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Accelerometer Based Gesture Driven Embedded System for Differently Abled

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Abstract

This document proposes an idea of an automated system based on accelerometer which can be very helpful for the differently abled patients. The limited number of pre-defined actions by the patients can be deciphered through automated system and can be used to convey the message to the medical staff .The proposed system will be very useful in enhancing the communication between the patients and the medical staff and reduce the burden on the personnel looking after the patients.

Keywords: Accelerometer, Paralysed, Automation, R-F module, Flex sensor, SD card.

Introduction

Today, even the modern hospitals do not have enough automated assistance for paralysed people. There is only an emergency bell available to call for help. Generally, in big hospitals, many patients of paralysis are admitted at a time. If, in such a scenario, there are multiple calls at same time, medical staff cannot identify which patient needs more urgent attention than others.

Modern technologies and automated systems can be effectively utilized to solve this problem. A system based on accelerometer can act as a great help for recognising the intentions of the patient. It asks the patient to just make some limited predefined gestures with any one of his/her hands. The speaker plays the message the patient wants to say. Achieving exactness and compactness is made easy by making a gesture correspond to an entire message.So the intended staffs only have to attend the patient & other staff can continue performing their other equally important work. This ensures both effective utilization of staff & immediate service of patients simultaneously.

This paper explains how this system can be implemented practically with the help of a wireless communication system using a block diagram. It also talks about working of various modules and the advantages of the system in the end

Background for Components Used

The various components used at base (patient) end are merged in a circuit fitted on a *Hand glove* which patient has to wear while performing different gestures.

A. Glove End

1) ***Accelerometer***: An accelerometer is an electromechanical device that will measure acceleration forces. [3] By sensing the amount of dynamic acceleration, you can analyse the way the device is moving using good programs. Here, is the list of some commonly used accelerometers. It outputs the signals which are analog voltages that are proportional to acceleration. The main purpose of accelerometer is to sense the actions of the palm. Accelerometer gives new meaning to same finger actions. Finally, the message previously stored in the microcontroller's memory corresponding to this combination of voltages is played on loudspeaker. If the message is such that an urgent action needs to be taken, the buzzer also rings.

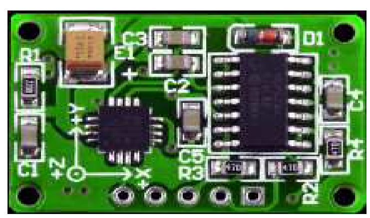

Fig. 1 A Typical Accelerometer Circuit Board

TABLE I

VARIOUS ACCELEROMETER TYPES [9]

Sr. No.	Sensor Category	Key Technologies
1	Capacitive	Metal beam or micro machined feature produces capacitance; change in capacitance related to acceleration

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2	Piezoelectric	Accelerometers use materials such as crystals, which generate electric potential from an applied stress
3	Hall Effect	Motion converted to electrical signal by sensing of changing magnetic fields.
4	Magneto resistive	Material resistivity changes in presence of magnetic field.

Accelerometers can measure vibrations, shocks, tilt, impacts and motion of an object.

1) ***R-F Transceiver:*** It is used for wireless transmission between Glove circuit & Base station. Range of typical 433 MHz transceiver is about 100-120 meter.

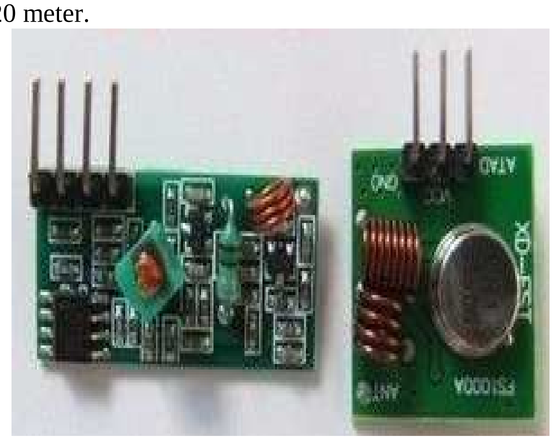

Fig. 2 A Typical R-F Transceiver circuit [4]

2) ***Flex sensors****:* The flex sensors are variable resistors. As the flex sensors are bent, the resistance changes in an approximately linear fashion, as shown in the diagram below. They are used to sense the actions of fingers. The flex sensors will be fixed on the fingers such that they will bend along with the bent fingers and can record the bending easily. Various combinations of flex sensors can help to encode various messages along with accelerometer.

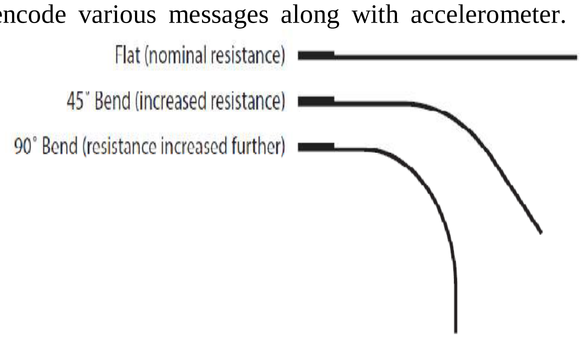

Fig. 3 Variation of Resistance of the Flex Sensor [5]

3) ***Contact Sensor:*** The contact sensors employed use a simple design. Copper strips are taped round one of the fingers. For these finger, the copper tape is wired with pull up resistors enabled. When they are not in contact with anything, the input on the microcontroller is high. There is also copper tape on top of the adjacent finger, which is wired to ground. When both the fingers come into contact, the corresponding inputs on the microcontroller are pulled to ground, resulting in an active low signal. The contact sensors provide a very stable signal.

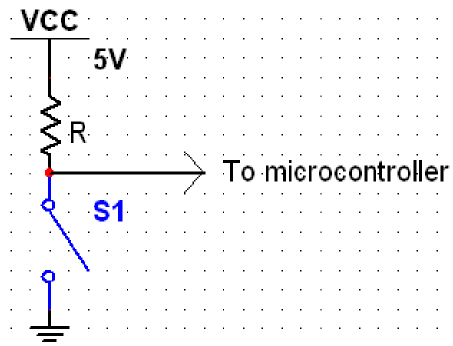

Fig. 4 Electrical representation of contact sensors

4) ***CPU AND Comparator:*** Comparators take input from flex sensors and then convert them to digital. Each flex sensor only needs to be converted to one bit: flexed or not flexed. A Schmitt Trigger with a proper threshold can serve as an ADC for this. The accelerometer gives more than 1 bit of digital output and hence the microcontroller which is ideal for this is ATmega16.[7] It has internal ADCs which can be used to digitize three different outputs from accelerometer. The outputs of the 2 one bit ADCs (for 2 flex sensors) are also fed to microcontroller. The microcontroller then outputs the data to the R-F transmitter.

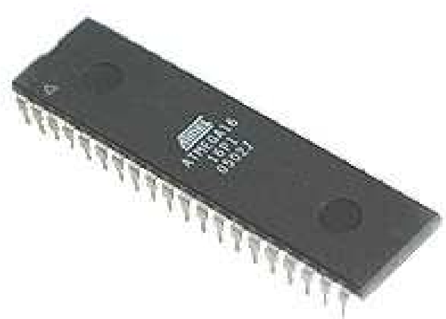

Fig. 5 the ATmega 16 Microcontroller [1]

Base End

1) ***CPU:*** It receives data from R-F transceiver. It understands the message based on database stored in EEPROM of microcontroller. It then blows the buzzer if needed.

2) ***Speaker and Buzzer:*** The Buzzer is used to alert the receiver when the message is obtained to indicate that the user requires immediate attention. Recordings corresponding to different messages are stored on an external SD card. SD card is interfaced with the ATmega16 processor unit via the SPI (Serial Peripheral Interface) protocol. The SD card can be controlled with only 6 lines, 2 for power supply and 4 as control signals.

Fig. 6 A typical SDHC card [2]

The memory card contains pre-recorded messages in the raw (8000Hz x 8 bits=64kbps) PCM (Pulse Code Modulation) format which AT-mega16 can use to generate fast PWM.[8] This fast PWM (Pulse Width Modulation) signal is directly fed to speaker to get the message played. The need of complex processor to decode standard audio format (e.g. mp3, wma, wav etc.) is eliminated due to PCM. Similarly need of DAC (Digital to Analog converter) prior to speaker is eliminated due to fast PWM.[6]

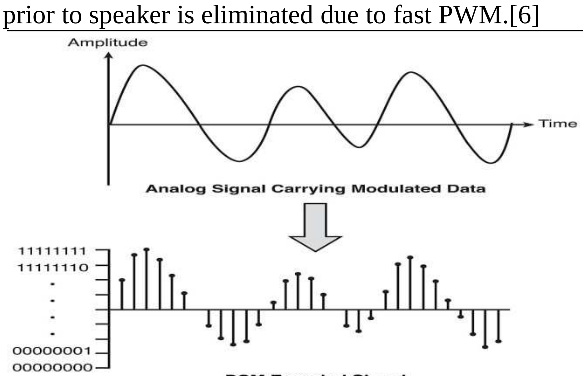

Fig. 7 Pulse Code Modulation

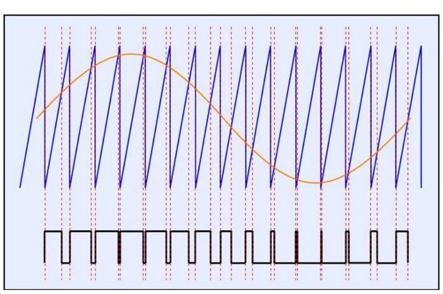

Fig. 8 Pulse Width Modulation

Block Diagram and Working

As the patient performs a specific movement, the accelerometer and flex sensors which are fixed on the fingers of the patient detect the movement and send the corresponding analog signals to the microcontroller. These signals are encoded by the microcontroller and transmitted over the wireless medium using R – F transceivers. These encoded signals are received by the base station unit and analyzed by the base station microcontroller. Finally, an appropriate audio message which is already stored on the memory card in PCM format is played on the speakers.

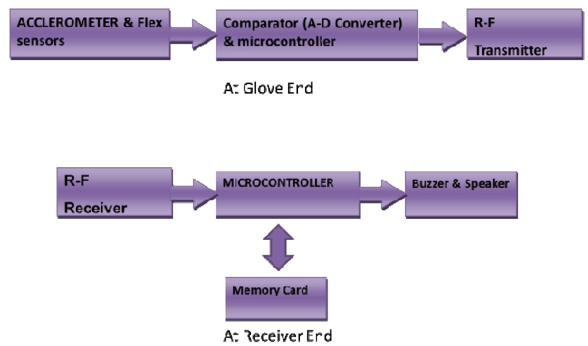

Fig. 9 Block Diagram of the System

Advantages

A very much customized system, in that, while installing the system, any message can be associated with any of the gestures.

Since, there are very limited number messages, patient has to remember very less and after a very little practice, he/she becomes familiar with the system.

Again, as a single gesture means entire message, a lot of time is saved during the conveying of message.

Being a wireless system, patient feels very comfortable using this system.

The system can be programmed from time to time to include or delete any commands so as to suit the user.

This system is ideal for big hospitals since it involves wireless communication and it can be easily installed and maintained.

Conclusions

The possibility of automating the communication between patients and medical staff in a hospital was reviewed and analyzed. During the course of analysis, we assembled knowledge and data of various electronic components as mentioned above and developed an outline of the entire application specific embedded system. From the concept presented, the accelerometer has been proved to be a very useful and attractive option to automate those systems which when performed manually are complex, time consuming and comparatively inefficient. It is also inferred that, accelerometer lends itself to practically implement any such theoretical idea. An USA standard of sign language can be used here to do the job. But, it requires the patient to gesture for every letter in the sentence instead of some repeatedly needed messages like "I have got a headache" or "I am uneasy" or "I want some water" and so on. The proposed system solves this question by assigning a gesture to an entire message.

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