A Cost Effective "Embedded Translator" for Paralyzed People

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***Abstract*— In this paper, one of the challenges being faced by full or semi body paralyzed people caused by collapse in central nervous system along with slurred speech, hearing impairment and neuromuscular disorders is successful communication with their neighbors. Moreover, gesture recognition with the help of accelerometer sensors becomes so popular in developing various assistive modules for them in which the concept of decoding gesture position by considering the axis orientation from acceleration sensor with respect to gravity. In this work, to fulfill the need for paralyzed persons' communication, the authors proposed a cost effective embedded translator module and discussed on how the accelerations of a hand motion in three perpendicular directions are detected by accelerometers and those acceleration values are translated as a message using embedded system. According to recognized gesture, based on the acceleration appropriate pre-stored template messages will be transmitted and displayed at the attendees' point of service. Further, the incorporation of GSM feature will also be helpful if necessary in transmitting the same to the alternate attendees and the medical practitioner concerned.**

Keywords*— *Communication, Accelerometer, Paralyzed, Gesture Recognition, Translator

I. INTRODUCTION

In 2010 World Health Organization (WHO) declared that more than 17,000,000 people are affected with stroke annually in most of the countries resulting towards the brain injury and prevent damage to the blood supply. This leads to the injury that the patient is suffering of total paralysis or paraplegia. In the past decades the way of human interaction with computers and the input from the human to machine have been changed. As several diseases increase that affect the spinal card, part of one's body, according to its severity there is a need for assistive device for them to live longer, happy and independent through human interaction. In this connection, hand gesture recognition is mainly used in many applications which are developed so far for paralyzed persons rather than tongue and eyeball. Generally, a stroke causes damage to the brain and depends on the part of the brain that is affected. For some people different stroke effects are mild and last a short time whereas some other strokes may cause more severe or lasting disability. The right half of the brain controls the left side of the body and vice versa. For most people, the left side of the brain controls language. The right side controls perceptual skills and spatial skills. 73% of stroke survivors lack confidence. 56% feels friends and family treat them differently.69% of 25-59 year olds were unable to return to work.

Moreover, Paralysis is caused by stroke that leads towards damage in the central nervous system and around 80% of people who survive that will suffer paralysis partially on the body. This can either be partial or complete depending on the seriousness of the stroke. About 83% of people who are affected by paralysis also suffer from non-communicative issues like slurred speech and hearing impartment. They may experience aphasia (also known as dysphasia). Ability of the user is affected in understanding and usage of language. Two major communication problems exist which are (i) Not being able to understand the spoken word and (ii) Not being able to express words and some speech characteristics that may be difficult to understand such as Slurred, choppy or mumbled, slow rate of speech, and Rapid rate of speech with a mumbling quality and so on.

Hence, in order to make them feel happy and independent it is decided to design and develop a 24 x 7 user friendly, compact and cost effective communicating assistive module which converts the tilting angles computed based on the gesture movement into meaningful messages. The authors aim is to find and embed a translator for better conveying (Transmitter) and understanding (Receiver) the meaning expressed by the patient.

II. RELATED WORKS

With the advent of science and technology, day by day researchers are working in the real time embedded applications development especially for disabilities. For paralyzed, various applications have been launched so far in which some of the related works carried out are detailed in this section.

In one of the wheel chair applications for paralyzed, Janardhana Rao utilized both voice and gesture recognition modules and discussed in their work how the inputs from these modules are given to the ARM controller and the motors are controlled which are fixed on the wheelchair. The concept of MEMS accelerometer is introduced to recognize the hand gesture and control the motor accordingly using controller. Since the size of accelerometer is so small and less weight, they have been attached to the fingertips and back of the hand. It is a 3-axes accelerometer which generates three different voltages in three directions depending upon the tilt, which are

analogous in nature and hence they will be fed to the built-in ADC to convert the same into digital form.

Similarly for voice based control actions, speech recognition concept is incorporated and is divided into two broad processing categories; speaker dependent and speaker independent. The individual who will be training the system is speaker dependent whereas speaker independent is a system trained to respond to a word regardless of who speaks. Output of the speech recognition and gesture recognition modules is interfaced to controller that controls the wheelchair based on received gesture or voice command.

Another automatic wheelchair application which is proposed by Tameemsultana the movement of head and finger of a physically challenged person have been used to control the wheelchair motor. A driver circuit is composed of four elements often called high side left and right, low side left and right. The switches are turned on in pairs both left and right on either low or high and vice versa, but never both switches on the same "side" of the bridge. The responses of motor driver circuit depend on the inputs from accelerometer and flex sensors which are analog resistors in the form of a strip.

Moreover, as a solution for stroke patients Azmi Shawkat Abdulbaki has suggested a system in order to help and perform daily functions easily using Hand Gesture. In his proposed model Supervised Neural Networks (SNN) algorithm is developed and applied. The idea of the system is to monitor the patient's hand gesture. The obtained hand gesture movement of the patient will be interpreted and compared with the database. But at the same time, the system rejects any gestures not exist (contrary to the rules) and an error message will be displayed when the patient's gesture is out of system rules.

It is inferred from the application modules those have been launched so far, hand gesture is mostly used for recognition and so, the same is considered in the proposed work that is accelerometer technique to translate the physical changes into useful messages that are essentially required to fulfill the paralyzed people. The block diagram and the experiments carried out with the developed module are detailed in the following section.

III.PROPOSED WORK

Aim of the authors is to design and develop a user friendly translator module especially for paralyzed people to minimize the common issues that are present in the launched products such as complexity, cost, size, power consumption and so on thereby an unskilled can get benefited. The proposed work comprises Accelerometer, Microcontroller(s), RF modules both Transmitter and Receiver, GSM module, LCD, Buzzer etc. The block diagram of the proposed work is shown in Figure 1.

In this work, accelerometer plays a major role that is to be placed on either side of the patient's hand palm or even on finger. The ADXL 335 is a triple axis accelerometer sensor provides the data for the orientation of the hand palm and therefore helps in recognizing the gestures. The accelerating force sensed by the accelerometer sensor (acceleration due to gravity or g) gives a particular voltage for the x, y and z coordinate orientation.

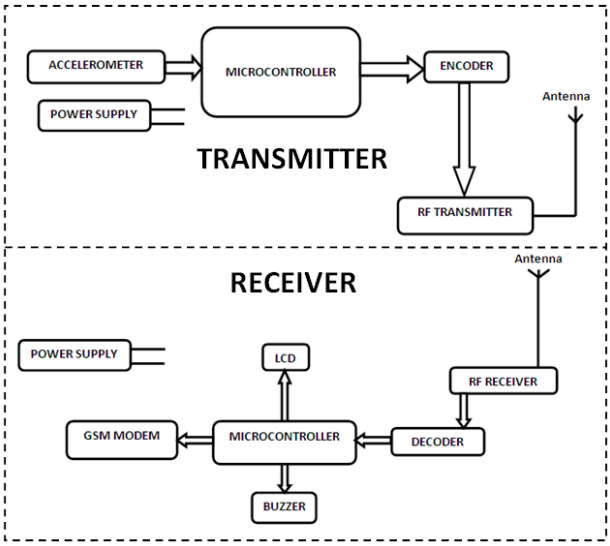


Fig. 1 Block diagram of the proposed work

Through the proposed module using this accelerometer, the user will definitely have privacy as well as feel independent in such a way that the user can convey the requirements to attendees if anything needed just by titling the accelerometer accordingly. The tilting angle range is provided with tolerance considering the steadiness of the user's physique to have an ease of usage. In this work, both x and y axes the tilt angle range is provided between 20^{o} and 60^{o} and z-axis is not considered since its value is always greater than x and y.

The analogous output of the accelerometer is amplified and given as input to the ADC 0808 that converts it into its equivalent digital output. The converted value is fetched to the microcontroller to translate it as message to be conveyed and transfers the control to RF transmitter CC2500. The message is divided into 30 bytes packets and they are transmitted sequentially as loops. On receipt of the message, it will be displayed on LCD provided for attendees' / medical practitioners' attention to fulfill the request. For e.g. If FOOD is requested, then it starts to transmit as FFF…, till 30 bytes for first iteration. Then it repeats the same for second iteration till the target of total bytes. When the message is received, a variable is being incremented

for each byte transmitted and when the condition satisfies an array is loaded with a required value like FOOD, WATER or ATTEN. If there is no attempt for the request, after the predefined time, the same will be transmitted again along with buzzer and also through GSM to the people concerned by enabling it. For the proposed work, the approaches towards design and development of the system and the results along with inferences during the experimental are presented in detail in the following sections. Moreover, having the expected system's behavior and performance of the Embedded Translator, the authors have developed a complete functional flow diagram. Since it is a round the clock operating system, on receipt of a request from the accelerometer if any, a process needs to be introduced to verify whether the request is a valid one or not. Upon validation, according to the position a decision process supposed to be introduced for appropriate selection of message, which will be conveyed to the attendees either through LCD or GSM. The developed complete functional flow diagram is shown in Figure 2.

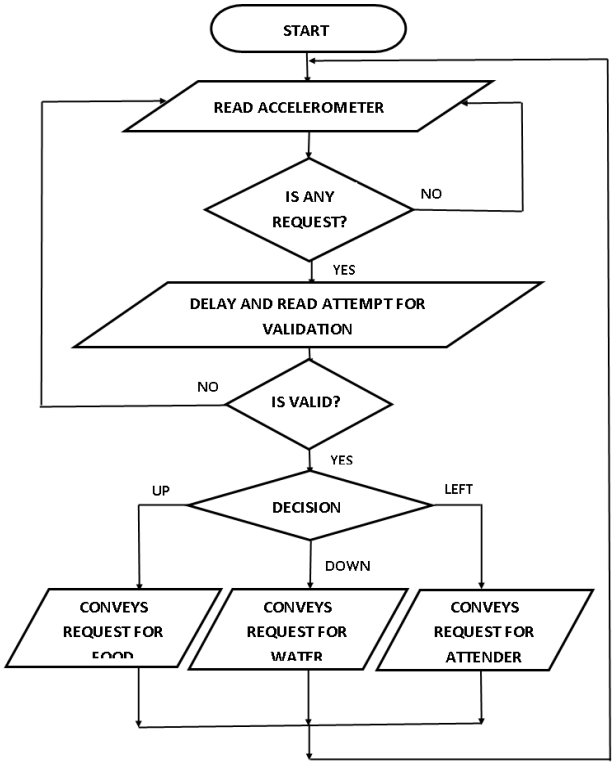


Fig. 2 Functional flow diagram of the proposed work

IV.RESULTS AND DISCUSSIONS

The proposed model is constructed using Accelerometer, Analog-to-Digital converter, Microcontrollers, RF modules for both Transmitter and Receiver, GSM module, LCD and Buzzer. As discussed in the earlier section, the developed module comprises two parts viz. Transmitter and Receiver.

Transmitter Part: In the transmitter part, a suitable triple axis accelerometer sensor ADXL 335 is used to convey the user's request through its tilt angle by recognizing the hand gestures. In order to convert the analogous output from the triple axis accelerometer, an Analog-to-Digital converter is needed and hence ADC 0808 is utilized for the purpose of microcontroller understandable binary format conversion. A microcontroller 89S52 is identified for processing because of its built-in features like Memory, I/O lines etc., thereby reduction of components usage can be achieved and so obviously less and space and power consumption. A single chip 2.4 GHz RF Transceiver CC2500 wireless module is connected to enable message transmission whenever any valid request is from the user. In addition, an LCD is also provided which is not needed at the transmitter side, but to monitor the message at the time of transmission during experimental study. The assembled transmitter module is shown in Figure 3.

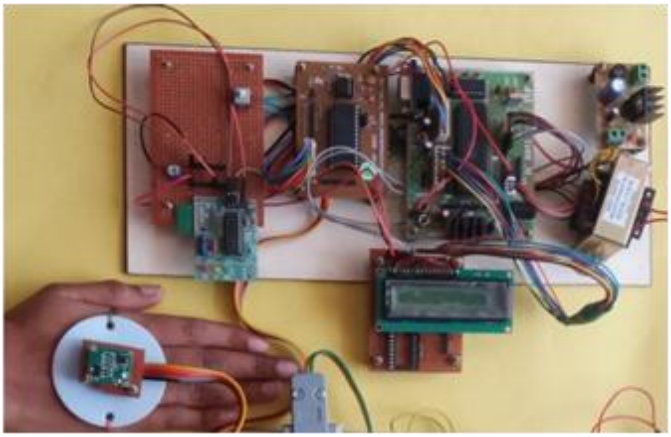


Fig. 3 Developed module – Transmitter Part

Receiver Part: RF Transceiver CC2500 wireless module is used to receive the request message from the user. Microcontroller in the receiver will do the needful to display the received message in LCD to alert the attendees. In case of no response within the predefined time, then the same request is considered once again and since this request is second attempt, the microcontroller enables both Buzzer and SIM 800 a complete quad band GSM module. Through the GSM the request message is delivered to the other registered attendees also thereby care will be taken on the user and their request also fulfilled. The developed receiver module is shown in Figure 4.

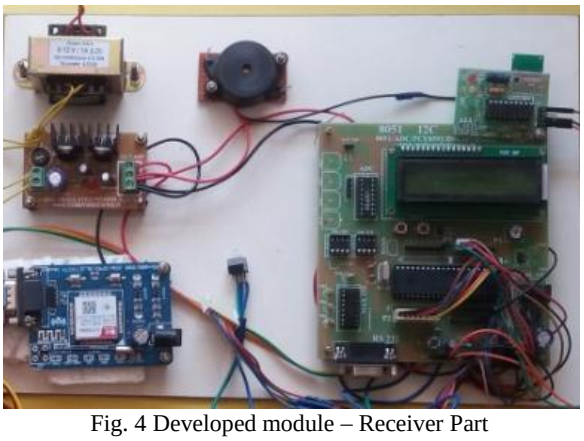
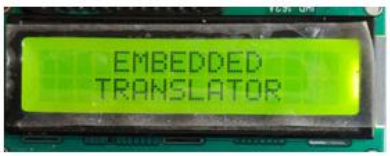


Fig. 4 Developed module – Receiver Part

Experiment is started with behavioral study of the triple axis accelerometer and upon successful study, based on the obtained values of x, y and z axis, it is decided to fix four actions initially such as Normal (Neutral), Up, Down and Right. Moreover, from the study the angular ranges of all the axes can be allocated for the user's request. Because the steadiness varies person to person that depends upon the level of attack. Since the developed module is a program based, the coding is developed in embedded C Language to respond for the requests from accelerometer in LCD as a message accordingly. The developed program is burnt on the Microcontroller's built-in memory. During experimentation, it is inferred that the behavior of the developed module is satisfactory and the obtained outputs are also as expected. The obtained results of the developed Embedded Translator module for four actions and the corresponding request are provided along with triple axis values in the Table I.

Table I Request actions and their triple axis values

ACTION AND ITS VALUES	REQUEST
NEUTRAL  X=58,Y=57,Z=68	
UP  X=56 TO 59,Y<=52	
DOWN  X=56 TO 59,Y>=5B	
LEFT  X<=4E,Y=55 TO 58	

The user's request can be extended by introducing few more hand gesture actions and calibration like process will be done effectively to fix the user's request angular range. As far as the attendee's point of view is concerned, it is inferred that in case of illiterate (or) unskilled attendees they need to depend others to know the request displayed in the LCD. In the absence of such skilled people, possibilities are there for a delayed attempt which is not an appreciable one. Hence authors are also working on the concept of voice message transaction by which the above said issue can be minimized and the system will become a complete user friendly one. For voice message transaction, in addition to the developed module a microprocessor compatible speech synthesizer IC is to be added which has the built-in feature voice record and play. At the time of successful development of embedded translator module with voice message then the module can be utilized anywhere in the world because regardless of any language the voice can be stored and played using the voice synthesizer. Also, the RF module in the developed system has the capability of voice transmission and reception.

In addition, as discussed earlier if the given request is not met within the predefined time, once again the same request will be given and at that time in addition to LCD the GSM module also gets activated through which the other authorized attendees will get SMS alert. During experimentation, at the first request along with buzzer the request message is displayed in the LCD and after predefined time the presence of same request is made as a second request. In the second attempt of earlier (or) same request, along with buzzer the concerned request message is sent to the attendee's mobile by activating the GSM module and the obtained results snap shot is shown in Figure 5.

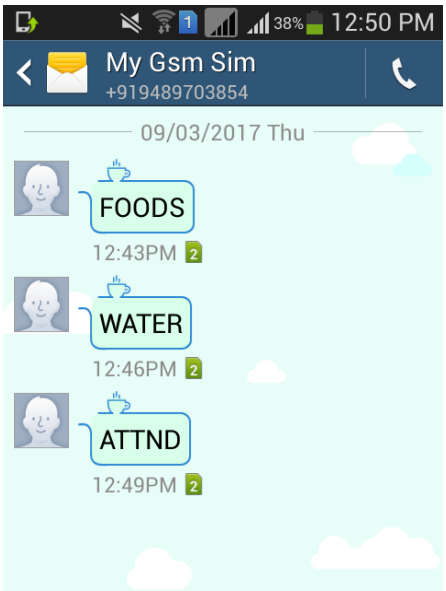


Fig. 5 Snapshot of the received SMS

V. CONCLUSION

The Embedded Translator proposed by the authors has been developed and experimented successfully. The RF modules incorporated in the system facilitate message transaction through GSM between the user and attendees. Since the module has been developed for study purpose, it is composed of

various components. If the utilized components are integrated altogether using large scale and launched as a product, then definitely the embedded translator will become a compact, low cost and power consuming one. Moreover, the authors are working on voice message transaction in order to encourage the unskilled attendees' involvement in future. The same concept can be applied to operate various electrical and electronic appliances, channel selection while watching TV, inbox mail verification and so on without any one's help thereby the end users of such disable category will definitely feel happy, privacy and independent which are the ultimate aim of the authors.

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