

Remote Communication for Disabled Person using EEG, EOG & Motion Sensor

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ABSTRACT: It is a matter of concern for leaving the aged or disabled persons alone in the house. In this paper, three different ways are implemented in order to communicate with a disabled person in any type of emergency or unwanted physiological situations. Through this method, one of his/her family members can easily communicate with that person. In this regard, Neurosky, PIR sensor and Electro-oculogram (EOG) electrodes are used simultaneously. At first, their family member is to be communicated through Electroencephalogram (EEG) signals which are collected by Neurosky through their brain activity. The brain signals are recorded by Neurosky in different emotional patterns such as attention, meditation etc. All signals are transferred to Arduino Uno from LabVIEW software and then to GSM module. Then a call will send to their family members by GSM module. Similarly, a Passive Infra-Red (PIR) sensor is used to detect the motion of any body part. If a disabled person can only move his/her fingers, PIR sensor can sense the motion of the movement and subsequent voltages are transferred to the GSM module through Arduino Uno. It also generates a call through GSM module to inform his/her one family member about the emergency situation. Finally, the signal from movements of the cornea is recorded if the disabled person is able to move his/her eyes. This EOG signal is recorded by the electrodes. All these signals are transferred to GSM module through LabVIEW and Arduino Uno in order to send a call or message to his/her relatives or nearby neighbours or doctors.

KEYWORDS: Neurosky, PIR sensor, Arduino Uno, GSM module, EEG, EOG.

I. INTRODUCTION

As of the year 2020; 1,378,085,450 people of different ages live in India. Among them, 60%-70% fully or partially disabled people are aged (age 60+). Most of the disabled and aged people live in the rural area from which they have to face many problems in their daily life. In the rural area, this is very hard to communicate with one another person as the houses are placed in distances. This creates a communication gap between a disabled person and other normal persons. The aged or disabled person may suffer from different types of disabilities such as vision problems, hearing problems, speaking problems etc. Many people suffer many other types of disabilities. In urban areas, there are many developed technologies used by common people which are very useful for disabled persons. But in rural areas, no such technologies are available and the hospitals and medical staffs are also very sparse in numbers. Also, the technologies available are not affordable for every people in rural areas and also in some places in the urban areas. So, mainly our work is for those people who cannot invest their money more than one time for disabled people. When they are alone in their house and nobody is present with them, they are facing a lot of problems. In any emergency situation, they may not communicate with the relatives, nearby neighbours or nearby doctors because of their ill-health and disabilities. This could prove fatal for their lives (due to sudden heart stroke, brain stroke etc.). Through this work the aged person can communicate with one caring family member or a nearby neighbour or a nearby doctor in any difficult and emergencies using his/her bio-signals such as EEG, EOG and motion of fingers.

II. RELATED WORK

Usage of bio-potentials in patient monitoring, household load controlling and message transmission is increasing in this modern society. The signals such as EEG, EOG, electrocardiogram (ECG) or electromyography (EMG) are extensively used for these purposes. Several works were already conducted in the domain of EEG [1]. The paper correlates between the EEG cell potentials using different stimulations. Another paper [2] surveyed the effects of brain injuries of patients. They proposed a medical communication system between doctors and the patients using the flex sensor installed at their fingers. An excellent review of Brain-Computer Interface (BCI) is given by [3]. The extraction and research on

EEG is very advanced in modern days. In the last century, extensive analysis of EEG is carried out at different laboratories. They have shown that the brain exerted EEG signal helps the person to communicate with the computer. This is really helpful for any dumb persons who are paralyzed or disabled. Another paper [4] introduces a machine learning approach on brain and computer interface. This provides an adaptive learning technology to the machine that can sense the EEG signal and creates a model that can predict the person’s behaviour in future. The paper [5] provides an insight to the standard methodologies to extract clinical EOG bio-potentials, their values, standard instrumentation etc. They also mentioned standard guidelines of how to place electrodes near the eyes to take the corneal voltage changes with the change in pupil movements. Another paper [6] extracts the best features from a set of different eye movements which can produce optimum results. The basic applications of PIR sensor as motion detection are discussed in [7]. The corresponding applications of PIR sensors as a home security system are discussed in paper [8] and [9].

The current paper proposes an application combining the applications of EEG, EOG and the motion sensor in order to establish a communication between aged/disabled persons and one healthy person. As the bio-potential dependent system is subject to noise attenuation, using a three-fold approach increases the accuracy of the system to a greater extent. This justifies the assimilation of three technologies together in order to accomplish a noble cause (of saving aged/disabled persons in the emergency situations), especially in rural areas.

III. OBJECTIVES

The work satisfies the following objectives:

- One of the objectives of this work is to use different emotional and brain relaxation/anxiety signals to send EEG signals and drive the GSM communication system using Neurosky.
- With the help of EOG sensors, a disabled person can easily communicate with his/her one family member in any type of emergency using his/her eyeball movements.
- Using motion sensors, the disabled person can communicate with one other person in a difficult situation by doing tiny movements of fingers.

The block diagram of PIR sensor and corresponding interfacing with GSM module using Arduino Uno is shown in Fig.1.

IV. BLOCK DIAGRAM AND DESCRIPTION

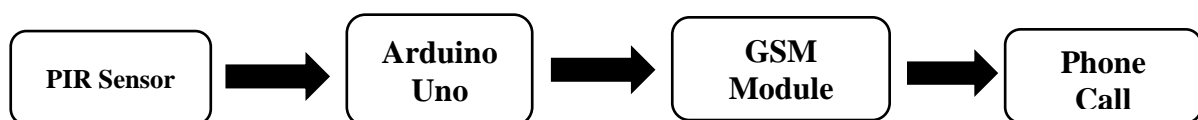


Fig. 1. Block Diagram of PIR Sensor interfacing with Arduino Uno

In this work, the PIR sensor is used to detect the motion of the fingers of a disabled person. By moving the finger, a disabled person can communicate with his family member. A PIR sensor will be connected near the user and this sensor will work in a specific range. When the patient moves his finger at a certain distance from the sensor, the infrared radiation coming from his finger falls on the sensor. Then the PIR generates electrical energy which goes through Arduino Uno as shown in Fig. 1. With the help of GSM module which is connected with Arduino Uno, the phone call goes to the patient’s family member. The designated phone number is inserted in the Arduino Uno based GSM code in order to send the phone call or message.

The block diagram interfacing EEG and EOG sensors with the GSM module is shown in Fig. 2.

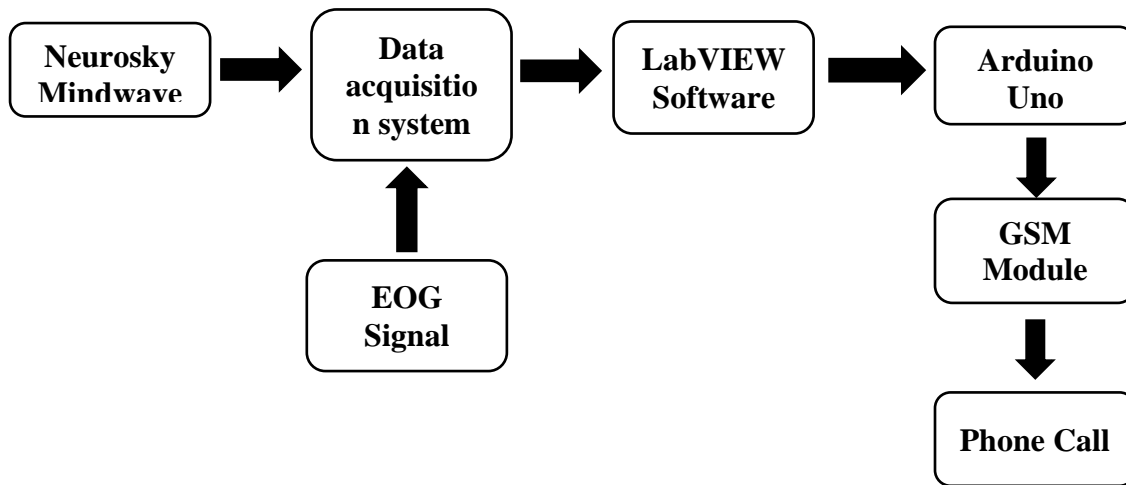


Fig. 2. Block diagram of EEG and EOG signal interfacing with LabView software and GSM Module

EEG signal has different frequency and different voltage due to different electrical activity of the brain. These electrical activities depend on the mental state of the patient. When the patient sleeps or he feels bad, at that time electrical waves of the brain are changed. The Electroencephalograph (EEG) signal has been acquired from a human brain using a Neurosky that is brought to the Data Acquisition System (DAQ) through a particular channel. The same particular channel has been accessed through the LabVIEW software to acquire the signal. In that LabVIEW software, proper VI diagram of the signal conditioning circuit must be implemented. For EEG, the circuit consists of filtering in order to remove the noises. This signal conditioning system also includes a frequency to voltage conversion circuit in order to get different voltage values from different frequency levels. Then after this frequency to voltage conversion necessary comparator circuit is applied for thresholding. This thresholding differentiates different voltage levels which are analogous to different frequencies. Thus, these threshold levels help us to get different outcomes for different mental states of the person like relaxation, concentration, attention etc. Then the voltage (decision) is amplified by suitable factors as because the bio-potentials are very low. This amplified version of that voltage is transferred to the particular digital pin to the Arduino Uno. In Arduino IDE we have written a code that consists of two parts. One part is to acquire that digital signal from that particular digital pin summarizing the decision whether the person is relaxed or anxious or any other condition. Proper values or proper decisions are taken and a phone call or message is generated to a nearby family member or doctor using the GSM Module. That code is also included in the Arduino IDE code. For EOG the sensor senses in voltage form. Thus, we need filtering, amplification and some thresholding. After that, it determines the direction of the eyeball movement and according to that decision, proper phone calls are conducted using Arduino IDE and GSM to some persons.

V. COMPONENTS

EOG Electrodes

Basically, the condition of our eye is checked or monitored by these electrodes. This process is known as Electrooculography (EOG). Mainly, for recording or measuring the voltage of the eye we used gold cup electrodes or silver-silver chloride electrodes. To measure the proper voltage, we need to place the electrodes near both the eyes at both sides (right & left) and above and bottom portion of the eye. We get every voltage for every little movement of our eyeball. One pair of electrodes are needed to place both sides of the eye to record the horizontal movement of the eyeball or cornea and one another pair of electrodes are needed to be placed in the up and down directions of the eye to measure the vertical movement of the cornea. So, mainly EOG records the movement of eye potential difference by using electrodes. Electrodes are the important components for Electrooculography (EOG). A snapshot of the EOG electrodes is shown in Fig. 3.



Fig. 3. Snapshot of EOG Electrodes used in this work

Neurosky Mindwave

Neurosky Mindwave headset is a sensor used to record the brain signal or Electroencephalograph (EEG) signal. Neurosky is a moderately costly sensor. It is a small, low weight device which we can easily carry with us at any place. It is Bluetooth driven device to record human brain waves. We can also monitor our brain condition by Neurosky and can analyze different EEG frequencies exerted from the brain in different mental conditions. It has dry electrodes through which the sensor senses the signal from the human brain. There are a lot of inter-related neurons in human's brain. For this inter-relation of neurons, there are various or different types of perceptions and responses in human brain. As a result, waves with different frequencies are generated during different brain conditions like Delta, Theta, Alpha, Beta and Gamma waves. Our brain exerted Delta wave (0.5-4 Hz) in sleeping conditions. It is a low frequency signal. In daydreaming or drowsy mode, we get Theta wave (4-8 Hz) which is a slow wave in low frequency. In relaxing mode, we get Alpha (8-13 Hz) which is a fast wave. In physically active conditions, we get Beta wave (13-22 Hz) which is a fast wave in high frequency. Finally, in stressed situations, we get Gamma wave (22-30 Hz) which is a fast wave in high frequency. In this work, we mainly implemented the algorithm based on the attention mode and relaxation mode. In the future, there are provisions for further thresholding in order to add other mental conditions in our work. The snapshot of neurosky mindwave is shown in Fig. 4.



Fig. 4. Snapshot of Neurosky Mindwave used in this work

Arduino UNO

There are various types of Arduino boards available in the market. But Arduino Uno is the most common board which we also used in our work. Arduino is one of the most important hardware in every automatic device and Internet of Things (IoT) based devices. Arduino boards consist of Atmega328P microcontroller and related peripheral devices and analog/digital input-output ports. In this board, there are 14 digital input and output pins and 6 analog I/O pins. It is an open-source board. Through Arduino IDE software the necessary program is written and through USB port the program is uploaded to the Arduino Uno board. We also use the USB cable or external 5-9 volt battery to electrically power the board. Arduino Uno also consists of analog to digital and digital to analog converter. These convert the analog incoming signal from any sensors into a digital output and a digital signal into analog output for human use. The snapshot of the used Arduino Uno is shown in Fig. 5.



Fig. 5. Snapshot of Arduino Uno used in this work

GSM Module

Global System for Mobile Communication (GSM) Module is a chip that is used for communication between mobile or computer and General Packet Radio Service (GPRS) system. A SIM card is required for GSM to activate communication with networks. GSM module is used for transmitting voice calls like a mobile phone and can also be used for sending SMS also. GSM is connected with the computer through USB or Bluetooth connection. Here GSM SIM900A is used for the communication system. This type of GSM is a dual-band GPRS module and it has low power consumption. 900 and 1800 MHz frequency bands are used for transmitting voice calls or SMS. The snapshot of the used GSM SIM900A module is shown in Fig. 6.



Fig. 6. Snapshot of GSM Module used in this work

PIR Sensors

Passive Infrared Sensor (PIR) is essentially a motion sensor which is mainly a passive sensor because it can not emit energy itself. This sensor is made of pyro-electric material. Basically, PIR is used for home security based automation systems and various types of robotic applications. Infra-red signals ejected from humans or any living animals are detected by PIR sensors. PIR is able to sense radiations of any intensity from the ambient environment if emitted from a specific range. The sensor is very rugged and low cost. In many literatures, it is shown to be used as an intruder detector. In our work, PIR is used for detecting the tiny movements of the user's finger. The snapshot of the used PIR sensor module is shown in Fig. 7.



Fig. 7. Snapshot of PIR sensor used in this work

VI. CIRCUIT DESCRIPTIONS

PIR interfacing with Arduino Uno

Infra-red emission from human or any living animals or particles can be detected by PIR sensors if installed in a specific range. PIR sensor has the ability to sense infra-red emissions from any kind of ambient environmental conditions. When the infrared radiation from the human body or particles falls on the PIR, which is essentially designed by pyro-electric materials, generates electrical energy.

There are 3 pins in PIR sensor which is connected with Arduino:

- Ground (GND) pin of PIR is connected to the GND pin of Arduino Uno
- Vcc pin of PIR is used to connect with supply voltage. Therefore, Vcc pin of PIR is connected to +5 DC Voltages.
- The third pin is of output which is connected to Arduino Uno pin 7.

The connection diagram is shown in Fig. 8.

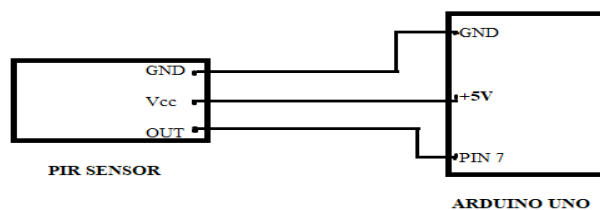


Fig. 8. Circuit diagram of PIR sensor and Arduino Uno

In this work, the PIR sensor has been electrically connected near the disabled person in a specific range. By moving his/her fingers, the disabled person can contact his family members with the help of PIR, Arduino Uno and GSM module. When he moves his finger, the infrared radiation from his finger falls on the sensor. Then the generated energy or output of the sensor is collected by Arduino Uno.

GSM SIM 900A Module interfacing with Arduino Uno

GSM SIM 900A is the cheapest module which is used to establish communication between mobile or computing device and GPRS system. By using this module users can send or receive a phone call and SMS. 900 MHz and 1800 MHz frequency bands are used in this module. A GSM module has 68 pins.

- Tx pin of GSM is connected to the Arduino Uno Rx pin.

- Rx pin of GSM is connected to the Arduino Uno Tx pin.
- Vcc or supply pin is connected to +5 DC voltage pin of Arduino Uno.
- GSM GND pin is connected to GND of Arduino Uno.

By this work, the disabled person can communicate with his family member in an emergency with the help of the GSM module. The necessary connections are shown in Fig. 9. The snapshot of a call being conducted using the GSM module is also shown in Fig. 10.

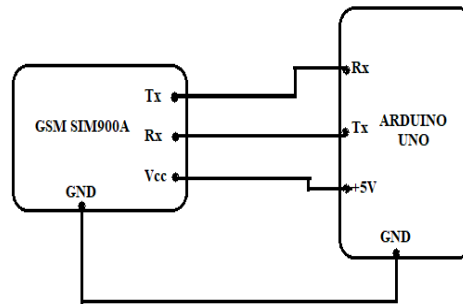


Fig. 9. Circuit diagram of GSM Module



Fig. 10. Snapshot of the work with a call is successfully generated by GSM module

VII. ADVANTAGES AND DISADVANTAGES OF THE WORK

Advantages

- The work is flexible and can be upgraded by using other bio-potentials. ECG can be implemented in this work. So, we can check the heart and brain conditions of the patient simultaneously.
- Being a flexible design, any part of the system can be easily replaced without hampering the other devices.
- As multiple techniques are used so there is less chance of failure to detect the emergency situation.
- In this work, each technique can be used to call different persons using these different techniques. Thus help can be assured from more persons. This increases a patient's chances of being rescued.
- The cost is a completely one-time investment. Thus it can be said that it is cost-effective.

Disadvantages

- Multiple techniques are used, as a result, the circuit may become complex in some cases.
- Sometimes noise can still exist in the bio-signals (EEG, EOG).

VIII.CONCLUSIONS

A new method is implemented in order to reduce the risk levels of an aged or disabled family member when he or she is alone in a room. By this method, he or she can easily communicate with others by using his/her bio-potentials. This will definitely decrease the communication gap between disabled people with other normal persons. The work can be further upgraded by implementing IoT and incorporating the ECG technique. Using IoT data of bio-signals the patient health conditions can be extensively monitored through a web page with predefined log-in and security systems.

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