MOVEMENT BASED WHEELCHAIR CONTROL FOR PHYSICALLY CHALLENGED HEAD

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Abstract

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. Medical devices designed to help them are very complicated, rare and expensive. In this paper a microcontroller system that enables standard electric wheelchair control by head motion is presented. The system comprises electronic and mechanic components. A novel head motion recognition technique based on accelerometer data processing is designed. The wheelchair joystick is controlled by the system's mechanical actuator. The system can be used with several different types of standard electric wheelchairs. It is tested and verified through an experiment performed within this paper.

Keywords: Micro-electromechanical systems (MEMS), Medical devices, Motion recognition, Inertial sensors, Wheelchair, Quadriplegia, Novel algorithm.

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. In this paper, a microcontroller system that enables standard electric wheelchair control by head motion is developed. A prototype of the system is implemented and experimentally tested. The prototype consists of the digital system (an accelerometer and a microcontroller) and a mechanical actuator. The accelerometer is used to gather head motion data. To process the sensor data, a novel algorithm is implemented using a microcontroller. The output of the digital system is connected with the mechanical actuator, which is used to position the wheelchair joystick in accordance with the user's command. Sensor data is processed by a novel algorithm, implemented within the microcontroller. Thus, user head motion is translated into electric wheelchair joystick position. The mechanical actuator is compatible with several different types of standard electric wheelchair.

II. LITERATURE REVIEW

Various methods have been proposed for allowing disabled persons, including a quadriplegic to control a motorized wheelchair. There are proposed methodologies in recent times which involve various gestures like hand gesture, accelerometer & voice controlled, EEG based system etc

A. Motion Recognitions

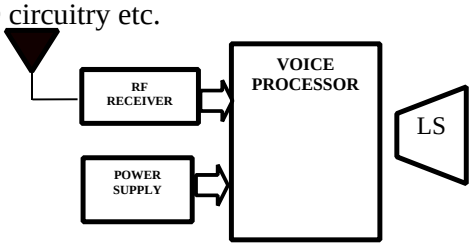
Motion recognition is a process in which a receiver recognizes user's motion. In this context, motions are expressional movements of human body parts, such as: fingers, hands, arms, head, face, legs. The purpose of these movements can be information transfer or the interaction with the environments

B. Accelerometer and Voice Controlled

This work describes a wheelchair for physically disabled people & developed it using voice recognition kit and MEMS motion sensor. User dependent voice recognition system had been integrated in the wheelchair. In this way they had obtained a wheelchair which can be driven using both motion and voice commands.

III. BLOCK DIAGRAM OF PROPOSED SYSTEM

The system consists of major components like PIC Microcontroller 16F877A with 8K Flash memory, Sensor MEMs MMA 7260Q, Two DC Motors of 195rpm and 20V DC supply, Driver L293D, PWM Circuit, Reset Emergency circuit, ADC, Crystal oscillator, LED circuitry etc.



IV. DESIGN DETAILS

Arduino:

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or aTwitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructionsto the microcontroller on the board. To do so you use the Arduino programming language(based onWiring), and the Arduino Software (IDE), based on Processing.

Motor driving (H-Bridge):

Generally, L293D motor driver can control two motor at one time or called is a dual H-Bridge motor driver. By using this IC, it can interface DC motor which can be controlled in both clockwise and counter clockwise direction.

Gear motor:

A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction.

Temperature sensor:

LM35:- The LM35 series are precision integratedcircuit temperature sensors, whose output voltage is linearly proportional to the temperature in degree centigrade.

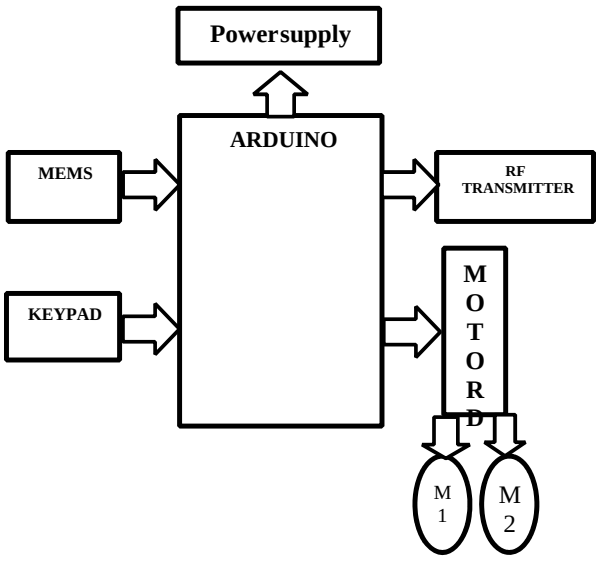
Voice processor:

The APR9600 is a good standalone voice recorder or playback IC with non-volatile storage and playback capability for 32 to 60.It can record and play multiple messages at random or in sequential mode. The user can select sample rates with consequent quality and recording time trade-off. Microphone amplifier, automatic gain control (AGC) circuit, internal anti-aliasing filter, integrated output amplifier and messages management are some of the features of the APR9600 chip.

RF Transmitter and Receiver:

RF transmitter:

The ASK (Amplitude Shift Keying) type Transmitter tuned at 433MHz frequency gets the data out pin of HT 12E encoder IC. There 8 number of address lines & number of data lines are present in HT 12E. The data on D0-D3 pin transmitted serially & available at data O/P pin. A RF transmitter of 433MHz have a pin of data in now the serial data from HT 12E is given to this pin. The respective Vcc(5V) & ground pins are connected . An antenna terminal is connected



to a Telescopic antenna. If the I/P data for HT 12E is 0001 (Binary) the D0-D3 bits transmitted serially & 433MHz transmitter transmit these

bits in the form of RF waves through an transmitting antenna.

RF receiver:

HT 12D Decoder decodes the serial data to parallel & it is available at D1- D4 data bits the oscillating resistor of 51K is connected to its oscillating pins (pin 15 pin16) Pin 17 is considered as going high when Transmitter starts generating & sending RF wave the pin 17 is connected to a transistor & an LED which glows & indicates the link between Transmitter & Receiver. If a data bit of 1010 is applied to the D0-D3 of HT 12E is Transmit serially. Transmit 433MHz & now through Transmitter& Receiver receives the data bits & HT 12D decodes the serial data bits to parallel & the same data i.e. 1010 is available at D1-D4 pins of HT 12 D.

V. MODEL DESCRIPTION

The circuit model works on the wheels of chair switching relays & motors with MEMS sensor placed on patients head. MEMS is used to send tilt signal to the wheelchair i.e., left or right or front or back. These tilt signals are passed to the controller as instructions. According to the program written for the controller, controller will give instructions to the wheelchair via relay. Here relay acts as a switching circuit. According to the relay operation wheelchair will move in that corresponding direction. If both the inputs to the Motor Driver are low and high at the same time than the motor is in halt position. If the first output is high, Second output is low then DC Motor moves forward. If the first output is low, second output is high then DC Motor moves reverse.

A. No load Condition

This includes wheelchair operation with no-load on it. The wheelchair is moved in forward, reverse, left & right directions for a distance of 4 meters controlled by head gestures in the above mentioned directions for testing its behavior. The response of the system is observed and tabulated as shown in Table 1.

B. With load Condition

Wheelchair is operated with a patient's weight of 30kg & 60kg respectively on it. The wheelchair is observed to move in forward, reverse, left & right directions as per the head gestures for 4 meters of testing. Also the movement is tested for emergency stop if the Reset switch is pressed. The observations are tabulated in terms of Distance vs. Time.

VI. CONCLUSION AND FUTURE SCOPE

From the above obtained results, we conclude that the developed head gesture based control of wheel chair is tested and works satisfactorily in an indoor environment with minimum assistance to the person suffering with Quadriplegia or Paraplegia. It has a good response with MEMS activating the motors connected to the wheels of the chair. The response and distance covered by wheelchair can be further improved if the gear system connected to motors are replaced by crank and pinion joint which has less friction and mechanical wear & tear. In future we would work on this concept to improve the response and embed more sensors like proximity, ultrasonic, GPS to guide the impaired person in much more better way and use this wheel chair even under outdoor conditions.

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