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Cognitive State Analysis System to Ensure Safety of Women and Elderly

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Abstract: ***Though we live in the 21st century with high degree of comfort and sophistication, we fail utterly in cases of women safety. Around 34,600 sexual molestation cases were reported against men in last 6 years in India. In 2017, everyday 6 sexual molestation cases are being reported in India, in an average. So, there is a huge and urgent need to re-fabricate the social fabric of the society to ensure women safety. Hereby, we propose a system of complete automation to ensure the safety of women which also enables us to identify and act accordingly in the cases of emergency. This system can be used to ensure the safety of any living individual. The main advantage of this system is that it does not require any action of the affected individual to get help, i.e., Supreme automation. It can be used to check the clean flow of life of individuals especially, the elders, women and kids. It enables us to help the needed in the exact time of need. This system works on the basis of the user's cognitive state analysis (Normal/Unconscious/High alertness (Fear)).***

Keyword: ***Cognitive state, IR sensor, Pulse rate Sensor, ATMEGA 32, Safety Ensurance***

I. INTRODUCTION

Cognitive state analysis is a technique being used to identify the thought processing state or mental state of an individual. Based on this analysis various smart applications are being developed such as Home Automation, etc. In the proposed system, based on the cognitive state analysis using various biological data that changes due to the change in the cognitive state, personal well being or safety of an individual is being ensured.The system uses the Heart Beat rate and Eye Blink rate data acquired from the individual (user) through various sensor units worn by him/her. The data thus acquired is being processed by a micro controller. The processed data is being analyzed and compared with the threshold data fed to the controller. The threshold data is the result of a survey that is being made to individuals of varied age at numerous circumstances.

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II. DESCRIPTION OF PROPOSED WORK

Based on the comparison results of the data, the cognitive state of the individual is being chosen. With the cognitive state results, further actions, such as alert or remain idle, are taken care by the controller.

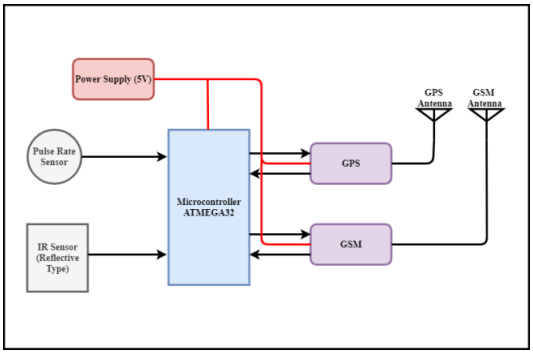

Fig.1 Block Diagram of the Proposed System

a) Eye Blink rate Measurement Unit

It consists of a reflective type IR (Infra Red) sensor which is placed in a proximity range of 15cm from the eye. The sensor consists of a photo transmitter and a photo receiver. The photo transmitter is an LED in IR range and the receiver is a photo diode. Based on the reflecting material, the intensity of the reflected light varies which in turn affects the current developed in the photo diode. The output of this unit is in digital form.

b) Heart Beat rate Measurement Unit

It consists of a Pulse rate sensor which is attached to a fingertip of the user. The working principle of the Pulse Rate sensor is the same as that of the IR sensor. It also consists of a photo transmitter and a photo receiver. The photo transmitter sends an IR pulse which passes through the fingertip. Based on the blood flow rate, the intensity of the reflected light intensity varies which is used to detect the pulse rate. The output of this sensor unit is in analog form.

c) Controller Unit

The controller used in the proposed system is ATMEGA32. It is an 8 bit controller from Atmel's Mega AVR family. It is a 40 pin controller with enhanced RISC (Reduced Instruction Set Computing) architecture with 131 powerful instructions. It also consists of 32 programmable I/O lines, 10 bit internal ADC, programmable serial UART, 2 8 bit timers and a 16 bit timer. This controller offers a considerable 32KB of programmable Flash memory, 1KB of EEPROM and 2KB of internal SRAM.

d) GSM and GPS Unit

This unit is formed by a SIM808 module. It is a module with both GSM and GPS modules which can be driven by a single UART bus from the controller. It offers 2 SIM slots. It also offers 2 orient able antennae, one for GSM and the other for GPS respectively.

The instruction set SIM908 is clear with versatile functionality format so that it can communicate either with another mobile phone or a PC or a server with encrypted message transmission format. It uses 915MHz band for GSM.

The proposed system is a simple architecture which consists of 4 units, namely, 2 sensor units and a controller unit along with a communication unit. The sensors, controller and communication unit (GSM & GPS) are powered with 5V DC supply. All the sensor interfaces are wired and are serial since there is no complex or bulk data transfer involved. The sensor interfaces are designed in such a way that the sensor data is thrown to the controller for every 2 milliseconds. Both the sensor throw lie in alternate time slots, thus the sleep time of the controller is minimized. Once the system become alive, the sensors begin to read the data from the user and throw it to the controller in their respective time slots. The data when reached the controller is being processed to compute the values of Heart Beat rate and Eye Blink rate of the individual. Then the computed value is compared with the data that is already fed to the controller. Based on this comparison, the controller would form various conclusions which in turn lead to further function calling which includes sending alert message to the registered user ID and start sending the tracking information, i.e., sending the GPS data in a particular time interval or begin to start the read cycle again. The communication unit is interfaced by UART (Universal Asynchronous Receiver Transmitter) interface. The controller is provided with an external clock of 8MHz.

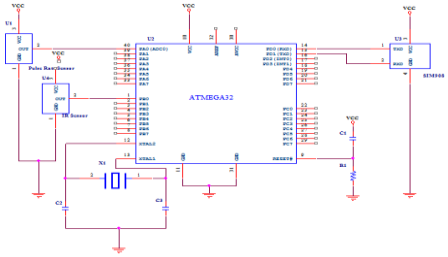

Fig.2 Circuit Diagram of the Proposed System

The IR sensor is connected to the Port B (PB0) which is bidirectional digital I/O port. The Pulse rate sensor is connected to the Port A (PA0) which is bidirectional analog port. The communication unit is interfaced with the Port D (PD0 & PD1) which is the TXD and RXD pins of the controller.

In this system, once it become lively, the IR sensor and the Pulse rate sensor begin to sense the biological signals such as the eye blink and heart beat respectively. Both the sensor data are thrown at a rate of 2ms. So, the processor cycle allotted for each sensor data is 1ms which is controlled by an interrupt which is being enabled by Timer0.

Once the data from the IR sensor is thrown, which is in digital format is being stored in the general purpose register of Port B. The data from is used to compute the number of eye blink rate based on the current state and previous state values of the sensor data. For this operation, data of one previous cycle is being buffered by the controller. Based on the eye blink rate value, it is identified that whether the user is in normal mental state or alert or in extreme sense of fear or unconscious.

Table 1 Survey of Eye blink rate measurement of both gender of varied age

Eye Blink Rate	Male	Female
Normal	11-16	15-20
Fear	14-18	15-23
Extreme Alert	18-25	20-27
Drunken	8-10	10-12

Once the data from the Pulse rate sensor is thrown to the controller, it is being pushed to the ADC for digital conversion. The 10 bit on-chip ADC is utilized by enabling an interrupt cycle. The digitized data is stored in the Port A general purpose register for computation. This data is then computed to find the heart beat rate. For this computation, past 10 cycle data is being buffered. Based on all the 10 data, the heart beat rate is computed. Based on the result and its comparison with the threshold data, further functions are being called.

Table 2 Survey of Heart beat rate measurement of both gender of varied age

Heart Beat Rate	Male	Female
Normal	72-75	70-73
Fear	75-78	75-80
Extreme Alert	100-110	100-112

Based on the functional calls once the user is identified to be in danger, the GSM/GPS module which is made to be in the state of operation. During initial setup, a privileged number is being registered to it. It can have 1 to n number of privileged number. Privileged numbers can be either added or removed but the system ensures that at least one privileged ser s being available. Also, once the system is turned ON, it begin to send the GPS coordinates of the user for every 1 minute which can be stopped by sending a message from the privileged number.

The system does not allow even the privileged number to track the user if he/she is not identified to be in the state of danger. Thus, the privacy of the user is ensured.

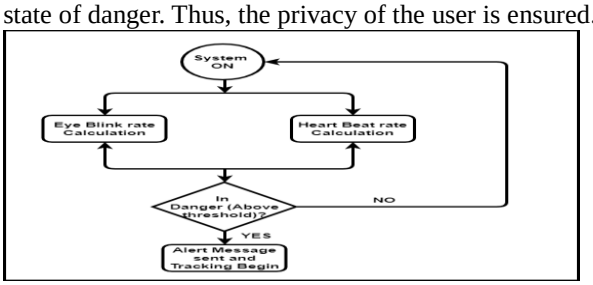

Fig.3 Flow Diagram of the Proposed System

III. RESULTS

Simulation Result:

Proteus is a simulation and design software tool

developed by Labcenter Electronics for Electrical and Electronic circuit design. It also possesses 2D CAD drawing feature. It deserves to bear the tagline "From concept to completion".

The proposed System model is simulated and the model results are downloaded for various test cases. Since the physiological data cannot be acquired in the time of testing, additional external interrupts are used for demonstration of test cases.

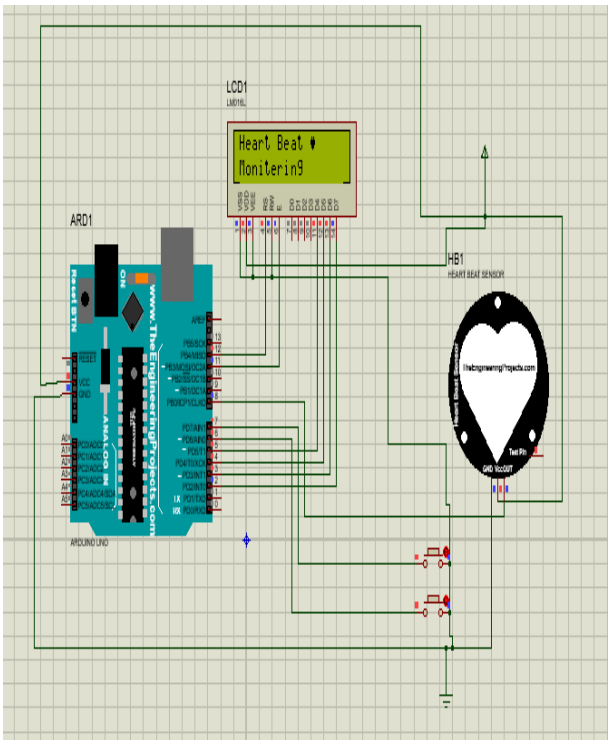

Fig.4 Simulation of the Proposed System

- **Adding an User**

```
Add User
 (User Name)
 (10-Digit Number)
```

- **Return Template from the system**

```
Edit the User name up to 10 letters
Edit the 10-Digit mobile number and send
```

- **Privileged User removal**

```
Users List
 1. User1
 1234567890
 2. User2
 0123456789
 To remove user#1 reply
 RU1
```

- **Real Time OUTPUT**

```
Latitude:

1234.123456N

Longitude:

12.123456E
```

IV. CONCLUSION

This system offers a solution to ensure the safety of elders and women who are alone, by their loved ones. It also offers encrypted data transmission which reaches only the privileged number and not others. Also, the user can view the activity log of the unit if the system is enhanced further. The system offends the tracking of the user from any of the privileged number and also notifies the user about it.

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