Iot Patient Health Monitoring System

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ABSTRACT

The increased use of mobile technologies and smart devices in the health zone has brought on extraordinary effect on the world's critical care. Health specialists and doctors are using these technologies to create critical change in medicinal services during clinical settings. Likewise, many users are being served from the upsides of the M-Health (Mobile Health) applications and E-Health (social insurance upheld by ICT) to enhance, help and assist their well-being. The Internet of things is progressively permitting to coordinate gadgets fit for associating with the Internet and give data on the condition of health of patients and give data continuously to specialists who help. The main aim of this 'Patient Monitoring System' is to build up a system fit for observing vital body signs, for example, body temperature, heart rate, pulse oximetry. The System is additionally equipped for fall detection and sleep pattern analysis. To accomplish this, the system involves many sensors to screen fundamental signs that can be interfaced to the doctor's mobile or the web. The gadget will exchange the readings from the sensor to cloud remotely and the information gathered will be accessible for analysis progressively. It has the capacity of reading and transmitting emergency signs to the cloud and then to doctor's web portal or to Doctor's Smartphone. These readings can be utilized to recognize the health state of the patient and as an alert system against the emergency health condition.

Keywords: *IOT, Raspberry pi, AWT cloud, Patient Monitoring.*

INTRODUCTION

Patient Monitoring System can be characterized as the system utilized for observing physiological signs that incorporate the parameters like the electrocardiogram (ECG), respiratory signs, intrusive and noninvasive blood pressure body temperature, gases related parameters, and so forth. Understanding and checking monitoring system is a piece of M-health innovation. It can be named as m-health or mobile health. These systems are utilized for the practice of medicinal and general health with the assistance of cell phones. These frameworks observation can be utilized nearby or remotely. Patient monitoring is relevant in various circumstances when a patient is in the accompanying conditions:

- In unstable physiological regulatory systems – for instance, in the case of overdose of anesthesia.
- In a life-threatening condition – for instance, when there is an indication of heart attack in a patient.
- In a situation leading to the developing of a risky life-threatening condition.
- In a critical physiological state.

Patient monitoring is not another new framework in medicinal services as it was first begun in the year 1625 for checking the body temperature and pulse of patients. Subsequently, this framework has started to discover its utilization and acknowledgement for checking diverse sorts of physiological parameters and health-related angles that are being performed [1] as of not long ago. These days' patient monitoring frameworks are accessible in two structures:

- **Single-parameter monitoring system:** This system is utilized for measuring the blood pressure of a human body, observing ECG, checking SPO2 (oxygen level in the blood), etc.
- **Multi parameter monitoring system:** This system is utilized for checking different crucial physiological indications of patients by transmitting the fundamental data like ECG, breath rate and blood pressure, and so on. Because of these reasons, multi-parameter observing system holds a huge part in the field of medicinal devices.

These days, the health care sensors are playing a fundamental part in hospitals. The patient checking

monitoring is one of the significant improvements as a result of its creative innovation. A programmed remote health observing system is utilized to quantify patient's body temperature, pulse by utilizing implanted innovation. The proposed system utilizes sensors like pulse sensor, oximeter, temperature sensor, accelerometer and gyroscope. These sensors mostly include in observing the health condition, fall detection and sleep pattern of the patient.

BACKGROUND

A large portion of the developing nations have extremely poor healthcare foundation there are not very many clinics [2] in contrast with blasting population. Few of doctor's facilities are deficiently prepared where very less number of specialists is available. The basic diagnostic equipment for the diagnosis of life-threatening diseases is absent. In the event that this paper could fabricate an ease compact health detecting gadget, involving a few sensors, equipped for measuring the vital attributes of a human body, and can speak with the doctor's facility database, it could furnish with quality therapeutic guidance. The restorative administration is given after one of the authority specialists from a group of particular specialists display everywhere throughout the globe assesses those health parameters on the clinic's database.

In today's social protection system for patients who remains in home amid post operational days checking is done either by means of administrator/medicinal guardian. Endless watching may not be expected by this system, in light of the fact that anything can change in prosperity parameter within some fraction of seconds and in the midst of that time if the specialist is not in the premises causes more important damage. So with this advancement made period where the web directs the world gives an idea to add to doctors from a group of specialized doctors present all over the globe [3] where time to time consistent checking of the patient is refined.

Also, if the health detecting gadget is made to speak with a compact system like a tab or a cell phone which has the default capacity of speaking with Cloud (hospital or clinic database), then the entire system would be considerably more financially effective. This is on the grounds that these days a great many people have entry to versatile specialized devices and these devices have turned out to be very shabby. The system can likewise be made IoT (Internet of Things) empowered and M2M (Machine To Machine) is good. This system, usage of such a healthcare checking system is displayed. Thus, this will possibly profit an extensive population. For the healthcare checking system to be solid, every sensor should timely measure the information taking the recommended examining rate of the parameter, and the information should be sent to the data processor with no overlap. Every sensor has fluctuating necessities regarding information length or size and examining rate the sensor information gathered without overlap by information processor can replace notepad at patient's bed with smart gadget and patient's information can be accessed to from specialist's Smartphone or web.

Existing System:

- In a hospital, either the nurse or the doctor has to move physically from one person to another for health check, which may not be possible to monitor their conditions continuously. Thus, any critical situations cannot be found easily unless the nurse or doctor checks the person's health at that moment. This may be a strain for the doctors who have to take care of a lot number of people in the hospital. Also, when medical emergencies happen to the patient, they are often unconscious and unable to press an Emergency Alert Button.
- One of the application protocols that are being used to transfer data is Hyper Text Transfer Protocol (HTTP) for general communication over Internet. However, when HTTP is applied to communication in IOT, protocol overhead and resulting performance degradation are a serious problem. Moreover, IP addressing depends on physical location, which causes the problem of complexity of network control.

Proposed System

- Our system continuously monitors patient's vital signs and sense abnormalities. The monitored data is delivered to medical staff. Upon encountering abnormalities, the system alerts the medical staff about the abnormal parameter. Thus, reduces the need for manual monitoring done by the medical staff.
- Our proposed system uses MQTT client to send data from sensors to cloud platform. It is a publish/subscribe, extremely simple and lightweight

messaging protocol, designed for constrained devices and low-bandwidth, high-latency or unreliable networks. The design principles are to minimize network bandwidth and device resource requirements whilst also attempting to ensure reliability and some degree of assurance of delivery.

Monitoring System Description

This paper proposes a model of Patient Health Monitoring System, with different components like fall detection and sleep pattern analysis. The sensors utilized as a part of this project are Accelerometer and Gyroscope (MPU6050), Heart beat sensor, Body temperature sensor, and blood oxygen level (MAX30100), and Proximity sensor (KY032). These sensors work autonomously of each other. The measured reading from the sensor is broke down for the patient and is made accessible to the specialist or to any concerned individual in the type of the web or smart phones. This web interface and additionally versatile application serves as the user interface for this model. The other element added to this application is examination of the information in past to caution visualizing the latest and the current reading of the exposure of the patients monitored, along with the display of graph. Another element added to this application is investigation of the information in past to caution the specialist and patient about huge changes event, or make an alarm to specialist or any concerned individual related with the patient when it sees any probability of therapeutic crisis. The interfacing between the equipment and the product part is done on the stage of AWS IoT. The readings are sent to AWS IoT through. The Modular diagram of the patient monitoring system is described in Fig 1.

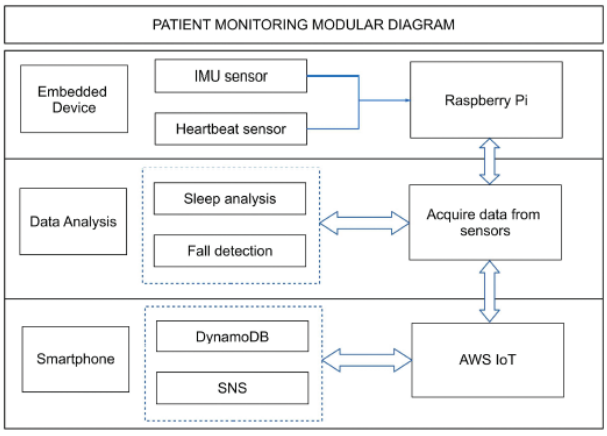

Fig. 1. Module design of Patient Monitoring System

Design approach: The sensor modules fused in the implanted device yields the computerized value which can be interpreted by aligning the sensors. These readings are transmitted to the AWS IOT through the MQTT which can be utilized by both Smartphone and analytics module.

Hardware Description: The hardware part of the project involves the Raspberry Pi 3 Model B, MAX30100, MPU-6050. The two sensors are connected to the Pi via the I2C interface. The sensor values are read by the Pi, processed, and then sent to the AWS IOT server using the Pi's Wi-Fi module. The MQTT protocol is used for the transmission.

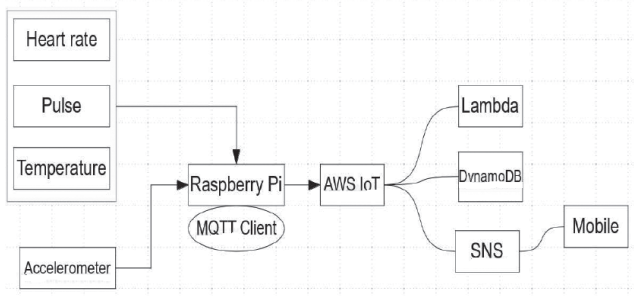

Fig. 2: PMS with MQTT and AWS communication

MQTT: It is a Publish/subscribe, amazingly basic and lightweight messaging convention, intended for constrained gadgets and low-transfer speed, high-idleness or unstable and deceptive systems. The design principles are to limit network bandwidth and gadget resource necessities while additionally endeavoring to guarantee reliability and some level of confirmation of delivery. These principles end up making the convention perfect of the developing "machine-to-machine" (M2M) or "Web of Things" world of associated devices, and for portable applications where transmission capacity and battery power are at a premium.

Data analysis

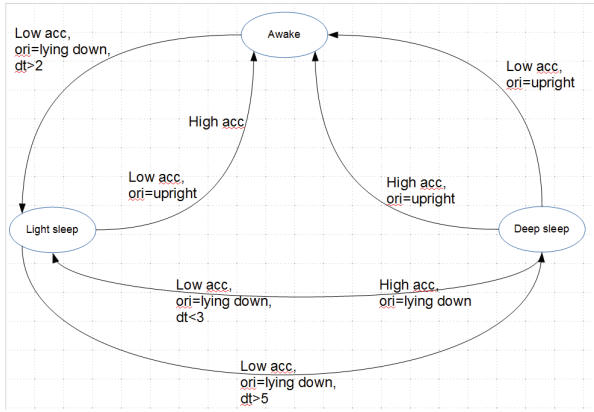

Fig. 3: State diagram of sleep pattern of a patient.

In this model, there are three stages of sleep awake state, Light Sleep state and Deep Sleep state. The

transition diagram for the sleep pattern analysis is shown in the Fig 3, where the state of sleep is defined using the previous state of sleep, data from accelerometer sensor and the orientation of the patient. Also, there can be change in states if the patient continues in a state for a longer duration for e.g. if the patient is in light sleep and stays for a duration of more than 5 minutes then the probability of patient to go to deep state is high. Thus, sleep state can be predicted using the accelerometer data and orientation posture of the patient. From our observations, the accuracy of the state prediction is higher than threshold based predictions.

The figure 4 above shows the flow of data from sensors to the end device (mobile phone) through various stages. The data from various sensors are filtered in the raspberry pi and is given for the data analysis stage. Thus, the data from accelerometer [4] and gyroscope is used for the fall detection [5] [6] and for the sleep pattern analysis. The result is then passed to the AWS IoT platform as different topics. These different topics are used to know the current state of the patient and heartbeat rate. Also, different rules are being set to notify the relatives and doctors about the state of the patient.

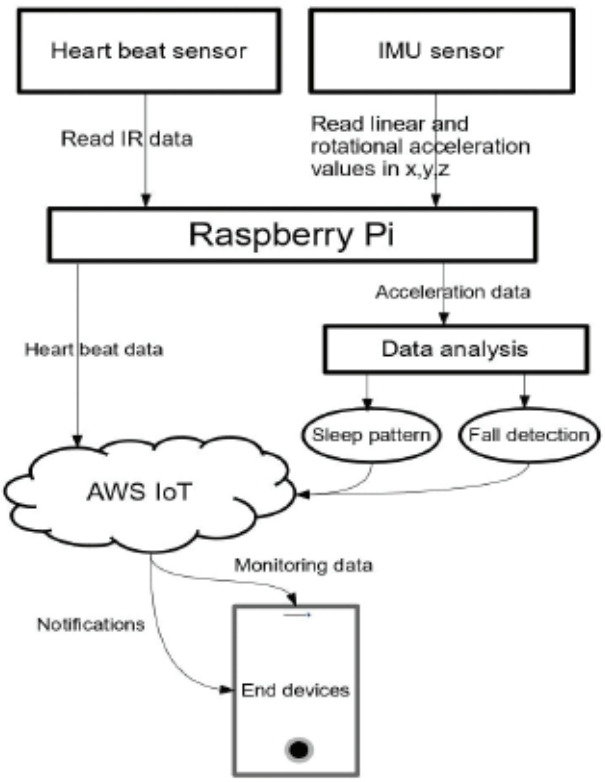

Fig. 4: End to End communication for PMS

USER INTERFACE

Android App Interface: The Smartphone application provides the user with an interface to interact with the device. The application provides the user real time reading of the sensors thereby getting the patient's status to the subscribed clients. The application queries data from Dynamo DB and displays it. Heartbeat, SPO_2, last fall detected and current sleep state are shown. The application also has a separate screen for showing the sleep history chart. The android application shows the measured parameters heart rate, SPO_2, last fall detected, and current detected sleep state. The android application shows the measured parameters heart rate, SPO_2, last fall detected, and current detected sleep state as in Fig 5.

AWS: AWS IoT is a managed cloud platform that lets connected devices easily and securely interact with cloud applications. AWS IoT provides authentication and end-to-end encryption throughout all points of connection, so that data is never exchanged between devices and AWS IoT without proven identity. Thus, data is securely being transmitted to the AWS IoT platform through MQTT protocol. AWS helps the data to be stored in the DynamoDB database and the data can then be used for sleep pattern analysis. In case of emergency it helps in sending mobile notifications to the relatives and doctors of the patient (fig 7).

IOT Healthcare Platforms: Since the engineering of IOT-based health care equipment is more refined than that of common IOT gadgets and requires an ongoing working system with more stringent necessities, there is a requirement for a modified processing platform with run-time libraries. To figure a relevant platform, a service-oriented architecture (SOA) [7] can be taken to such an extent that administrations can be overburdened and used by utilizing distinctive application program interfaces (APIs).

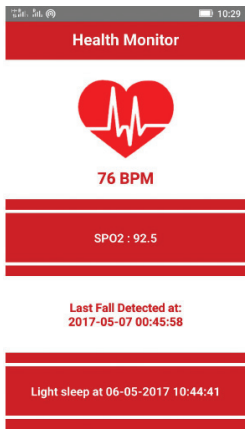

Fig. 5: User Interface to End User

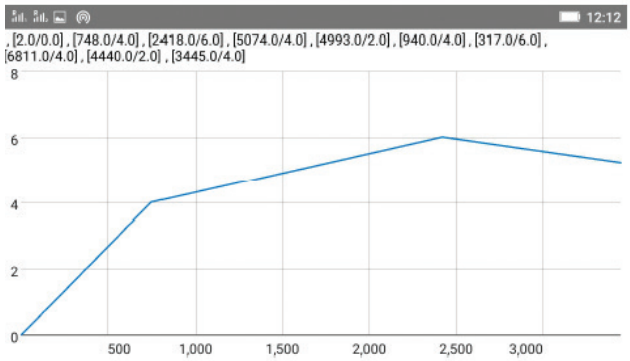

Fig. 6: Sleep pattern graph

RESULTS AND DISCUSSIONS

The ambition of the project was to plan a system which could gather reading of various important indications of the patient and after that evaluate at cloud then caution the doctor or concerned individuals about the health condition. This was accomplished by building implanted system which depends on sensors to transmit the reading of important signs to cloud administrations given by AWS IOT stage. These reading are chronicled and can be obtained by either the web interface to give a pictorial representation of information or by the information analysis module to decide the seriousness of the patient.

The figure above shows the output of the data analysis done on the accelerometer and gyroscope data for sleep state detection. The sensor readings are used for monitoring any change in state and in case of a change in the state, the new state is sent to AWS IOT using MQTT.

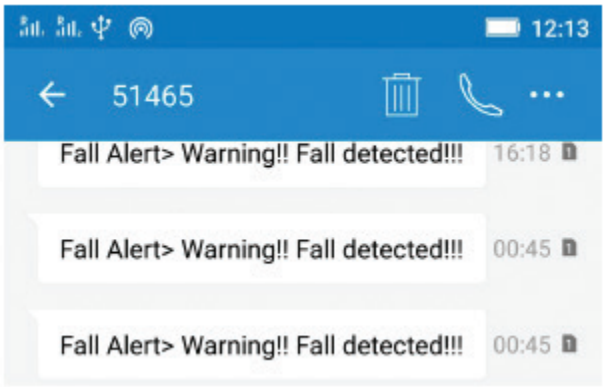

Fig. 7: SMS notification when fall notification

The figure (Fig 6 & 7) above shows the output of the data analysis done on the accelerometer and gyroscope data for sleep state detection. The sensor readings are used for monitoring any change in state and in case of a change in the state, the new state is sent to AWS IoT using MQTT. The accelerometer and gyroscope readings and sends a notification to AWS IoT in case a fall is detected.

The figure (Fig 8 & 9) below shows the input readings of IR and red led for the SPO_2 and heartbeat sensor. Figure 8 represents the data for SPO_2 from both IR led and Red led. Figure 9 represents the input data for heartbeat from IR led. This data is then filtered to get the SPO_2 and heartbeat value.

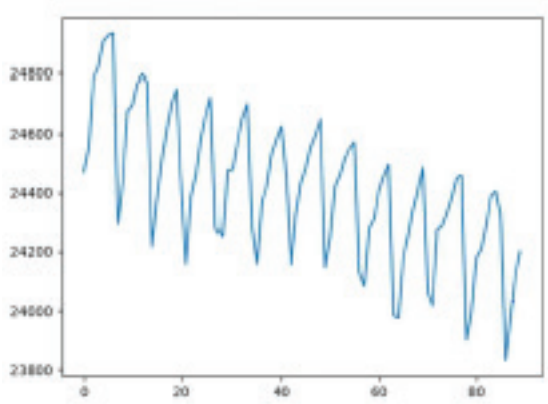

Fig. 8: SPO2 graph

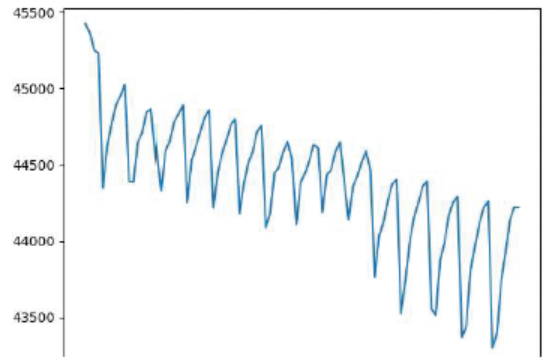

Fig. 9: Heart Beat graph

CONCLUSION

Thus, the proposed system could gather, reading of various important indications of the patient and after that evaluate at cloud then caution the doctor or concerned individuals about the health condition. It monitors the vital signs and sense abnormalities. These abnormalities alert the medical staff, it reduces the manual monitoring. The system uses MQTT communication to send the data to cloud platform. This message protocol transmits the readings of important patient's vital sense and helps a web interface to give a pictorial representation of information.

Ethical clearance: Not applicable

Source of funding: Nil

Conflict of Interest: Nil

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