on the values recorded by accelerometer and gyroscope sensor, which alerts the guardian. Alerting system in this device conveys the fall message to the patient's closed ones. The device starts its alarm when fall detector monitors the signals from the accelerometer and gyroscope sensor in real time in-order to provide a warning to the patients that they are going to fall. The warning will be generated when the sensor values exceed a certain threshold value or when the values keep on increasing at a certain rate. Further, the proposed device also contains a push button that can be activated by the patient to cut-off the alarm in case of generation of a false alarm. In case, the push button is not activated within 10 seconds, the message will be sent to the patient's guardian. By using Python software, the entire algorithm is coded into a raspberry pi environment.

II. Twilio and IOT

Twilio is a super web of connections between the telecommunication and the network which helps in connecting customers seamlessly at anywhere at any

time. This activation starts with the sign up an account using patient's guardian mail ID and merge the guardian phone number into this account. Further, the "Account SID", "Auth token" and "Twilio phone number" will be generated in the Twilio. This can be viewed in the console part of this Twilio web page. Figure 2 represents the console webpage in Twilio account. Twilio have libraries for NodeJS that can be used to provide text-controlled functionality to your Raspberry Pi.

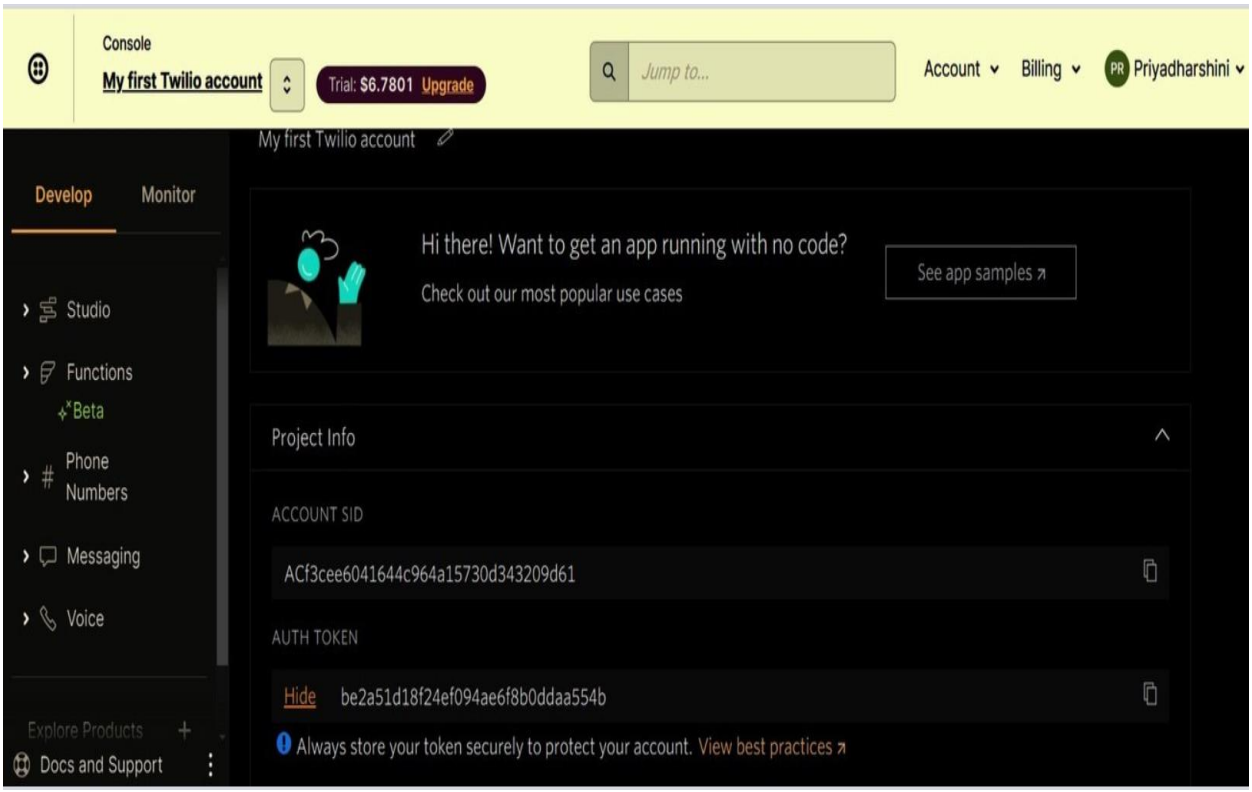

Fig.2. Twilio Activation

III Thingspeak IoT Platform

Figure 3 shows Thingspeak dashboard. In this work, a Thingspeak IoT platform is utilized to provide the fall condition and location of fall device. Further, the care taker can visualize the patient's fall condition and location by simply signing into their respective Thingspeak account. Also, the Write Application Programming Interface (API) is utilized as an authentication token to access Thingspeak account and by using API key, the gyroscope and accelerometer sensor values are updated to Thingspeak IoT platform.

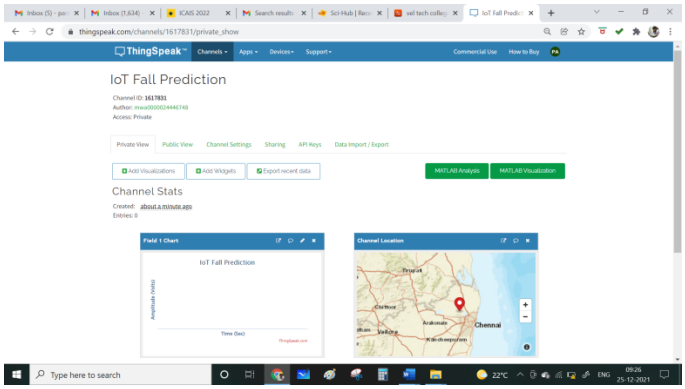

Fig.3. Thing speak IoT dashboard

RESULTS AND DISCUSSION

Figure 4 represents the visual representation of the buzzer activation with the help of LED. This LED is used exclusively for the deaf people who are unable to hear the alarm sounds.

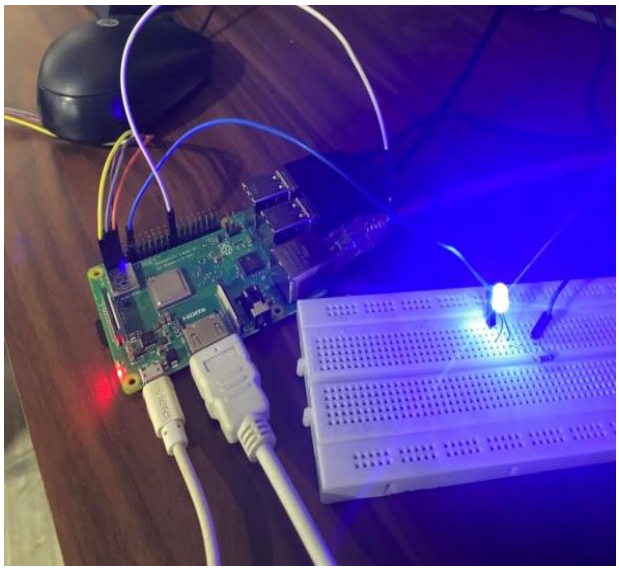

Fig.4. Visual representation

Acquiring the values from accelerometer and gyroscope sensor was achieved and through those values the buzzer gets activated. The buzzer sounds when the patient is about to fall or patient was fallen is acquired. If it was a false fall there is an option (switch) for patient to switch off the buzzer. The false fall is differentiated by the time allotted (10seconds). If the buzzer was activated for more than 10 second them the message to the guardian is sent through Twilio online platform. This conveys the message and alerts that patient had a fall from the wheelchair. Figure 5 represents the hardware photograph and actual testing of the proposed model.

Fig.5. Field Testing

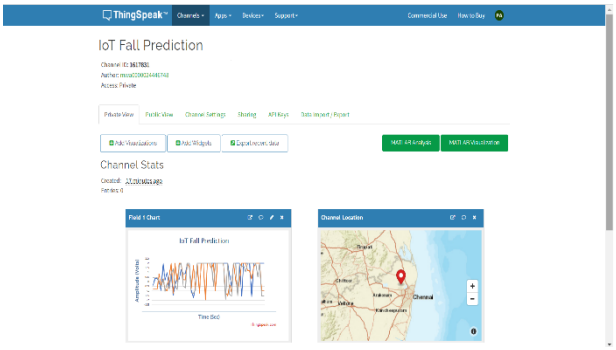

Fig. 6. Thingspeak IoT care taker account

Figure 6 shows the Thingspeak IoT care taker account. It is seen that the sensor values and location of the patient is updated in the Thingspeak IoT care taker account. Furthermore, the care taker shall view the fall condition and location of the patient by signing into the Thingspeak account using mobile phone/Computer system.

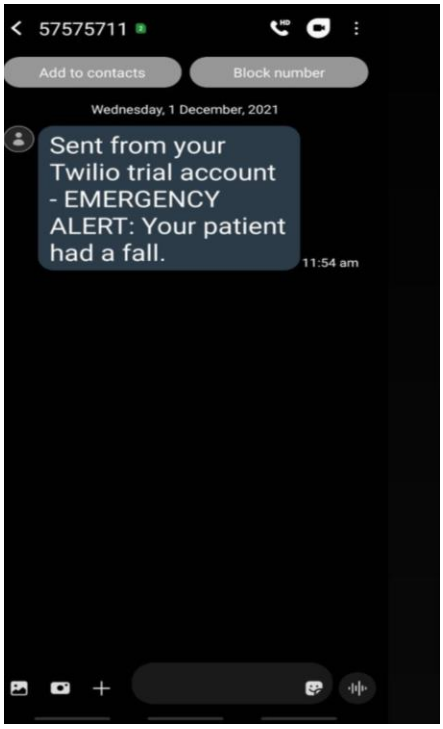

Fig. 7. Alerting Message

Figure 7 shows the alerting message that has been sent to the patient's guardian phone number when the device detects the fall.

CONCLUSION

The one of the major challenges in healthcare for elder people is fall detection. Hence, this IOT based fall prediction and alerting device have developed using accelerometer and gyroscope sensor with Raspberry pi. Further, the sensor monitors the movement of the patient and senses the fall. The threshold value is used to detect the fall detection, whenever the sensed value exceeds the threshold value and the buzzer interfaced with raspberry pi gives alarming sound to indicate the patient. Further, the snooze button is given in order to deactivate the buzzer in case of any false fall detection and if not, the buzzer automatically stops after some 10 seconds and the message through Twilio communication platform sends alert to the patient's guardian. Also, the thingspeak platform updates the fall condition and location to the care taker.

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