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IOT based Smart Homes for Elderly Healthcare

[1] Aishwarya Bhagat, [2] Shirina Aalagi, [3] Snehal Gaikwad

[1][2][3] Marathwada Mitra Mandal's College of Engineering, Pune, India

***Abstract*---In old age, the need for medical support is required, this leads to unplanned visits to the doctors frequently. Smart homes, integrate health and other ambient assisted living technologies, playing a lead role in revolutionizing the way in which healthcare services are being provided to the elderly. The objective of this work is to provide an affordable smart home system focusing on all the elderly people who need lifestyle/health monitoring in real time. A notification message is sent to elderly person's relative and doctor in emergency situations. The system is made user friendly taking into consideration the daily needs of the elderly.**

***Keywords*--- Notification, Smart Home System, Raspberry Pi**

I. INTRODUCTION

Smart homes integrate health and other ambient assisted living technologies, playing a lead role in revolutionizing the way in which healthcare services are being provided to the elderly.[1] In old age, the need for medical support is increases, this leads to unplanned visits to the doctors frequently. A **health monitoring system** provides an alternative to the traditional health management, it consists of **wireless devises** with sensors paired with an application to access the real time medical information of that individual.[2]

Smart home automation systems provide assistances in independent living, preventive care and user-friendly technologies which are integrated with wireless sensor devises and web applications. Understanding the elders' basic needs, specific requirements are essential for the success of the smart homes system. Their safety comfort and convenience are the crucial factor for devising the smart home health monitoring systems.[3]

The objective of this work is to provide an affordable smart home system focusing on real time health monitoring using wireless wearable devises thus helps in providing timely medical support and reducing the dependence on human supervising. A notification message is sent to elderly person's relative and doctor in emergency situations. Secondly The system is made **user friendly** taking into consideration the daily needs and comforts of the elderly. The work aims to provide simple and understandable instructions.

II. LITERATURE SURVEY

As part of our pre-study, we conducted an elaborate literature survey. The literature survey presents an overview on the Home Automation Systems for Elderly Healthcare. The journals were analyzed, and content is presented. After analyzing what systems have been in the published in the journals, we presented our ideas which were focused on providing affordable and understandable health monitoring system.

Generally, in a smart home automation system the smooth interactions between the smart devices and humans is a key factor. The sensors and actuators along with the communication network (wired or wireless) form the core part of such smart homes. Artificial intelligent (AI) techniques are often used to gather and analyze the information of the occupants' health status and report any kind of abnormalities; thereby enabling to take certain decisions and provides recommendations. All these systems include a combination of sensors, softwares and networking technology to collect, process, analyze, and transfer the data either to the smart home service providers or to a remote healthcare center.

III. WORKING PRINCIPLE

First, the compatibility of the smart devices needs to be checked. Raspberry Pi uses an open-source software. In this project generic sensors were used. These sensors were interfaced with Arduino Nano or ESP8266 to form a sensor node. Here the Raspberry Pi was the master and the Arduino Nano/ESP8266 was the slave.

Next, the Arduino IDE was configured into using python commands in the Raspberry Pi command prompt. Once the connection was established, the sensor module collected and stored the data and sent the data to the Raspberry Pi.

At the Raspberry Pi the data was stored on a micro-SD card and as well as sent to a data storage and processing website.

While the data collection procedure was going on, the commands and the processes on the terminal got shared on a GitHub repository. From then on two separate procedures took place.

One Data link went to an IoT analytics platform to generate graphical reports of the data generated. The output was shared back to Raspberry Pi.

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While this procedure took place, timer commands were initiated for monitoring purposes. The Raspberry Pi was connected and configured to a GSM module all the time. After the stipulated amount of time, the notification was sent through the GSM sim800 via SMS. Reminders were also sent through a google voice assistant which was connected to a Bluetooth speaker through the Raspberry Pi.

IV. COMPONENTS

Raspberry Pi is a mini programmable computer with fast processing speed. The GPIO pins were used to connect and command external electronic devices.
Arduino Nano is a low powered processor, in which Wi-Fi and Bluetooth connectivity is available. The Arduino Nano works well as a wireless transceiver**.**
ESP8266 is a Wi-Fi microchip suitable for remote environments. It is a low cost low powered micro controller suitable for specific tasks.
HC-SR501 is a PIR sensor module used for detecting the movements of the elderly people in their homes.
MS5837 is a pressure sensor module used to monitor the sleep patterns of the elderly person.
MQ-2 is a gas sensor module commonly used to detect smoke, LPG fumes, methane, and carbon monoxide concentration in the air.
Pulse heartbeat sensor module is used to measure the heart rate at regular intervals.
REES52 SIM800 is a GSM/GPRS module for raspberry pi with MicroSD card slot. It is used to send and receive SMSs and calls as well as to access the internet.

V. RESULTS AND OBSERVATIONS

A. Motion Detection Module

The motion detection module was used to monitor how many times the elderly person frequents the bathroom and how much time was required. A timer of thirty minutes was set by the system. If the person exceeded the time limit and no movement was detected by the system a SMS was sent to the elderly person's relative to notify them that the person has not come out of the bathroom.

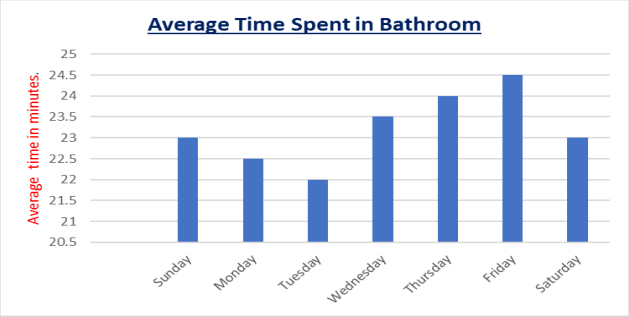

Fig.1

The **Fig.1** indicates the average time spent by the elderly person spent in the bathroom. The motion detector was placed near the bathroom door and the system noted the time. Simultaneously a timer was started for thirty minutes to detect the opening of the door again. When no movement was detected after thirty minutes, the Raspberry Pi sent a SMS to the person's relative/emergency contact..

B. Sleep Monitoring Module

The sleep monitor recorded the amount of time the person slept during the night. The data was collected daily and sent to the system. The Raspberry Pi sent the collected data to an IOT analytics web platform which then compiled the information into a graphical format and sent it back to the system. The smart home system then sent a SMS the next day to notify the elderly person on how much time they slept.

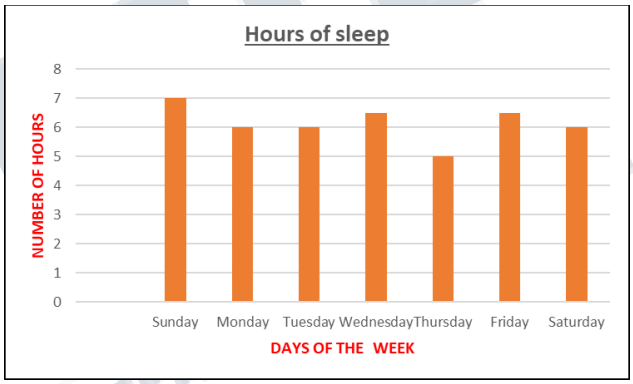

Fig.2

The Fig. 2 shows the average amount of time the person slept. The information was then collected and stored by the system. The GSM then sent a notification the following morning about the number of hours the person slept

C. Heart Rate Monitoring Module

The pulse heartbeat sensor module collected the data at regular intervals and the raspberry pi stored the data on the SD card. The data was then sent to IOT analytics platform and was compiled in a graphical form. The results were sent back to the system.

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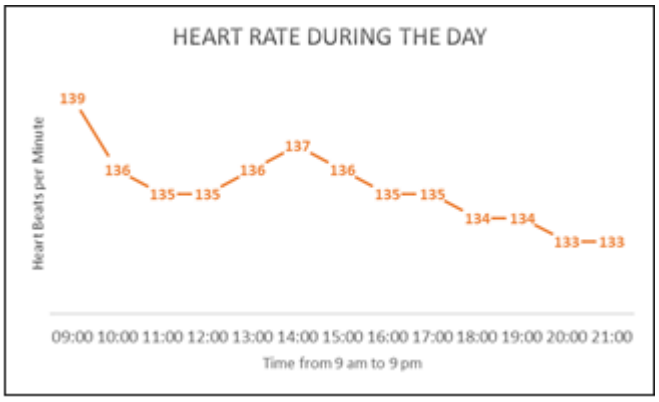

Fig.3

The Fig.3 shows the heart pulse data collected for twelve hours. The heart pulse was measured at hourly basis. An average of the above data was calculated and was then sent to the elder person's mobile phone on the next day.

D. Gas Sensor Module

The Gas monitor module was used to check whether the gas stove was accidentally left on. A timer was set by the system to check the whether the stove was left on. If fumes were detected by the sensor module, the data was sent to the raspberry pi and voice notification was sent to the elderly person. The Raspberry Pi was connected to a Bluetooth speaker through which the voice notification was given. A SMS notification was also sent notifying that the gas stove was left on for more than five minutes.

E. Emergency SOS Module

An emergency SOS function was also added to the system. A SOS button device was connected to the Raspberry Pi via Bluetooth. Whenever the button was pressed, the system sent a SMS to the elder person's relative, notifying that there is an emergency.

F. Daily Reminders

Daily reminders were also sent to the elder person in the form of SMS. Reminders such as to take their medicines at the given time, to perform their daily chores were programmed into the system.

The system was designed with this built-in feature. The system sent the reminders through SMS notifications and through voice commands.

VI. MERITS

Smooth and hassle-free interaction between the system and the elder people was made possible. Considering the limited knowledge the elderly people have about these technologies, the use of SMS notifications reduced the tediousness present in commercial systems.

All the reports are made available on a single platform. There are specific platforms for the individual smart devices. This smart home system removed the tiresome and confusing task of acquiring and understanding the information, by sending SMS's with only the required information. The reports were also made available on the IOT analytics platform.

With the help of regular monitoring made available, the elder people became proactive in their lifestyle choices. The messages sent by the smart home system assisted the elderly people involved to make healthier decisions.

Most commercial systems do not provide emergency contact services to the elder person's relatives. This system simply sent SMS notifications to the family members whenever the elder person needed help or was unresponsive.

VII. LIMITATIONS

The system heavily relied on steady Wi-Fi network. The IOT based smart home automation system is fully dependent on working Wi-Fi and Bluetooth network. The system cannot function optimally if there is any break in the connection.

Finding compatible smart devices was a big issue while designing the smart home system. Raspberry Pi has open-source software and most smart devices are platform specific applications. The compatibility of the smart with the Raspberry Pi was needed to be checked.

Implementing such a smart home system will be a noticeably big challenge in rural areas. A stable connectivity to the internet and consistent power supply are big issues in rural regions

As more and more smart devices are added, the system configuration starts becoming complicated. With more data collected and stored the system infrastructure would need to be upgraded.

Maintaining confidentiality, preventing data breach and cloud storage are expensive but vital parts of the system. The system at this stage does not provide any data security and privacy feature.

VIII. CONCLUSIONS

An IoT based home automation system was designed and implemented for the elderly healthcare and real time health monitoring was provided along affordable and understandable services.

The data was gathered from different wireless sensor modules, forming the wireless sensor node, which was then processed by the Raspberry Pi computer and decisions were taken accordingly.

A motion detection module sensed the movements of the elderly people in and out of the bathroom. A pressure sensor module monitored the sleep. The gas sensor module monitored whether the stove was accidentally left on. The

heartbeat pulse monitor regularly gathered the pulse of the elder person.

A notification message was sent via the GSM module to the elderly person and the relatives in case of emergency. Furthermore, regular reports, voice reminders and SMS reminders were also sent to the elder person.

IX. FUTURE SCOPE

This system application is very adaptable and could be extended to full time health monitoring, child monitoring as well as pet monitoring. Specific medical smart devices could be configured into the home automation system and provide medical amenities at the comfort of the home.

Such a system could also be used for monitoring the health of quarantined patients.

As we go on integrating more and more smart sensors, assisted by reinforced learning algorithms, we could obtain a fully accurate picture of the person's health and recognize the patterns in abnormality and help facilitate quick diagnosis.

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