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Gesture Controlled Wheel-Chair:A Review

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Abstract: Robots of the future should communicate with human in natural way. Hence, we are especially interested in hand motion based gesture interface. The purpose of this study was to present the reliable means of human-computer interfacing based on hand gestures made in three dimensions. In this paper we present a hand gesture recognition system which is of general use and can be used for different applications. The system is based on a MEMS accelerometer and it is able to recognize several gestures. The system can be divided in two parts: a gesture recognition module with MEMS sensor and a wheel-Chair controlled by the microcontroller.
Keywords- hand gesture recognition, micro-electromechanical systems (MEMS), gesture control, and wheel-chair.

I. INTRODUCTION

People with physical disabilities and partial paralysis always find it too difficult to navigate through their habitat or their home without the assistant of someone. In today's fast world, everyone is busy and there are less people to care for their elderly and physically challenged people. Also these people find it tough to navigate inside the home without external aids. The wheel-chairs are the most common means of locomotion for these people. But navigates through the outside the home these people needs continue assistant of someone every time that can be demoralizing for the person as well.

In biomedical field, a wheel-chair is an important device because of recent shift in the industrial populations. The present wheel-chairsdo not have integration of technology for their working. These either require constant monitoring of someone or needs lots of efforts.

Traditional wheel-chairs used by the physically challenged and elderly people have some limited functions and flexibilities.Most of the conventional electric powered wheelchairs are using joystick as a used input mode of control to

Maneuver the powered wheelchairs. The drawback of joystick control is that it is not suitable for physical disabled person who cannot control their movements especially the hands.The recent development in robotics and Sensor technology promises to develop an advanced wheel-chair that could overcome the drawback in traditional wheel-chairs.

In existing system a pc will be used for the gesture recognition and controlling the movement of wheel-chair [1]. Hence along with wheel-chair a pc is to be used which would increases the complexity of the system. The complexity of system can be reduced by using MEMS accelerometer instead of a pc which is very small IC placed on the fingertips of the patient. Gesture controlrobots are extensively employed in human non-verbal communication which works with our hand gesture also making the system less complex and lighter in weight. The whole system can be divided into two practical parts: 1. Transmitter – The gesture device. 2. Receiver. The microcontroller that controls movements of motors installed on wheel-chair. The MEMS accelerometer which is used for gesture recognition is a micro electromechanical sensor which is highly sensitive sensor and capable of detecting the tilt. This sensor finds the tilt and makes use of the accelerometer to change the direction of the wheel-chair depending on tilt. For example if the tilt is to the right side then the wheel-chair moves in right direction and if the tilt is to the left side then the wheel moves in left direction. The wheel-chair movement can be controlled in forward, reverse, left and right direction with obstacle detection using ultrasonic sensor. This wheel-chair automatically senses the presence of obstacle in its path and deviate its direction of movement.

The whole device is portable and system operation is entirely driven by wireless technology. The system uses a microcontroller, which is programmed, with the help of embedded c instructions. This microcontroller is capable of communicating with transmitter and receiver modules. The MEMS sensor detect the tilt and provide the information to the microcontroller and the controlled judges the instruction for the movements i.e. right, left, forward and backward. The controller is interfaced with two motors to controls the direction of wheel-chair. Also, the devices are operated wirelessly through MEMS accelerometer sensor. To perform the task the controller is loaded with intelligent program written using embedded _c' language and this program is converted into .hex file using 'keiluvision' complier.

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II. VARIOUS ASSISTIVE TECHNOLOGY

Several attempts have been made in the field of wheel-chair technology to provide the proper assistant to the needy people. However even these significant advances haven't been able to help these people. The current electric powered wheelchairs (EPWs) are mostly joystick-driven, and cannot fully meet the need of the disabled and elderly people whose autonomies are seriously affected by decline in their motor function and cognitive performance. Up to now, various hands-free HMIs have been developed for the disabled and elderly people to control EPWs by using shoulder, head and tongue motion, as well as eye tracking.

A. Head Mounted Assistive Technology

The head mounted assistive technology is developed for such a person who is suffering from quadriplegia but has retained certain kind of neck or shoulder movements. This technology is mainly used to make devices that imitate computer mouse using head movement. In one of the approach, an infrared beam emitted or reflected from a transmitter or reflector attached to user's cap, glasses or headband is tracked, for controlling the movement of cursor. In one of the system tilt sensors are used to move the cursor in vertical and horizontal direction on computer screen. To detect the tilt from the gravity vector, the tilt sensor generally makes use of inertia [2]. As the user move the head in some direction the angle between a sensing axis and a reference vector that is earth's magnetic field is detected by sensor and depending upon the angle cursor movement will take place. One more system known as ―Camera Mouse has been developed to control the movement of cursor. This system consist of a video camera in front of the user, which continuously track the head or nose movement and proportionally moves the mouse pointer on the computer. Jia et al. [3] developed a visual based HMI for controlling a wheelchair by head gestures which were recognized by detecting the position of the nose on user's face. The main drawback of these systems is that it constantly requires neck or shoulder movement which is tiring and uncomfortable for the user. The head of the user should always be in the range of sensor otherwise the user cannot be able to control the movement of cursor. Also the design limits the allowable commands to be generated.

B. Eye Tracking Assistance

In eye tracking assistive technology instead of using a camera for tracking the eye movement several light sensors can be used [1]. The sensors can be fitted in eye glass type apparatus that can be easily wearable by the user. Also, the light sensors are cheap in cost hence, reducing the whole system cost.Furthermore since the used light sensors are small in numbers, the generated vectors dimension is small and easy to calculation and fast as well instead of size of typical video frame captured by the camera decreasing the computational complexity of the system. In eye tracking assistive technology an Eye touch system is used. Eye touch system consists of components such as infrared light sensitive apparatus such as infrared light sensitive apparatus, a data acquisition unit, computer software and the power supply.

Gajwani and Chhabria[4] used eye tracking and eye blinking obtained by a camera mounted on a cap to control a wheelchair. However, the performances of these HMIs are likely affected by environmental noises such as illumination, brightness, and the camera position. Additionally, eye tracking may force and affect the vision of the user, causing tiredness and dizziness. Ericka Janet Rechy-Ramirez et al. developed a intelligent wheel chair which uses An EEG device, namely Emotiv EPOC to be installed on used head that make it bulky and complex [**5**].This paper is inspired from a research paper titled 'Head Gesture Recognition for Hands-free Control of an Intelligent Wheelchair' by Jia et al. [3]. This paper approach was to control a wheel chair using visual recognition of head gesture.

C. Neural Interface Assistive Technology

Recent advancement in neuro-technology has helped the users who cannot benefit from mechanical movement of any body organs by developing the series of devices known as Brain Computer Interfaces (BCI) or Neural Interface System (NSI). This system control the external devices by detecting user's intention by utilizing electric signal originated from brain wave. Recently, a new EEG sensor, Emotive EPOC, has been available on the market to provide potential applications on hands-free HMIs [**5**]. It has three suites: 'cognitive suite' to detect thoughts, 'expressive suite' to detect facial expressions and 'affective suite' to detect emotions, as well as a gyroscope to detect head movements. It was used to recognize four trained muscular events to steer a tractor:

1) eyes looking to the right and jaw opened,
2) eyes looking to the right and jaw closed,
3) eyes looking to the left and jaw opened, and
4) eyes looking to the left and jaw closed.

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In such systems for making good electrode contact with the cortical region considerable amount of time is required because if good contact is not possible the electrode is removed and cleaned each and every time until we create good electrode contact. Hence it set up time is more. Also this system is prone to high error rate as the signal generated by the EEG has very small amplitude. The system can give unwanted command to the device due to interference of signals resulted from other activities such as talking and muscle contractions. To overcome such problem heavy signal processing and complex computational algorithm can be used, but it will increase the cost and delay.

D. Voice Controlled Assistive Technology

Voice controlled mechanism can also be used to operate power wheelchair by the individual who can produce consistent and distinguishable voice. This technology makes use of speech recognition system for taking voice of the user as the input signal. Before this speech recognition system is used for actual control of the wheelchair it has to be trained. The set of command spoken by the user will be saved by this system. During operation the user speaks a command into the microphone; the speech recognition system will compare the spoken command with the saved command and will transmit the computer code associated with it. In this way we can operate the wheelchair. The advantage of this technology is that, users don't have to physically operate the wheelchair and it is also easy to learn. Out of all these assistive technologies which were developed, very few assistive technologies has been proved successful in outer environment rather than in research laboratories. There are various technical and psychophysical factors which affect the acceptance rate of an assistive technology which are as follows

1) it should be easy and convenient to operate
2) device should require less time to learn
3) it should be cosmetically suitable

III. PROPOSED WORK

Instead of using all these existing and above discussed technology we can use a MEMS sensor that would detect the tilt according to the hand movement of user and provides RF signal to the microcontroller that controls the direction movements of motorsalong with a ultrasonic sensor used for obstacle detection. To collect reliable hand gesture data for the sensing element, the gesture should be performed as indicated and threshold exist time interval between two gestures so that segmentation program can separate the gesture sequence correctly.

A. Hidden Morkov Model

Hidden Markov models (HMMs) [6] are widely used in the area of gesture recognition. HMMs are comprised of two main components: a Markov chain of states, which is the hidden portion of the model, and statistical descriptors for each state in the Markov chain that are associated with the probabilistic nature of the observed data. This structure enables the HMM to simultaneously characterize local signal properties (i.e. regularities in the signal that occur in a short time span) and global signal properties by modeling local signal properties as a sequence of events. As gesture can be considered a quasistatic signal, the structure of HMMs makes it ideal for gesture recognition.

B. Block Diagram

Implementation of this proposed work mainly involves three steps. They are gesture recognition by tilting action of accelerometer, transmitting and receiving of signal by RF module and finally controlling the direction of wheel-chair based on received gesture commands by making use of motors. The motors will be driven by the controller. The block diagram of system is shown in the fig-1 given below. DC motors are fixed on the wheels of wheel-chair hence based on the rotation of motor the direction of motion is controlled. Motors are interfaced with the CPU through the motor drivers.

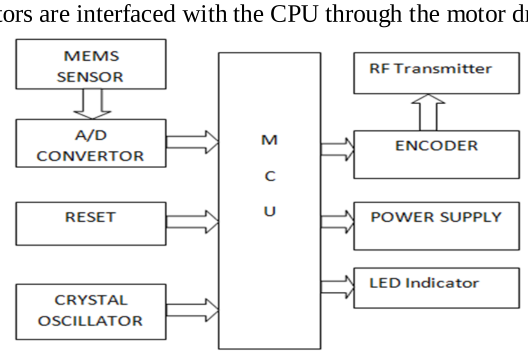

Figure1(a):- Gesture controlled wheel-chair transmitter block

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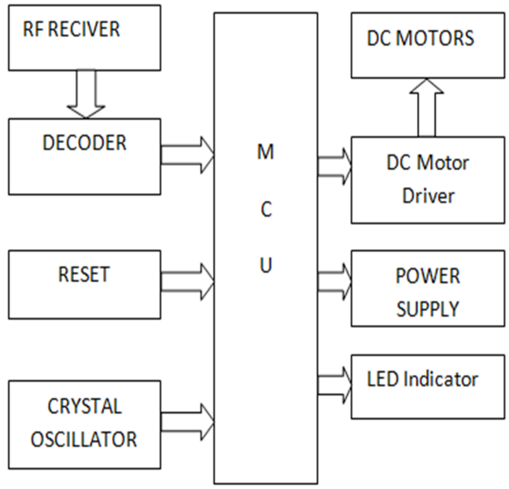

Figure1(b):- gesture controlled wheel-chair receiver block

C. Hand Gesture Module

Hand gesture module can be prepared by a sensing device known as MEMS accelerometer than can measure the movement in three directions i.e. x, y and z. the relatively low cost accelerometer (ADXL 335) can be used for this.The accelerometer sensor senses the accelerating force (acceleration due to gravity or g) and thus gives a particular voltage for the x, y and z coordinate orientation thus the data is processed by the MCU unit and that provides controls to the wheel-chair. The basic block diagram of accelerometer is given in figure (2).

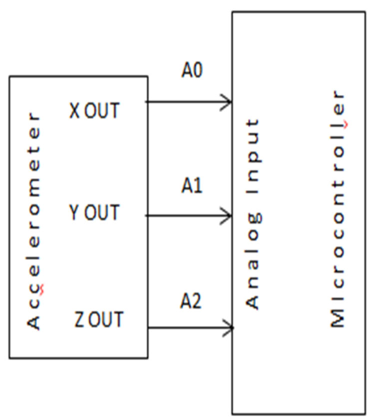

Figure 2:- Accelerometer outputs to microcontroller

The accelerometer sensor has specific values which are read as analog inputs by the microcontroller thus give controlling instructions the motors.

D. RF Module

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (TX /RX) pair operates at a frequency of 433 MHz an RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

E. Motor Driver

For the locomotion of the wheelchair we can use general DC motors as part of the model for the project. The motors are controlled by the bi-directional motor driver IC – L293D. The motor driver can be connected through the microcontroller on the wheel chair which sends the signal to the driver for the various conditions.

IV. RESULT AND EXPERIMENTATION

The prototype of gesture control wheel-chair has been shown in the figure. This wheel-chair has been tested by tilting transmitter attached on hand.

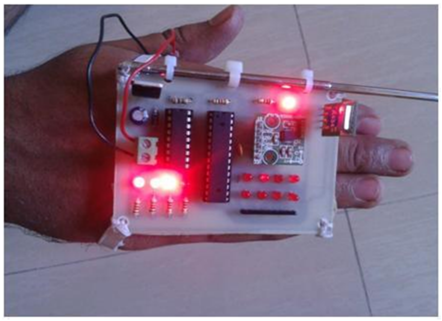

Figure3(a):- prototype transmitter

Figure3(b):- movement of wheel-chair

The receiver module controls the movement of wheelchair in four direction i.e. forward, backward, left direction and right direction. And if any obstacle present in the path of wheel-chair then the wheel-chair automatically stops.

V. CONCLUSION

In this paper, various types of assistive technology are discussed. The approach of every assistive technology was based, to the large extent, on the level of disabled person incapacity. Also we proposed a low cost, minimal invasive, low power consuming and easy to learn assistive technology using MEMS which provide smooth controls to wheel-chair in associated with microcontroller.

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