Coma patient’s health monitoring and observatory system using internet of things

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Abstract. Once a patient enters the comatose stage, it is really difficult to predict when he/she will be out of it. It may be within days, weeks, or may even take months and years together. Due to this situation, it becomes difficult for the hospital staff to monitor and keep watch over the patient at all times and thus slight body movements and life-like indications or abnormal activities may go unnoticed. To prevent such a situation, the proposed system has a wide range of wearable sensors fitted to the patient’s body. Sensors used are flex sensors, MEMS Accelerometer, heartbeat sensor, SPO2 oximeter sensor, temperature sensor, IR sensor in the form of goggles. These sensors help monitor the patient’s vitals and these data are stored in the cloud server and can be accessed when the need arises through a PC or smart-phone. The parameters are then upon plotted on a graph and hence analysis can be done on it to predict the approximate chances of recovery of the patient.

Keywords: comatose, sensors, signal analysis, health monitoring, IoT

1. Introduction

The comatose stage is a state where a human body doesn’t show any body movements. A person enters into a coma stage when he/she experiences sudden and extraordinary shock which can result from accidents or this can happen when blood supply to the brain is cut-off or when blood pressure drops to a very low value. Though there aren’t any voluntary actions from the patient, life exists and the heart beats to pump the blood. It is just that there aren’t any limb movements. In such a situation, it becomes quite difficult for the doctor or healthcare worker to manually check the patient at regular intervals of time for movements. So, the proposed system consists of numerous sensors to monitor heartbeat, movements in the limbs, temperature, the oxygen level in the blood, and all these parameters are monitored round the clock. It also has an Arduino microcontroller to manage the circuitry which collects these data and uses a Wi-Fi module to display these results on a webpage.

A customized webpage is used instead of an open-source platform and the outputs are registered. In case any abnormality is detected, an E-mail is sent to the concerned family member/doctor through a message gateway protocol. So subsequently, there isn’t a need for a doctor to be always present to
have a check on the patient. This system continuously monitors the patient and updates the outcomes of the monitoring.

2. Existing system

The existing system in this paper [1] uses various sensors to monitor vital parameters of the patient and interface it with a microcontroller and a Wi-Fi module. It makes use of an open-source platform called Things Speak to monitor instantaneous results. A GSM module is used to send alerts to the concerned doctor if any abnormality is detected. The Disadvantages of this system uses an open-source platform rather than a customized web-page. The monitored values aren't stored anywhere and only the instantaneous values are displayed. To send alert SMS, a GSM module is used which tends to fail when there is a poor network.

In reference paper [2-3] comes up with a system to monitor the health status of the patient and gives utmost importance to the heart condition of the patient. Parameters are observed and an ECG plot is drawn to analyze the heart condition of the patient. The disadvantage of this system proposes an idea to monitor only the heart condition of the patient. A solution to various other health monitoring aspects isn't discussed here.

3. Proposed system

The proposed system contains various sensors to monitor the patient regularly. The sensors collect their respective values and transfer them to the Arduino microcontroller where they are acquired and processed. Arduino along with the Node MCU Wi-Fi module is the heart of the circuit [4]. These monitored parameters are then transferred via the cloud to a custom-designed web-page. The monitored parameters are displayed here. The web page keeps a count on the number of times the patient has shown movement in fingers, legs, eyes [5-9]. The data is recorded and refreshed after every two seconds. This web-page, not just shows the instantaneous value but also stores the history of monitored parameters and this data is stored in the cloud as a separate database by the Wi-Fi module and can be accessed anytime. The data acquired from the sensors are compared with the threshold values set in the processor [10]. If the obtained values are above the threshold values, then an E-mail alert is sent using a gateway SMS protocol to the concerned doctor rather than a GSM module. By using this gateway protocol, poor networks will not obstruct message delivery. After acquiring the output, these parameters are plotted as a graph. Taking a look at this graph gives an account of the frequency of the movements shown by the patient and this can give one a rough and approximate idea of the chances of recovery of the patient.

4. Methodology

4.1. This system uses the following sensors, Flex sensor for monitoring movement in fingers, a MEMS accelerometer for detecting muscle movements in the legs, an Infrared LED fitted to a glass-setup to detect eye-blinks or eyeball movements, a temperature sensor to track the temperature of the patient, a pulse sensor to ensure normal heartbeat function, SPO2 oximeter to measure the oxygen saturation level in the blood figure 1.

4.2. Flex Sensor: It is a variable resistance sensor which when encounters a bend, changes its output resistance, and thus change can be detected.

4.3. MEMS Accelerometer (ADXL 337): It senses movements in 3-axes. It has two fixed electrodes at the edge and one movable electrode in the middle, therefore there exists two capacitances in between them. During any movement, the movable electrode moves, and capacitance changes, and thus output voltage changes.
4.4. Eye-blink Detector: To monitor eye-blinks, an IR light emitter, and IR photodetector is arranged in a goggle-like set-up, once an eye-blink event is detected, the photodetector gives an output low.

4.5. Temperature Sensor: A LM35 temperature sensor is used to monitor the temperature.

4.6. Pulse sensor: A heartbeat sensor is employed to track the beats per minute of the heart. The finger is attached to the sensor, it emits an IR light which takes note of the thickness of the blood in capillaries at each heartbeat and thus accounts for the number of beats of heart in a minute.

4.7. SPO2 oximeter: It measures the oxygen saturation level in the blood.

Figure 1. Block Diagram

5. Results and Discussion

In this proposed concept, the vital parameters of the patient are monitored and are updated in the webpage by the Wi-Fi module through the cloud. The sensors are attached to the patient’s body. These sensors are also interfaced with the Arduino processor which collects all the output from the sensor and processes it. A threshold value is set for each sensor’s output. If at any instance, the sensor’s output exceeds this threshold, then the buzzer goes on and an alert E-mail is sent by gateway protocol
to the concerned doctor. The monitored values are displayed on a custom made web-page. This page also stores the previous monitored data under the history section. It gives the number of times the patient has shown body movements. The hardware connections are shown in figure 2 below.

![Hardware model](image)

**Figure 2.** Hardware model

The web page in figure 3 shows the monitored parameters of the patient. These values are acquired from the sensors, processed by the microcontroller and are displayed here.

![Results display in webpage](image)

**Figure 3.** Results display in webpage

figure 4 and 5 shows the part in which the monitored values are stored as history. These values are refreshed and stored every two seconds.
Figure 4. Database of the monitored values

Figure 5. E-mail received upon movement detection

6. Conclusion
An effective healthcare system for monitoring the vital parameters of a patient in comatose stage is built using various sensors which coordinate with processor. This processor in turn processes this data and transfers this to the Wi-Fi module. Wi-Fi module then transmits the data via the cloud to the web-page. It also makes sure to store the previously read data in a proper form as a database for a future access. An alert E-mail system is also setup to counter emergency situations by sending an alert. This data can be viewed by logging on to the web-page.

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