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61 – 66

Sensor Based Wearable System to Assist Paralytic Patient with Continuous Health Monitoring

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***Abstract*—** In Today's world many people are suffering from paralysis and most of the paralytic patients are dependent on care takers. Paralysis is a condition in which there is impairment of one or more muscles in the body. In order to assist these patients, fingers of the hand play a major role in this proposed system. The patient is made to wear the sensor glove and recognition of finger bending is the mathematical interpretation of finger movement by the computing device. The system ensures the patient to express his requirements by converting the finger bending into auditory speech. If the same action is repeated thrice, indicating that the requirement is not yet fulfilled, the system will send a text message to the concerned care taker with the help of GSM module. Home appliances are also controlled by the patient's finger wearing the sensor glove. In addition to this, the system continuously monitors the patient's heart beat and body temperature. If the body temperature and heart beat exceeds the normal value, the buzzer will be activated to show the abnormalities with respect to patient so that the care taker can attend the patient.

Keywords*-paralysis; sensor glove; auditory speech; GSM.*

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I. INTRODUCTION

The paralyzed patient suffers from several disabilities with respect to the physical movement of their body. In extreme cases of paralysis, the patient may be speech impaired which makes it difficult for him to communicate with others and to express his needs. The prime motive of the proposed system is to provide solution for these inabilities. The patient is made to wear the sensor glove. Whenever the patient bends his/her finger to express his/her requirements it will be interpreted into auditory speech through which the caretaker can understand the patient's needs. If the same action is repeated thrice in case if the requirement is not yet fulfilled, the system will send text message to the caretaker via GSM(Global System for Mobile Communication) module. In this way we made a small effort to express patient needs.

Physically challenged people often have to rely on others even to perform simple action like switching on the light, fan. In order to provide solution to these inabilities, the system again uses finger movement controlled device which is worn on their hands. Whenever the patient makes a small finger movement, a relay circuit will be activated which intern turns on the light and fan.

Patients Health monitoring is a process in which the doctor or caretaker will supervise patients health. There are cases of the patient's health becoming critical when the caretaker isn't nearby. To overcome this, the proposed system continuously monitors health related parameters of the patients which are heart beat and body temperature.

II. RELATED WORKS

X. Zheng et all.., [1] proposed a system which uses recognition of hand and eye gesture for expressing the needs of patients suffering from disabilities. The system consists of EOG sensors and IR cameras. These gestures can consequently be used for controlling home appliances, security systems and alarms. X. Udayashankar et all.., [2] designed a system to assist the paralyzed patients using eye blink detection. Recent advancement in software technology has resulted in development of many techniques which help such patients to communicate with others. These techniques include blink detection applications to control fans, lights, microwave etc. The system uses median blur filtering and contour extraction for eye blink detection. Michelle Alva et all.., [3] proposed a system which considers the use of a simple webcam of the computer system to detect the face of the patient. The system will provide the patient information with a grid of images of daily activities. The patient looks at a web camera for a few seconds to select it. The system tracks the point of gaze of the patient and selects the image accordingly after a confirmation from the patient. Solanki, Utpal V. et all.., [4] proposed a system which uses real time image processing techniques to recognize the hand gestures and translate them into control actions. Simple remote controlled gadgets can be operated to change a TV (Television) channel or to tune radio by finding the key on hand held remote control and pressing it. But in this paper author puts effort to control the same but using hand gesture. Simply a hand gesture or showing number of fingers TV channel can be changed or it can be On/Off. By showing a cross fingered gesture to the camera, TV can be muted, rotating the hand in clockwise or counter clockwise can change the volume level or TV channels. There is a computer application designed in Java Processing to have real time image processing. An infrared camera is giving images in infrared vision to the computer application. After processing the images and recognizing the hand gesture, decision data is send to a microcontroller hardware based on Arduino environment. This hardware sends the data to the gadgets in same way as a remote control does for general use. Ambika Gujrati et all.., [5] made a review on various sensor based gloves used to assist paralytic patients. In CMOS (Complementary Metal Oxide Semiconductor) camera based glove, a CMOS camera transmits image data via UART (Universal Asynchronous Receiver-Transmitter) serial port. The UART performs serial-to-parallel conversions on data received from a peripheral device and parallel to- serial conversion on data received from the CPU (Central Processing Unit). Leaf switch based glove are

 ISSN: 2454-4248
61 – 66

similar to normal switches but these are designed in such a way that when pressure is applied on the switch, the two ends come into contact and the switch will be closed. The leaf switches are placed on the fingers of the glove such that the two terminals of the switch come into contact when the finger is bent. M. M. A. Hashem et all.., [6] proposed a system for patient health monitoring. Light Dependent Resister (LDR) and powerful LED (Light Emitting Diode) are used to sense pulses of heart beat. By an amplifier circuit, the pulse signals are amplified and then filtered through a band pass filtering circuit. The filtered and amplified pulses are then sent to the microcontroller. Microcontroller counts the heart beat and displays the results on an LCD (Liquid Crystal Display) display. The system also includes infrared technology-based device to measure heart rate and temperature sensor to determine temperature of body. It uses wireless communication to send a data to the computer. Then by using the internet the data is sent to the web server and also it can be accessed using internet. M. Navale et all.., [7] designed a device which will monitor the patient health. The patient has to carry a hardware device connected with an android application through Bluetooth connection. The device measures the patient's parameters and sends it to the android application. Android application sends the information to the server and if the user has any problem like heart attack then it sends an emergency message to the patient's doctor and guardians containing the current location of the patient. N. Indumathy et all.., [9] developed an android based patient health monitoring system using several sensors like temperature, heart rate measuring sensor, eye blink detection sensors to detect the present condition of the patient. The system is developed such a way that if patients unable to speak or move his\her hand or any part of body then by just blinking patient's eyes 5 times then a SMS (Short Message Service) sent to the caretaker about the present condition of the patient and continually send the information about heart rate and body temperature to the server. An android application in the caretaker phone receives the message and generates voice commands so that caretaker can recognize the patient's present situation. At the same time, doctor can realize the present situation of the patient by accessing the patient information from the server.

III. PROPOSED METHODOLOGY

The proposed system encompasses three major tasks. The tasks are to generate voice commands to express patients needs by taking the inputs from flex sensor, to control home appliances and to monitor patients health continuously, the system should inform to care taker if the there is any changes in the patient's health like increasing in body temperature and variations in heartbeat. The overall architecture of the proposed system is illustrated in Figure 1. It is composed of two main units, one at the patient end and another at control end for home automation. The unit at patient end consists of flex sensor glove, temperature sensor, heartbeat sensor, RF (Radio Frequency) transmitter, GSM (Global System for Mobile communication) module, buzzer, voice processor and LCD (Liquid Crystal Display) and these are interfaced with Arduino Mega. A switch is also provided to choose the system to perform home automation or to choose system to express patients need to the care taker.

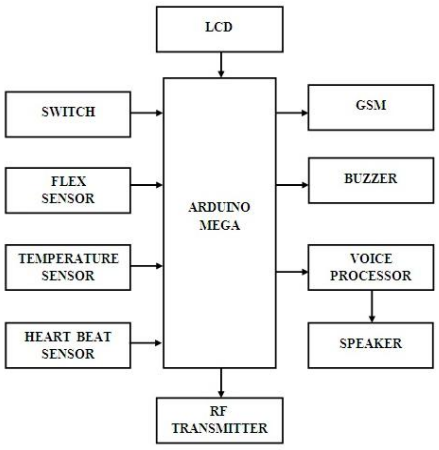

Figure 1. System architeture at patient end.

The unit used for home automation shown in Figure 2 consists of Arduino Uno and RF receiver. The transmitted signal from the unit at patient end will be received at the control unit to control home appliances after processing the signal using Arduino Uno.

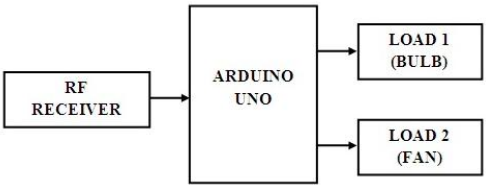

Figure 2. System architeture at control end for home automation.

IV. SYSTEM IMPLEMETATION

The proposed system encompasses three major tasks, i.e. to generate voice commands to express the need of a patient, to control and operate home appliances and to monitor patient's health continuously.

A. Interfacing flex sensor with Arduino

As the flex sensor is bent, the resistance across the sensor increases which is illustrated in Figure 3. The conversion from resistance to voltage shown in Figure 4 is done by forcing a current to flow through a varying resistor. Therefore a fixed resistor is connected to the flex sensor terminal. This forms a voltage divider thereby the 5V gets divided between the flex sensor and the resistor.

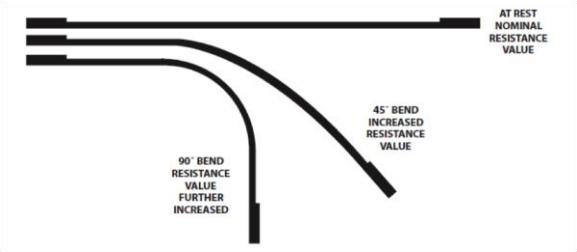

Figure 3. Change in resistance due to bend.

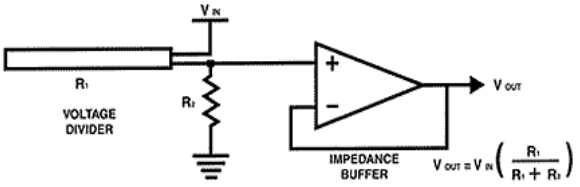

Figure 4. Flex sensor circuit.

 ISSN: 2454-4248
61 – 66

B. Interfacing temperature sensor with Arduino

In the proposed system the device used to measure temperature is LM35 shown in Figure 5.

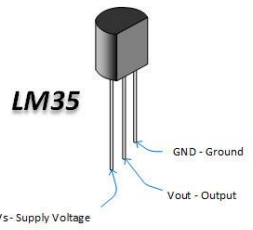

Figure 5. LM35 Temperature sensor.

LM35 is a precision integrated-circuit temperature sensor. The output voltage of this temperature sensor is linearly proportional to the Celsius temperature. It produces an increase in 10mV for every 10 degree Celsius rise in temperature. The interfacing of LM35 to Arduino is as shown in Figure 6.

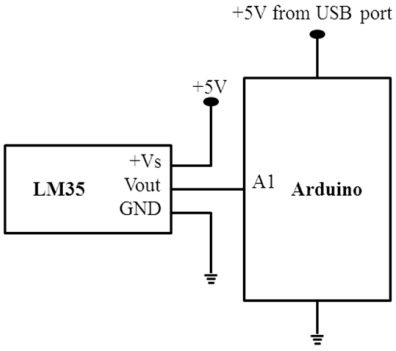

Figure 6. Interfacing of LM35 with Arduino.

C. Interfacing heart beat sensor with Arduino

Heart beat sensor is a device which is designed to give the rate of heart beat in the form of digital output whenever the finger is placed on it. The heart beat sensor works on the principle of light modulation by blood flow at each pulse. It measures if there is any variation in the volume of blood from any part of the body which thereby causes a change in the light intensity. In system applications where heart rate is to be considered, monitoring the timing of pulses is an important task. The flow of blood volume is determined by the heart pulse rate. As the light is absorbed by the blood, the signal pulses are equivalent to heart beat pulses.

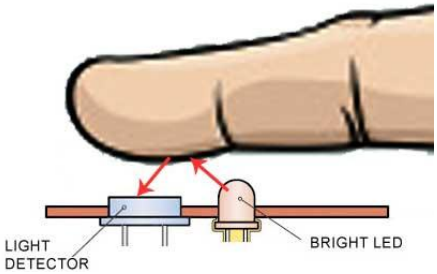

Figure 7. Working of heart beat sensor.

The sensor comprises of a super bright red LED and light detector as shown in Figure 7. The LED needs to be super bright since maximum light must pass through the finger and be detected by the detector. Whenever the heart pumps the blood, maximum light is absorbed by the blood vessels of the finger. As a result, less light reaches at the detector. For each heart pulse, there is a variation in the detector signal. This variation is converted into electrical pulse. This signal is amplified and later triggered through an amplifier. The interfacing of heart beat sensor with Arduino is as shown in Figure 8.

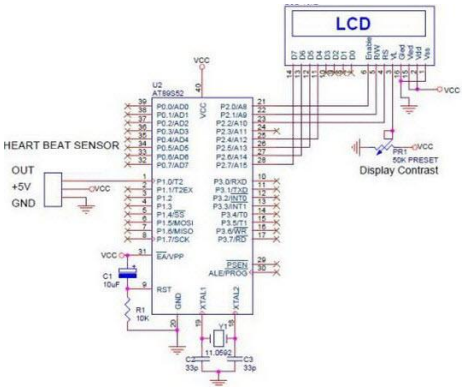

Figure 8. Interfacing of heart beat sensor with Arduino.

Calculation of total heart rate of the patient in minute is as follows.
Five pulse time = time 2 – time 1
Single pulse time = Five pulse time /5
Rate = 60000/ Single pulse time;
Where time 1 is first pulse counter value
time 2 is list pulse counter value
rate is final heart rate

D. GSM Module

GSM (Global System for Mobile Communication) refers to a Wireless Communication standard for mobile telephone systems.

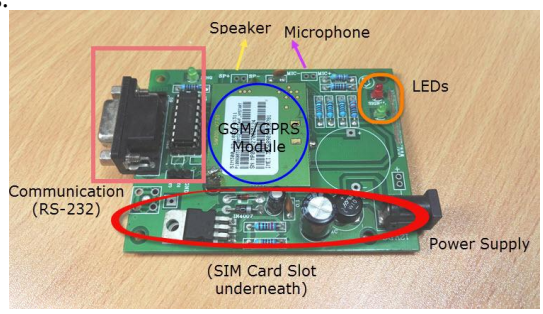

Figure 9. GSM SIM800

A GSM Module is an Integrated Circuit or a chip that connects to the GSM Network by making the use of a SIM (Subscriber Identity Module) and Radio Waves. Typically, the GSM module operates at the radio frequencies of 850MHz, 900MHz, 1800MHz and 1900MHz. The GSM MODEM consists of the GSM Module, SIM card slot underneath for inserting a SIM Card, LED's which indicates the signal status, the power supply, Communication Interface (RS-232) for connecting the GSM module with computer or a microcontroller and it also includes the provision for connecting the microphone and speaker to the GSM module which may be used during phone call.

The following tasks can be performed with the aid of GSM Module:

- It can make, receive or reject the voice calls

 ISSN: 2454-4248
61 – 66

- It can send, receive or delete SMS messages in the SIM Card
- It can add, read and search the contacts in the SIM Card

All the above mentioned tasks can be achieved with the help of Attention Commands or AT Commands. The controller to which the GSM Module is connected is responsible for sending the AT Commands to the module. In other words, for a specific task to take place, the processor will send the specific AT commands to the GSM module. In response to these AT commands the GSM Module will performs the specific tasks like answering a voice call, send an SMS Message, etc. The MODEM supports different AT Commands that can be sent by the processor to interact with the GSM cellular network. The interfacing of GSM module with Arduino is as shown in Figure 10.

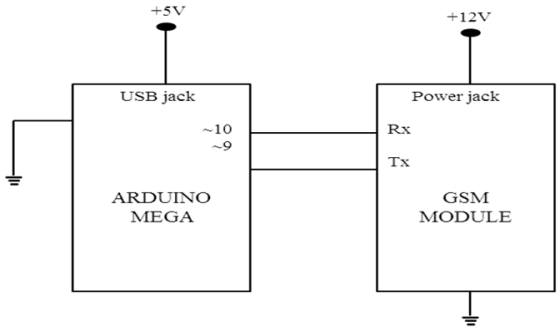

Figure 10. Interfacing of GSM module with Arduino.

E. RF trasmitter and receiver

An RF module (radio frequency module) is a small electronic device that is used to transmit or receive radio signals between two devices. The RF module operates at Radio Frequency that varies between 30 kHz to 300 GHz. In this system, the digital data is expressed as variations in the amplitude of carrier wave. This type of modulation is known as Amplitude Shift Keying (ASK).

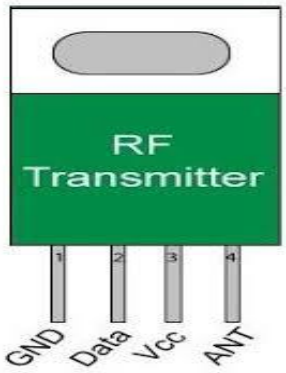

Figure 11. RF Trasmitter.

The microcontroller provides the data to the RF module which is to be transmitted. RF transmitters are usually subject to regulatory requirements which dictate the maximum allowable transmitter power output, harmonics, and band edge requirements. The interfacing of RF transmitter with Arduino is as shown in Figure 12.

RF receiver module takes the modulated RF signal and then demodulates it. RF receiver modules are usually of two types, namely the super-regenerative receivers and super-heterodyne receivers. Normally, the super-regenerative modules are of low cost and also have low power designs. These modules use a series of amplifiers to remove modulated data from a carrier wave.

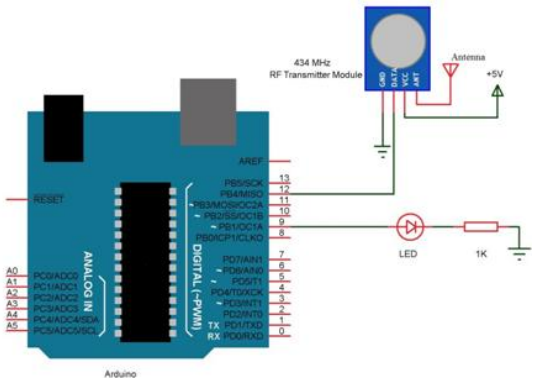

Figure 12. RF Trasmitter interfacing with Arduino

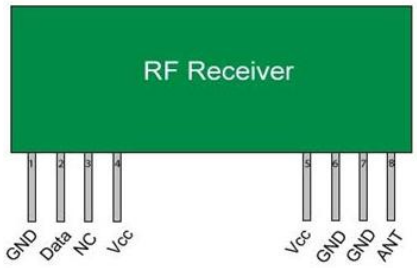

Figure 13. RF Receiver

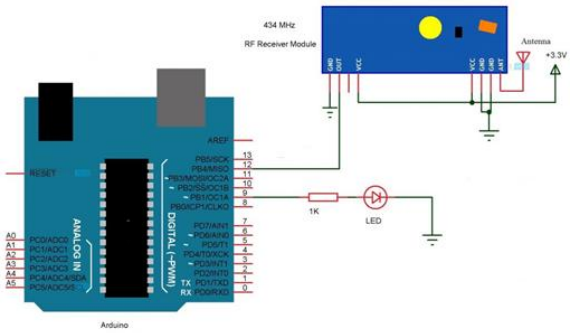

Figure 14. RF Receiver interfacing with Arduino

F. Voice Processor (APR33A3)

Voice Processor in the proposed system is used to store different voice commands to express patients need and activate specific voice command according to the requirement with the help of speaker connected to the voice processor.

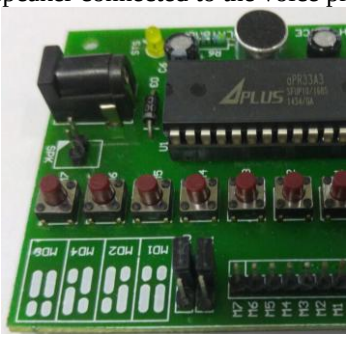

Figure 15. Voice Processor.

 ISSN: 2454-4248
61 – 66

The APR33A series are powerful audio processor along with high performance audio analog-to-digital converters (ADCs) and digital-to-analog converters (DACs). The APR33A series are a fully integrated solution offering high performance and unparalleled integration with analog input, digital processing and analog output functionality.

V. RESULTS AND DISCUSSION

The proposed system is very helpful for the paralytic patients and old aged people. The complete designed model is as shown Figure 12.

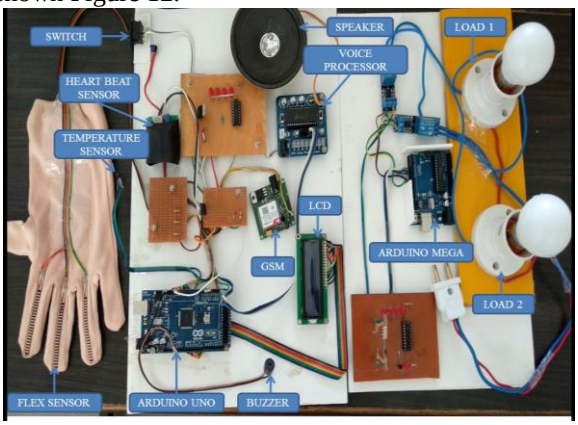

Figure 16. Proposed Model.

The system continuously monitors heart beat rate and body temperature of a patient. The heart beat rate and body temperature of a patient will be displayed using LCD shown in Figure 17, Figure 18.

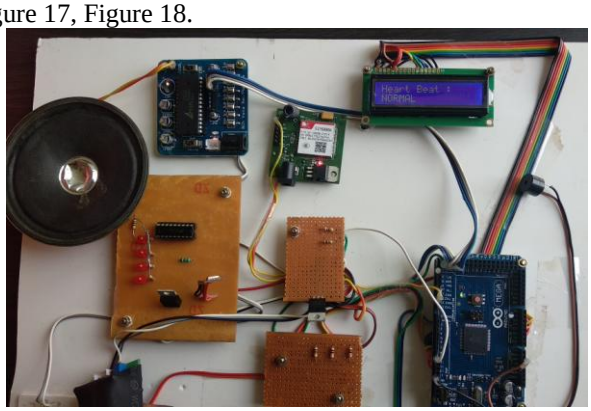

Figure 17. Diplaying Heart Beat is Normal using LCD.

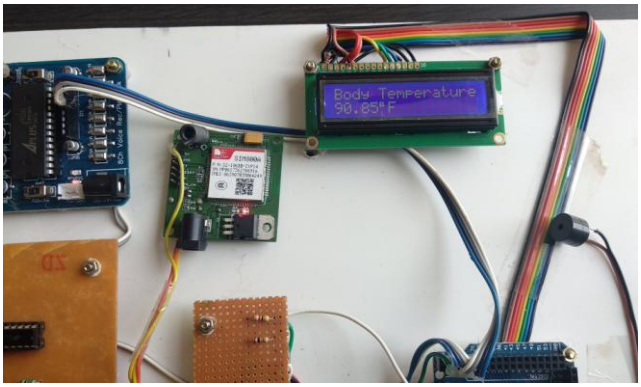

Figure 18. Diplaying Body Temperature of the patient using LCD.

The system also has the feature that the care taker will receive a message when the system is activated. The system will continuously monitors body temperature, heart beat rate and if any abnormalities found in the read values immediately the text message will be sent to the care taker about the read value of the heart beat sensor and body temperature.

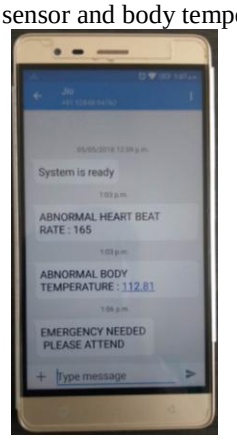

Figure 19. Different text messages received in the care taker mobile.

VI. CONCLUSION AND FUTURE SCOPE

The proposed system will be a helping hand for the old aged people and paralytic patients. The patients can express his needs with the help of designed system. The system can be used for home automation hence without the help of care taker patient can control different home appliances. The system also continuously monitors patients heart beat rate and body temperature and if there is any abnormalities found the same will be informed to the care taker through text message. In future more flex sensors can be used to perform multiple tasks and more health parameters can be added.

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BIOGRAPHY

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