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Long-Range Internet of things for health monitoring of elderly

Harshitha.B, Vivek.G, Vishesh chaubey, Ranjitha .P,Vijay.R
Department of electronics and communication engineering B.M.S.college of engineering Bangalore, India

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ABSTRACT—This paper presents Long Range (LoRa^{TM}) internet of things (IoT) based health monitoring system for elderly using Long Range (LoRa^{TM}) Low power wide area network (LPWAN) technology. It deals with fall detection, measurement of carbon dioxide (CO2), and heart rate monitoring. The LoRa^{TM} technology provides low power solution to communication and covers wide area.

KEYWORDS—Health monitoring, Internet of things, LoRa, Low Power Wide Area Network

I. OVERVIEW

Primary objective of this project is to implement an IoT based solution to keep a constant check for fall detection, measure the carbon dioxide (CO2) level in the environment around, particulate matter and other pollutant levels, and a steady heartbeat monitoring. The highlight of the paper is the implementation of LoRa^{TM} a low power solution to communication. The data collected from the sensors is uploaded to the cloud. The data can then be accessed from anywhere in the world. A personalized message about the warnings is also sent to the registered mobile number of the user. These are then integrated to the IoT which is more securable and many services can be used along with it.

One of the low power wide area network (LPWAN) protocols that can be used for IoT applications is LoRa^{TM}. LPWANs provide cost effective, energy efficient and long range coverage which makes it ideal for health monitoring applications [1].

II. LITERATURE SURVEY

A number of technologies have been used so far to utilize the IoT technology for the maximum extent. Few of the technologies that are associated with IOT are radio frequency identifiers (RFID), short range wireless communication.

Wireless communication technologies commonly used with IoT are NFC (Near Field Communication), Bluetooth, ZigBee, ad-hoc and wireless sensor networks (WSNs). However, the application is limited in terms of the area covered as these technologies provide short range low power communication capabilities. Off late IOT technology has witnessed the use of LPWAN which covers wider range. LoRa ^{TM} is a very promising LPWAN which is best suited to collect information from the sensors placed far apart [2].

With the changing lifestyle a number of elderly people stay alone at home after the kids grow up or leave for work. Monitoring the health of elderly remotely is a major concern in such a scenario. Main aspect of remote health monitoring of elderly is fall detection as fall can lead to major health issues leading to hospitalization[3]. As stated by A Shahzad and K. Kim in [4] Classification of fall detectors is as follows: context-aware systems and wearable devices. To monitor the movement of people Context-aware systems use; cameras, microphones, infrared pressure-sensors. Major advantage of this over wearable devices method is no device need to be worn by the elderly. However, the main concern with this method is the limited coverage capabilities of the devices involved.

Wearable devices used for fall detection covers a wider range and is also comparatively cost effective, but the senior population need to wear an external device. As per [5] analysis of fall detection can be categorised two methods as follows threshold analysis method and an intelligent algorithm.

Threshold analysis : The threshold analysis method is simpler compared to intelligent algorithm. In the threshold method the numerical value received by the sensor is observed and a reference value is defined. Fall detection is implemented by comparing the numerical value received by sensor with the threshold value, if the sensor value is greater or lesser compared todemarcated threshold it is concluded as the fall event. Upper and lower threshold values are defined to distinguish fall from regular activities.

Intelligent algorithm: This algorithm is complex compared to the threshold method of analysis. The intelligent algorithm analyses the sensor data using a specific method. A specific sorting module is created using the learning characteristics,

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which is there afterimplemented to classify the information obtained from the sensor. Though the intelligent method has higher recognition rate of fall detection, we have implemented threshold method as its implementation is simpler. A combination of data from on-board accelerometer and gyroscope gives accurate information about fall event [6]. In addition to fall detection the heath monitoring system we have implemented also deals with the measurement of CO2 level. Indoor air quality is at most important for the wellbeing of the inmates. There are a number of reasons for pollution of indoor air, the air flowing into the building from outside as well as the ventilation is the primary cause for indoor air pollution. Human activities namely cooking, electronic gadget usage, cleaning activities have a significant contribution to indoor air pollution. Exposure to polluted air has adverse effect on human health, it may damage the nerve, and other organs such as liver, kidney etc.,

Another parameter that is monitored is the heart rate. Heart is crucial to human body as it pumps blood to the entire human body. Improper heart functioning may at times be fatal.

As most of the communication technologies used in IoT have limited coverage area in our work we have incorporated LoRa™ technology for wider coverage.

III. IMPLEMENTAION

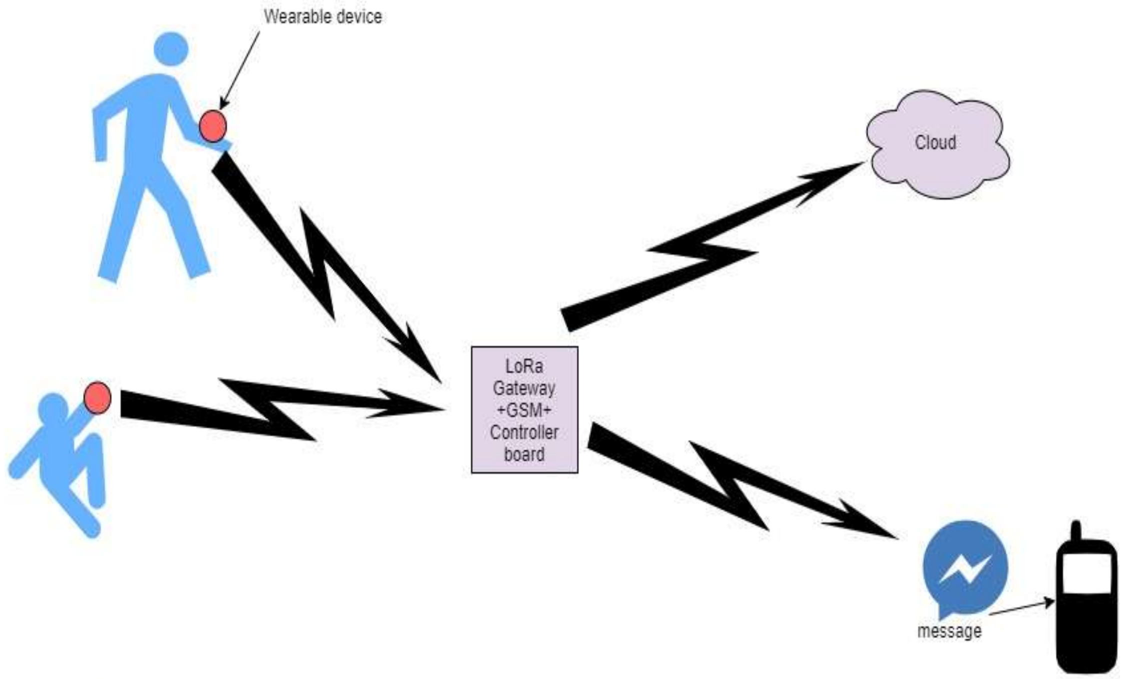

Fig. 1 IOT based sensing system

The proposed IoT sensing system setup as shown in Fig.1. , it consists of the following components

i) Wearable device consisting of sensor for air quality measurement. (MQ-135), GY-521 Module consisting of accelerometer and gyroscope for fall detection.
ii) LoRa™ receiver
iii) Controller board (Arduino nano)
iv) LoRa™ gateway
v) GSM module for message to be sent
vi) Controller board (Arduino nano)

The health monitoring system implemented also includes heart rate sensor to continuously monitor the heart rate of elderly. The sensor is plugged into the controller through the jumper cables while it is clipped to the fingertip of elderly.

Information collected by the sensor is transmitted to the LoRa™ gateway, this information is then used by GSM and the controller to send message about the findings to the registered mobile number and to upload the data to the cloud which can be accessed from anywhere.

IV. EXPERIMENTAL SETUP

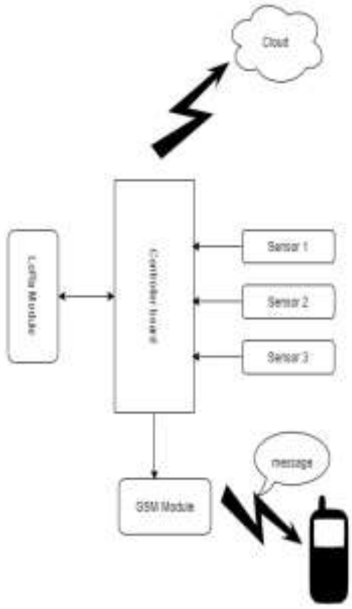

Fig. 2 Arrangement for experiment

Fig.2 demonstrates the experimental arrangement, the sensor data is read by the microcontroller this data is then transmitted through the LoRa™transmitter, the information is picked up by the LoRa™gateway. Microcontroller is programmed to send the data to the cloud and also send message to the registered mobile number through the GSM module connected to it.

V. EXPERIMENTAL RESULTS

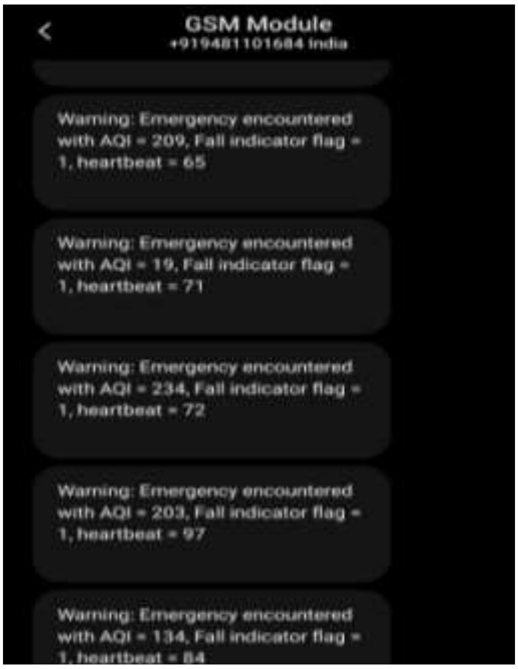

Fig.3. Mobile screen output

Fig.3 shows the information received by the registered mobile number. The Fall indication flag in fig.3 indicates the status of fall event. Numerical value one in this field indicates the confirmation of fall. False positives and false negatives are reduced by the algorithm as it use both accelerometer and gyroscope. Thus it also improvises the accuracy of fall detection.

Fig. 4, shows the website which shows the cloud data. Fig 5. Shows a chart of CO2 values with time and fig6, showsa chart of the heart rate sensor value with variations in time. Fig. 7 shows fall indication chart.

Fig 4 Website showing cloud data

Fig. 5 Air quality index chart

Fig. 6 Heart rate sensor value chart

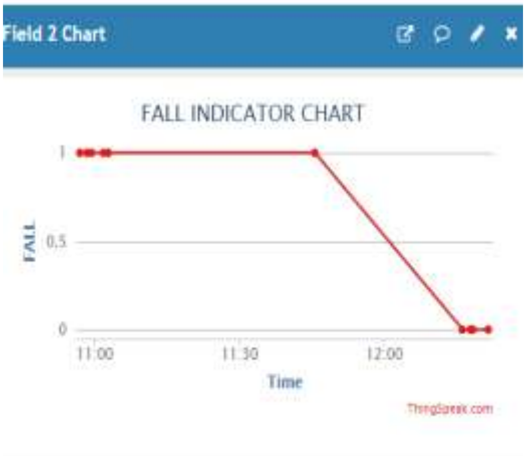

Fig. 7 Fall indicator chart

VI. CONCLUSION

In our work the implementation incorporates low power solution to measure the health parameters. As proposed in this paper the implementation can further be improvised by using a wearable device with battery powered system. A number of other parameters could also be measured with the integration of other sensors.

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