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Healthcare Smartwatch for Monitoring Elderly

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Abstract: ***According to the data provided by the Census in 2011, around 15 million elderly live alone in India. An NGO from Delhi named Agewell Foundation performed a survey on 10,000 elderly individuals and concluded that every fourth elderly that is 23.44% of the people who responded were living alone [1]. They also reported that around 88.5% felt the need of healthcare monitoring to ensure their independence. A lot of research work is going on to come up with a perfect solution to solve this problem and there are many computing devices which have been invented which solve the problem partially faced by elderly people. But none of them provide a solution which is convenient to use and which covers all aspects of the problem ranging from medicine reminders for elderly to proper maintaining of health records and it's timely reporting to the doctor and family members even during emergencies such as a cardiac arrest. This paper proposes a neat solution to help monitor the daily reports of the elderly by automatically sending the data [12] (real-time [10][15] heart rate and current location measured by smartwatch; blood pressure measured by machine; sugar level measured by machine) to their family via android application and also provide 1st degree detection of cardiac arrest and prediction of heart problems up to some accuracy. It will provide medication [9] reminders to the elderly by three vibrations after an interval of 5 minutes during one course of medication and will also provide assistance during emergencies by sending an SOS call to the family or doctor. The smartwatch uses microcontroller ATmega328, SIM800L GSM module [11][14], RSI 0.96 inch 4 Pin OLED display module, HC-06 Bluetooth module, small LiPo battery, mini 1020 flat vibration motor, pulse sensor, GPS NEO 6M module [11], micro USB, button. This solution will not only help the elderly in rightly monitoring [8] their daily data [12] but also inform their family with their daily reports and any unusual changes. The smart watch acts as a care taker of the elderly people and it will be useful to the elderly who stay alone most of the time and it can even be used by others for proper maintaining of their health records, for medicine reminders and assistance during emergency conditions.***

Keywords : Automatic daily reports; elderly; emergency help; medication reminders; android application.

I. INTRODUCTION

The objective of developing this is to deliver improved healthcare monitoring [8] to the elderly people with the help of a smartwatch.

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These days many people have to go out for work or stay away from home due to various reasons leaving behind their elderly parents. In the current culture, many elderly people are being neglected and abused by their family members. At this old age elderly need proper support for their health. In the current world, elderly people cannot depend on their family members who are not available due to some reasons or who do not want to support them [2]. At this age, people tend to forget things and there are many elderly who live alone after the death of their spouse which becomes even more dangerous during the occurrence of any emergency [17]. In India, there are 4.1 million people who are suffering from the disease called Dementia as published by Alzheimer's & Related Disorders Society (ARDS) of India. The number of elderly living alone is increasing by every passing year.

There is always a tension for the family to call back home and see if they are doing good or not and to remind them to take their medicines on time. This device will help in curbing down all these problems and provide better health security to the elderly and release tension from the family.

The machines used for measuring blood pressure and sugar level must be Bluetooth enabled. When measuring blood pressure or sugar level, the machine will first make Bluetooth connection with the smartwatch and will then start taking the readings. After that, it will automatically send the data [12] to the cloud [13][18] (ThingSpeak [3]). During the day the smartwatch gives reminders in the form of vibration to the elderly to have their medicines. The time can be set for the reminders can be set according to preferences and for one reminder it will vibrate 3 times for 15 seconds after an interval of 5 minutes. The user-friendly UI is via an android application that is paired with the smartwatch and retrieves data from the cloud [13] and with the help of application enables the family to monitor the health of their elderly. The android application emails the doctor monthly and weekly reports [14] generated. The other hardware components include ATmega328, SIM800L GSM module [11][14], RSI 0.96 inch 4 Pin OLEDD display module, HC06 Bluetooth module, small LiPo battery, mini 1020 flat vibration motor, pulse sensor, GPS NEO 6M module [11], micro USB, button. All this procedure relies on the simple coding of the microcontroller with which the entire procedure takes place. The android application plays a major role in displaying the readings, analyzing the data [12] and forming weekly and monthly statistics based on the data which helps the doctor in further reviewing the elderly. The smartwatch also takes care when the elderly is undergoing an emergency by informing the family and doctor with the help of an SOS call [4].

In figure 1 the functionality is described in the form of a block oriented diagram.

It shows the procedure how smartwatch receives data using Bluetooth and further pushes the data to the cloud using the internet [6][14]. The android application retrieves that data from the cloud [13] using the internet.

The application analyzes the data received and builds weekly and monthly reports [14] which is emailed to the doctor. The smartwatch during emergency [17] situation gives an SOS call to the users (family and doctor).

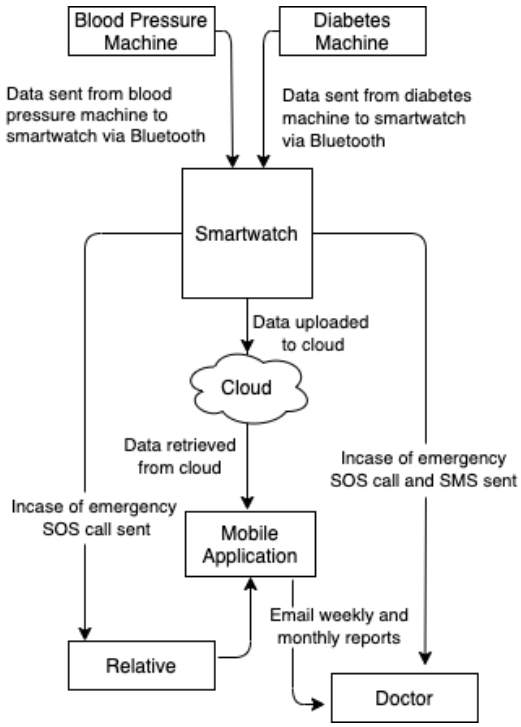

Fig 1 System Block Diagram

II. WORKING OF THE PROPOSED SYSTEM

There is a certain procedure according to which the entire system works. It can be broken down to various steps according to the different functionalities.

A. Algorithm for programming ATmega328

To run the entire system smoothly by sending and receiving the data at the right time the microcontroller has to be programmed accordingly. The ATmega328 [5] is programmed using C++ in the Arduino IDE. Various conditions are constructed to receive data via HC06 Bluetooth module from the blood pressure measuring machine and sugar level measuring machine. The data [12] is directly uploaded or sent to the android application using the smartwatch internet [14] by using SIM800L GSM module [6] [11] but it depends on the condition stated in the code. • If the data received from the machines is not health and requires attention first the data is uploaded to the cloud by using the internet [7] and through the android application the user (family) is immediately informed through a notification sent by the app about the concern and the problem detected.

- If the data is normal the smartwatch uploads the data on the cloud via the internet and through the android application the user (family) is notified about the good health of the elderly.
- If the data received from the machine signifies an emergency. Then data is uploaded to the cloud and the android application notifies the user (family and doctor) the reason for emergency. At the same time, the smartwatch calls the user to get his immediate attention towards the situation.
- If the smartwatch detects an emergency in the heart rate through pulse sensor it immediately calls the user (family and doctor) and a notification is sent through the app to the user informing the reason for emergency.

B. Construction of Android Application

The android application supports the system and acts as a mediator between the elderly health and the user (family and doctor). It is developed using Android Studio. It retrieves data from the cloud [13][18] (ThingSpeak).

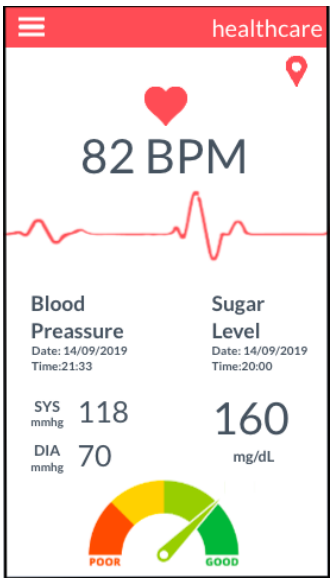

Fig 2 App Layout

Figure 2, shows the user interface of the android application with the following features.

- A user-friendly UI is developed which shows a real-time pulse rate measured by the pulse sensor and location using GPS NEO 6M module [7][11].
- It shows the latest reading taken through the blood pressure machine and the time and date of measurement.
- It shows the latest reading taken through the sugar level measuring machine and the time and date of measurement.
- It pushes notifications to the user's android phone when a new reading is taken signifying good or bad health.
- It develops weekly and monthly reports [14] and automatically emails it to the doctor.

C. Smartwatch

Figure 3 shows the place where all the data [12] collection and action occurs.

- The RSI 0.96 inch 4 Pin OLEDD display module displays the time, date and day.
- It collects data from the pulse sensor and GPS NEO 6M module and uploads [7] it to the cloud using SIM800L GSM module [11] [14].

Thus, enables user to keep a track of pulse and location in real time [10][15].

- Reminds the elderly for medication [9] reminder. The time can be set for the reminders can be set according to preferences and for one reminder it will vibrate 3 times for 15 seconds after an interval of 5 minutes.
- Retrieves data from blood pressure machine and diabetes machine and uploads it to the cloud.
- The smart watch has an SOS button which when pressed for 10 seconds calls the family and the app notifies that the call was sent by pressing the SOS button. It also calls the doctor and sends the SMS with the patient name , age, location and the cause which directed for emergency.
- In a situation of emergency it performs an SOS call to the family and the doctor. It also sends an SMS to the doctor immediately after the call with the patient name, age, location and the cause which directed for emergency.

Fig 3 Smartwatch

D. Pulse Sensor

As stated by the American Heart Association there are around 2,300 deaths caused every day by a heart disease in America. As stated by Centers for Disease Control and Prevention in the United States every 40 seconds someone experiences a cardiac arrest commonly called heart attack. This generally happens when suddenly heart experiences and an exponential decrease in its function which happens due to decrease in the flow of blood causing a reduction in the level of oxygen reaching to the heart. During the phase of heart attack heart starts to die due to no oxygen received.

A pulse sensor plays a major role in partly detecting a heart attack. There are various other symptoms which confirm a heart attack. The prediction through a pulse sensor is not 100% accurate but provides precaution. Normally a heart beats between 60 bpm to 100 bpm and during heart attack the heart rate either falls down or becomes slower which is called bradycardic or becomes faster which is called tachycardic.

Fig 4 Pulse Sensor

The pulse sensor used for measuring the heart rate is shown in figure 4 is placed on the bottom side of the wrist in the wrist watch which helps in the following activities:

- When heart beats beyond the boundaries it shows signs of emergency and the android application notifies the family about the sudden change. There is a limitation to it, if the elderly is doing some physical activity it will still increase the heart rate and will alert the family.
- It helps in detecting the resting heart rate which helps in predicting heart disease. A resting heart rate collects pulse data during a duration when the body is at rest. According to a survey conducted at Harvard Medical School elderly with a resting heart rate greater than 76 bpm are more likely to encounter a cardiac arrest.

Accordingly a time is set on the smart watch during which the elderly is at rest. The android application during the set time starts retrieving the pulse data for that particular hour and average is plotted.

This average heart rate is further averaged with the weekly pulse data. The final averaged value of the week is included in the weekly and monthly reports which is sent by the android application to the doctor for analysis.

III. RESULT

So far, the healthcare smartwatch has been prototyped and used in performing the tasks to retrieve data, upload data (pulse rate, blood pressure level, sugar level) on the cloud [13][18] and making SOS calls and texts. It successfully computes all the functionalities as it has been stated. The device works and solves the problem by providing healthcare monitoring [8][17] of elderly through the android application and reporting the case during emergencies.

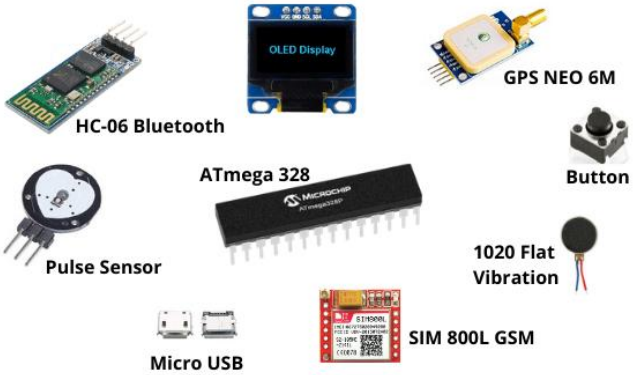

Fig 5 Smartwatch Internal Components

In figure 5, it shows the various components which work together to provide a solution to the problem. This smartwatch together with the Bluetooth enabled blood pressure machine, diabetes machine and the android application helps in releasing tension from the family and moreover it will help in saving lives of the elderly people around the world by providing and analyzing the data at the right time.

This smartwatch by using the pulse sensor provides real time [10][15] heart rate which helps to detect cardiac arrest and predicts heart problems up to some accuracy by analyzing the data. Figure 6 shows the experimental data and the output carried out by the smart watch in accordance with the data values.

Time & Date	Blood Pressure	Sugar Level	Pulse Rate	Output
11:07 15-10-2019	112 / 75	222 mg/dL	75 bpm	Nothing done. Healthy readings
21:35 15-10-2019	135 / 84	170 mg/dL	86 bmp	SOS call sent to family member for high B.P
12:15 16-10-2019	115 / 68	75 mg/dL	72 bpm	SOS call sent to family member for low sugar level

Fig 6 Experimental Data

IV. FUTURE SCOPE

In the present day health is a major concern of an individual and the concern is increasing by each passing day. With increase in number of people getting educated leads them to work in different cities or even country. Which leaves them helpless to leave their elders behind. This situation creates stress among the family members and the elderly who have the tendency to fall ill and might need help during emergencies.

As the need for this solution is increasing so is the technology advancement. In the future the smartwatch can be equipped with better sensors and more sophisticated machinery. Even machine learning will play a major role by working on the data collected and producing some valuable results.

V. CONCLUSION

This paper explains in detail the use and need of healthcare smartwatch for monitoring [17] the elderly living alone around the world. It acts as a new phase in taking care of the elderly people.

The methodology used in the smartwatch to provide automatic assistance is the best suited solution to the problem faced in taking care of the elderly people who live alone. The real time pulse monitoring can help in curbing down an emergency situation and even provide an immediate assistance during a heart attack is reported. Automatic transfer of data from blood pressure and diabetic machine to the cloud helps in maintaining the records better and generating monthly reports which are sent to the doctor for analysis. The smart watch provides with medicine reminders to the elderly who tend to forget. Any data value gathered which requires an immediate assistance is reported immediately via SOS call and message to the doctor and family members.

When this idea comes in implementation by people it will act as boon to the elderly and their family members. Moreover it will help in saving lives by overcoming the mishappening.

There were a few limitations which restrains the smartwatch from being a top notch solution.

- Equipping all the sensors (ATmega328, SIM800L GSM module, RSI 0.96 inch 4 Pin OLEDD display module, HC06 Bluetooth module, small LiPo battery, mini 1020 flat vibration motor, pulse sensor, GPS NEO 6M module, micro USB, button) in the smartwatch makes it bulky.
- Real time heart rate and location monitoring drains the battery.
- Special Bluetooth enabled blood pressure and diabetes machine have to be used.
- Increase in pulse rate when elderly performing physical activity is also reported.
- Talking on SOS call can be included but it was not equipped because it increased the bulkiness.
- Fall detection can be included for detecting emergencies.
- Assured security of health data [16] on the cloud is one of the concerns.

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AUTHORS PROFILE

Kush Rawal, UG- Student (4th year), Department of Technology (Computer Science), BML Munjal University, Gurugram, India. Two patents filed (approved by Ennoble IP).

One of the patents includes a smart glass for the hearing impaired people. It helps in converting speech to text and displays it on the smart glass with the help of an OLED and microcontroller. It also helps in detecting the amplification and direction of sound with the help of four mics placed on the smart glass.

The other patent includes a new method to recommend music. It follows the procedure of sending OTP to the user for logging into chat-bot, taking input in the form of voice from the user, analyzing the input by certain approaches i.e. rule based and retrieval-based approach, comparing user input from the internet and then providing output to the user.

Worked as an intern for three months at GradRight Inc, holding a position in Marketing and Management.

Dr. Goldie Gabrani, Doctorate from University of Delhi. Research areas include distributed computing, networks, IoT and data analytics. Currently working as a Professor of B.Tech in computer science at BML Munjal University.

Key publications include:

- "Real Time Sensor Grid based Secured Health Care Monitoring" IEEE Sponsored SAI international conference, London, 2017.
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