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Design and Development of Smart Wheel Chair using Voice Recognition and Head Motion

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ABSTRACT- The challenging problem faced by the paralyzed people is their independent mobility. They need an external help to perform their daily activities. Electric wheelchairs are designed to aid paraplegics. Unfortunately, these cannot be used by persons with higher degree of impairment, such as quadriplegics, i.e. persons that, due to age or illness, cannot move any of the body parts, except of the head. The main objective of this project is to provide an automated system for disabled people. The wheel chair will work based on the head movement of the user. The recognized gestures are used to generate motion control commands to the controller so that it can control the motion of the wheel chair according to the user intention. Design and development of Head motion controlled wheelchair has been achieved using MEM sensors and microcontroller. The system is implemented practically and works well. The MEM Sensor senses the change in direction of head and accordingly the signal is given to microcontroller. Depending on the direction of the Acceleration, microcontroller controls the wheel chair directions like LEFT, RIGHT, FRONT, and BACK with the aid of DC motors.

Keywords: Arduino microcontroller, DC motor, wheelchair,voice recognition, MEMS sensor.

I .INTRODUCTION

Quadriplegics are persons who are not able to use any of the extremities. The reasons for such decreased motion possibilities can be different: stroke, arthritis, high blood pressure, degenerative diseases of bones and joints and cases of paralysis and birth defects. Also, quadriplegia appears as a consequence of accidents or age. The patients with such severe disabilities are not able to perform their everyday actions, such as: feeding, toilette usage and movement through space. Depending on the severity of the disability, a patient can retain freedom of movement to a certain level by using different medical devices [1]. Mobility has become very important for a good quality of life. Designing a system with independent mobility for such disabled people is our aim in this project.

This system is an automatic head tilt movement controlled wheelchair that could operate in any direction using head movements, i.e. Forward, Backward, Left and Right. It stops when the person does not tilt his head in any direction. In this paper, a microcontroller system that enables standard electric wheelchair control by head motion is developed. The project describes a wheelchair for physically disabled people developed using head motion and MEM sensor which is interfaced with DC motors. The prototype of the wheel chair is built using a Arduino micro-Controller, chosen for its low cost, in addition to its features of easy erasing and programming. MEM SENSOR is a Micro Electro Mechanical Sensor can be used to effectively translate head movement into computer interpreted signals. For motion recognition the accelerometer data is calibrated and filtered. The accelerometers can measure the magnitude and direction of gravity in addition to movement induced acceleration. This project utilizes two DC Motors. The DC motor generates torque directly from DC power supplied to the motor by using internal commutation, stationary permanent magnets, and rotating electrical magnets, battery. The Microcontroller is programmed with the help of embedded C instructions.

II. METHODOLOGY

This project was implemented concentrating to design a power wheelchair which has both control systems for the disabled having just lower limb or both lower limb and upper limb injury as well as provide some therapy facilities to support them to gain their stain back. So the whole system is divided into two portions. First one is controlling portion whereas the other is therapy portion.

A.Controlling Portion

ITEAD joystick shield which sits on top of Arduino board was castoff for joystick operation and turns it into a simple controller. There are a joystick with button and additional 6 buttons. These buttons can be used as the replacement of joystick . Bestowing to potentiometer movement of joystick, an analog data is acknowledged through Arduino shield and the motors are driven rendering to the digital outputs provided by it for the four directional movements of wheelchair (forward, backward, left, right). As the operating voltage for both the Arduino board and joystick shield is 5V-12V dc, a 9V dc battery filled up the requirement. Person having permanent disabilities in upper limbs also part taking the option to use the chair via using voice command unit. An android phone and a Bluetooth module (HC-05) are the fragments of this module. HC-05 module is nothing but a Bluetooth SPP (Serial Port Protocol) component, which is premeditated for transparent wireless serial connection setup. The voice command (sound wave) from the user is collected through the microphone of the android phone and formerly this command is harmonized with some predefined command with the help of an android application. If both commands are the lookalikes then android application generates an equivalent character which indicates the users

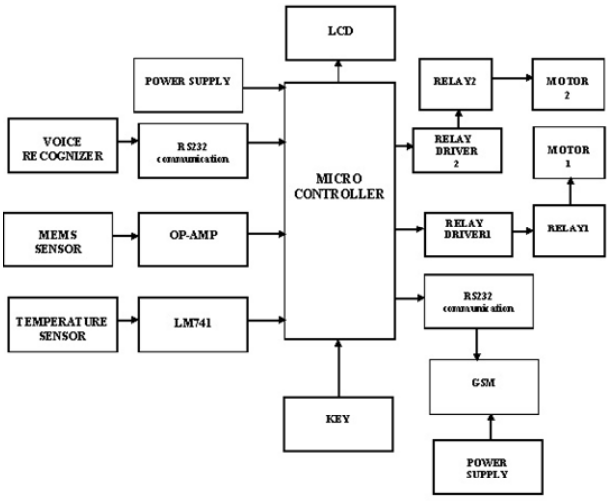


Fig.1.Over all Block Diagram

A. Therapy Portion

The therapy unit includes manually controlled weight loading, trunk flexors exercise and automatically controlled pulley system, vibration pad. The automatic pulley system is used for upper limbs due to left or right cerebral nervous system disorder .It helps the patient to regenerate blood circulation in upper limbs. We have used a servo motor (TowerPro MG995) which rotates within a specified angle. Its stall torque is 10.00 kg-cm and speed is 0.20 sec/60°. The rotational range is 180 degree. It can hold up to a 10 Kg weight . The motor makes a revolution of 180 degree to raise the hand. When the rotor rotates anti clockwise, it raises the hand and vice versa. In case of trunk flexors, the abdominal muscles may be worked by using 10-15 kg resistance, one to each hand. This has the effect of offering resistance to the abdominal muscles of up to 20-30 kg as the springs are being used in parallel or with the patient sitting holding a pole to which are attached two springs . Weight loading exercise increases strength and stability. For picking the flash card slot, there is an adjustment. The ADC (analog digital converter) yields sampling, quantizing, encrypting and adapting the analog audio signal into digital data and saves as files, which are the basic principles and methods of digital audio processing technology. Of course, throughout the playback, the digital data drives through the DAC, digital analog converter to reestablish the analogy signal form to be frolicked

out by the sound scheme. A specific switch is used to play an individual audio file adjacent to a particular therapy. When the user pushes one of the switches, he will get the procedure and benefits of prescribed therapy. This system can be also used for recreation or counseling purposes also.

III. ANALYSIS

The joystick provides analog value from 0 to 1023 in x & y axis which can be seen in serial monitor of Arduino environment. At the left most position in X axis, it gives 0 that is considered as LOW and right most position it gives 1023 that is considered as HIGH. Along Y axis at the upper most position it gives 1023 that is considered as LOW and lower most position it gives 0 that is considered as HIGH. At the central position for both X & Y axis the value is 512 to 516.The two Outputs of the joystick are connected to analog pin A0 & A1 of the Arduino. In algorithm, a threshold value of 1000 is defined in both X & Y axis to regulate right and forward movement. Any greater value than this in X axis gives the right movement and in Y axis gives the front movement. On the other hand, another threshold value of 10 is defined to realize the left and backward movement. Any value lower than this, gives left movement in X axis and back movement in Y axis. For voice command unit an android cell phone was used. An android app, named "Voice Recognition" was developed by the authors to receive the sound wave through the microphone of the phone, crisscross the matching with some predefined commands, and create some equivalent characters according to the commands.

For 'Front' it is 'F' while for 'Back' it is 'B'. Similarly for 'Left', 'Right' and 'Stop' these are 'L', 'R' and 'S' respectively. After receiving the characters by a Bluetooth module breakout (HC-05) [29], they are sent to Arduino MEGA [30] for accomplishing necessary procedures to drive the motor through motor driver circuit. Windows phone can be used instead of Android phone. Just the related app need to be developed in Windows platform. For constructing a power wheelchair, a manual wheelchair was modified by using two 12 Volts and 5A DC motors. The rear wheel' s radius is 0.35 m and RPM was 19 during the test drives. As manual wheelchair was modified, the structure was robust and bulky. Its weight is about 50 Kg. For the used DC motors, a wheel 's torque of 30.15 N-m is available which is able to carry a load of 93 Kg (considering the factors; surface friction for concrete surface 0.015, maximum incline angle zero degree, time required to achieve maximum speed 1s and frictional loss 10%). So a person of 43 Kg-weight can be carried by the chair. As for standard to carry a person of 70 kg-weight the required wheels'

In the test run, it is found that the motors can carry around 93 kg weight, but it have to carry at least 120 kg weight (assumed the patients weight is 70 kg). So the motors can carry only the wheelchair with additional apparatus not a person higher that 43 kg. However, the joystick shield is easy to use. The wheelchair can be moved easily only with the thumb movement. The switches are also works as good as a replacement of joystick. The voice control system works in the right way both in normal and noisy condition. User just has to raise voice level in noisy condition. The obstacle detection sensor also works properly. The detection distance is just one meter and the wheelchair stops after 0.4 meter. Besides these, all the therapy facility are comfortable.

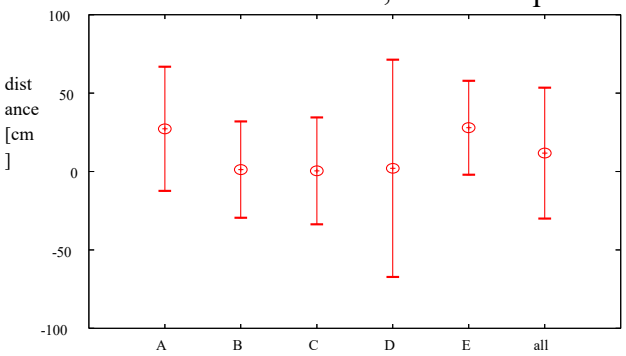
V.RESULT & DISCUSSION

Recognition experiment:

To evaluate recognition performance of Julian, we experiment speech recognition test with 15 students. The target words are nine reaction commands and five verification commands as shown in table 1.

This experiment is carried on in laboratory room. There were some voices of other people in the recording environment in the circumference. As the results, we obtained successful recognition rates of 98.3% of reaction command and 97.0% of

verification command, respectively.



Fig;2 Analysis Chart

Stopping experiment:

The action of this system executes until thenext command is give. For example, a wheelchair goes straight until stop or turn command is input. Then, we tested the following three experiments to verify the operation of our system. From two experimental results of ex.2 and ex.3, the braking distance of about 2m occurred until it actually stopped after stop command was input. This is the reason why two seconds are necessary for the recognition processing and the display of the result. The running speed is 1.8km/h, and our system runs 2m in 2 seconds. This distance supposed with the specifications of the voice controlled wheelchair though it can expect that the braking distance decreases by making improvement in the performance of the laptop and the low running speed. Here, the braking distance was about 50cm when button operation is used without using the voice input. Running experiment in the corridor

The next experiment is a running experiment. This experiment was carried out with same five persons of previous experiment. A running place was in the corridor of campus, and the width of the corridor was about 2 m, and one obstacle was put on the hall of the corridor. We set two courses A and B as shown in figure 8. The total distances of course A and B were about 16m and 13 m, respectively.

The experimental running time, the number of basic reaction command and the number of short moving reaction command are shown in table 2. Because a little moving distance operation of the course B is more necessary than the course A, there is more input of the short moving reaction command in the course B. Though the person E is one of the authors and he is control the system in a practiced operation, every person is almost running at the same time.

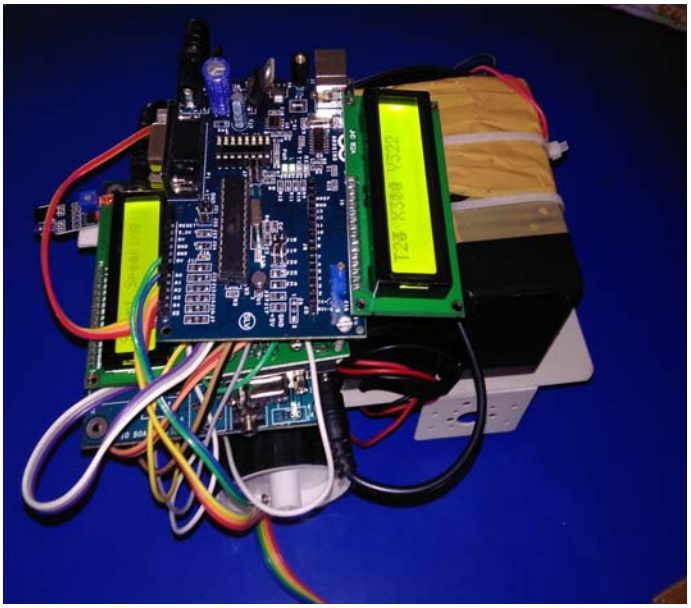


Fig 3.Snopshot of our Designed Module

VI.CONCLUSION

. In this project, Arduino based joystick wheel chair was developed with therapy facilities and obstacle detection. Besides joystick, voice control method through Bluetooth module also implemented for the person having upper limb injury. This wheel chair is more efficient and cost effective compared to other methods of control. Different types of therapy facility create a new revolution with this automated system. This system is very useful for a developing country like Bangladesh where most of the peoples are unable to effort the costly therapies from specialists of doctors. With the help of Government this system can be improved and implemented to a higher scale so that the poor and middle class family members can aim such type of system for their welfare and treatment

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