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System Design for User & Pocket Friendly Complete Monitoring of Alzheimer Patients

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Abstract—The worldwide dementia demographics is highly alarming. An increasing population of Alzheimer patients would be reaching about 75 million in 2030 and 131.5 million in 2050 .There are over 9.9 million new cases of dementia reported each year worldwide, implying one new case every 3.2 seconds. Other than the popularly known symptom of memory loss , they face several psychological problems, such as depression and anxiety.This calls for urgent attention and solution to help such patients and their family in a cost effective manner .The system introduced in this paper tends to give them an independent life , while continuously keeping a check on their movements and health parameters at low cost and accessible technological requirements.It has various advantages over pre-existing systems. With this we trying to make the people with such problems independent, self reliable and at the same time reduce the tension and stress of their family members

Keywords—Alzheimers, Haversine Formula, Great Circle, NMEA Format, GSM , Pulse Sensor

1. INTRODUCTION

Alzheimer's is an irreversible, progressive brain disorder that slowly destroys memory and thinking skills. Not only this but social seclusion , lack of independence and inability to carry out simple tasks leads to depression , anxiety and other psychological issues.[1] The foremost problem of concern with Alzheimer's patients is their vulnerability to get lost when alone. Therefore, having a proper trackingsystem is vital. Then we know that due to depression and other psychological factors , they suffer from acute anxiety. Anxiety is measurable using the heart rate of the person. So we will be keeping check on the pulse rate along with the location of the person. Then for times when the person collapse in public , we have a SOS button which can be pressed by nearby people to indicate emergency situation.[2]As of now the existing technologies related to this are either fleet management software based trackers, or caregiver transmitter receiver set tracker. All such gadgets have constraints of range, requires a 24-7 caregiver, internet, dedicated software etc. Our system aims to reduce the complexities and constraints and design a simple and pocket friendly monitoring system.

2. SYSTEM DESCRIPTION

Developed system deals with four different cases, i.e. defining a safe geographical zone and track when the person steps out of it, then keeping check on the BPM (beats per minute) to measure anxiety, SOS interrupt for emergency situation and for situations when device gets detached from patients body. It continuously checks persons current location calculate distance from default location using Haversine's formula , calculate BPM and check if its in the range or not, read signal from SOS button and informs the persons family when required by sending SMS reading the current latitudes ,longitude ,BPM and message corresponding to the issue.. This process repeats every 5 minutes. It even have a feature where the family member may ask for the patients parameters by sending request message to the device.

3. HARDWARE

The system uses Arduino Mega (Atmega2560) as the main microcontroller unit which takes coordinate input from GPS module SKG 13BL, BPM input from pulse sensor module and when required receives and sends messages to the family member using GSM module SIM 900.

A. Arduino Mega

Arduino Mega is an open source microcontroller based on ATmega 256 chip with a 16 MHz crystal oscillator. Ithas 54 digital inputs/outputpinswhich 15of them can be used as PWM outputs. This microcontroller supports up to16 analog inputs which we are using to interface GPS module and 4 USARTs ports which we will be using to ineact with the GSM module.This board canbe powered using a USB cable or with an AC-DC adapter or battery which should provide at least 5v voltage and 500mAcurrent to work properly.

B. Gps : Skg 13bl

The SKGBL is the GPS Module which has high sensitivity , works on ultra low power. An antenna is attached to the module to receive GPS data. For our purpose only Tx pin and Gnd pin of the module is used. Data received by the antenna is in NMEA Format. Out of various data available , we have used $GPGGA string to extract latitude and longitude coordinates[3] .

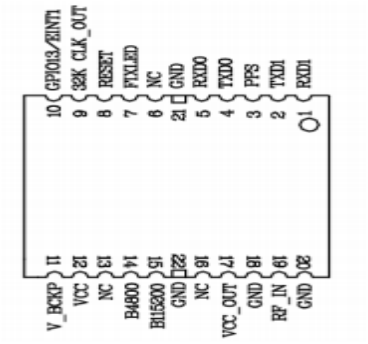

Figure 1:Pin Package of SKG13BL

C. Gsm Module : Sim 900

SIM900 is the GSM module used in the system . It has configurable baud rate (9600 – 115200) . It works with AT commands. It can be used sor sms, voice calls and data transfer applications. In our system we have interfaced it serially with or processor to transmit and receive sms data and AT commands.
The features of SIM900 are -
Features :

- Dual band GSM/GPRS 900/1800MHz.
- Configurable baud rate.
- SIM card holder.
- Built in network status LED.

D. Pulse Sensor

It is and analog sensor which gives voltage signal corresponding to a persons pulse rate. It works on the basic principle of optical absorbence of blood. It consists of of a LED and on Photodetector. When heart pumps blood , light transmitted by Led is absorbed more , hence intensity of light received by photodetector is low, its corresponding output voltage is low. It works on 3.3 V . Works well for mobile application.

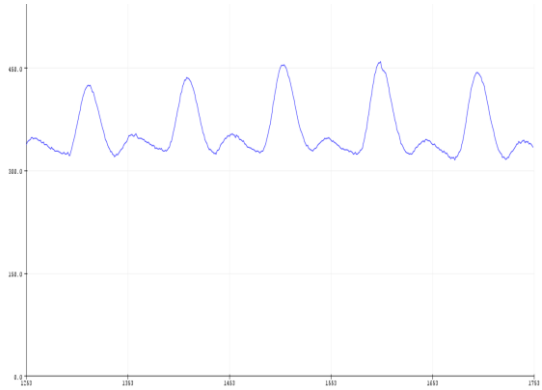

Figure 2: Analog waveform from pulse sensor

4. ALGORITHM& FLOWCHART

The Proposed system continuously gets geographical location locations from GPS module, this needs scripting as NMEA data strings have multiple data, from which we extract #GPGGA and then further longitude and latitude and extracted.As soon as the microcontroller extracts the coordinates, it converts it to the required format and then uses HAVERSINE's Formula to calculate the geographical distance between the pre-defined centre of the safe zone and the real time current location. Once the distance gets calculated, the microcontroller compares it with the safe zone radius. If the person is in the range, the microcontroller repeats the process. If the person if out of range the co-ordinates in GoogleMaps format is sent to family member's mobile with and alert message, A timer of 5 minutes if started and again location is sent until the person gets back to the safe zone. In between if the family member wants to know the location then they can send SMS, It is read by the Microcontroller and is treated as an interrupt, location is then sent to them irrespective of the defined safe zone condition.

A. Haversine's Formula : Distance Calculation

The haversine formula isan equation important in navigation, giving great-circle distances between two points on a sphere from their longitudes and latitudes. It is a special case of a more general formula in spherical trigonometry, the law of haversines, relating the sides and angles of spherical "triangles".

$$\boldsymbol{Distance} = 2.R.\arcsin\{\sin(Lat1 - Lat2|2) + \cos(Lat2).\cos(lat1).sin\,x^2(Long1 - Long2|2)\}$$

we implemented this in three steps –

a = (sin(dlat/2))^2 + cos(lat1) * cos(lat2) * (sin(dlon/2))^2

c = 2 * atan2(sqrt(a), sqrt(1-a))
d = R * c
where,

- R is the radius of the Earth
- dlat is the diffrence between the default (centre of safe zone) and current real time latitude in radians.
- dlon is the diffrence between the default (centre of safe zone) and current real time longitude in radians.

B. Coordinate Format Conversion

Google Map uses decimal degree format for latitude and longitude, whereas GPS receives latitude and longitude from satellite in degree minute format. For distance calculation and futher tracking purpose using Google Map we need to convert the coordinates received from satellite to decimal degree format. The method of conversion is –

Degree minute = 2356.3465 (ddmm.mmmm)
Degree = 23
Minute = 56.345
Decimal Degree Coordinate = Degree + Minute/60
Decimal Degree Coordinate = 23 + 56.3465/60
Decimal Degree Coordinate = 23 + 0.94
Decimal Degree Coordinate = 23.94

We implemented this while extracting latitude and longitude from NMEA format data.

C. Reading Pulse Sensor Input And Calculating Bpm

Pulse sensor module output is digital in nature, microcontroller reads time for 'n' consecutive pulses, and predicts approximate BPM.

Say, 'n' = 5;
Time1 = when pulse count starts = 5 sec
Time2 = when n pulse count ends = 10 sec
Time for n pulses = Time2 – Time1= 5 sec
No of pulses in I second = n / time = 5/5=1 pulse per second

⇨ BPM = no of pulse in one second * 60
⇨ BPM = 1 * 60 = 60 Beats per Minute

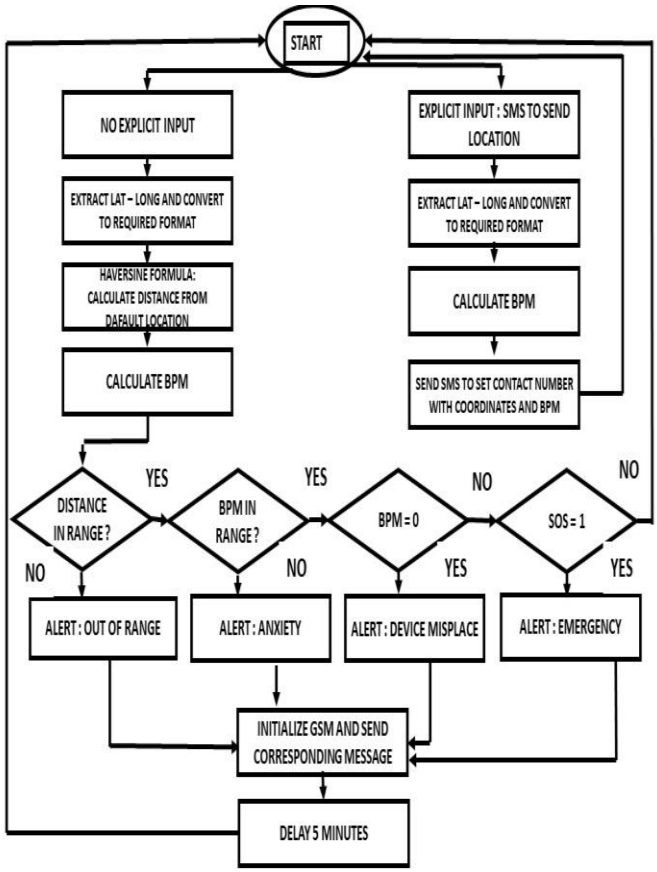

FIGURE3 : FLOW CHART

5. RESULT

A working design is implemented by providing suitable connection between the above components. The system is constantly monitoring the location and pulse rate of the person. Condition when he /she came out of safe zone or suffered from any anxiety, then an alert message wasreceived to the registered mobile number of any family member. For emergency situation like unconsciousness,a SOS button was delivering an emergency alert. This alert message was providing the information of current latitude, longitude and beats per minute of that person. Family member was continuously getting this information in every 5 minutes until the situation was back to normal.We also tried to extract same information, in safe and healthy environment, from the system explicitly. The performance of the system was verified for 7-person in different location and environment.

The system prototype is shown in figure 3–

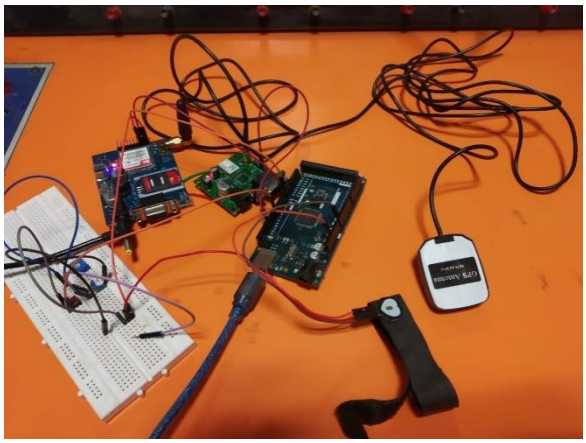

Figure 4 : System Prototype

Figure5 shows the received messages with different conditons-

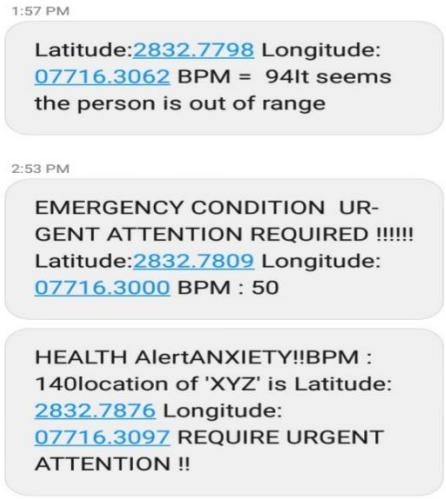

Figure 5 : Received Messages

This system is different from all the existing one and provides several advantages over them, some are mentioned below-

- No Rangebound
- No dedicated software or apps is required
- No smart device is required, can be used by people of any economic strata.
- No need of internet connectivity

With this system, we are completely monitoring our loved ones and protecting them from all the troublesor mishappening, which make them or us suffer.

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