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Head Motion Controlled Wheel Chair using MEMS

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Abstract: Traditional Wheelchairs though have certain limitations with the flexibility, heavy weight of the chair and limited functions. Tremendous developments have been made in the field of wheelchair technology. However, even these significant developments couldn't aid the quadriplegics to navigate wheelchair independently. Medical devices designed to help the Paraplegic and Quadriplegic patients are very complicated, rarely available and expensive. We aim at designing a simple cost effective automatic wheelchair using MEMS technology for quadriplegics with head and neck mobility. The control system translates the position of the user's head into speed and directional control of the wheelchair. The system is divided into two main units: MEMS Sensor and programmed PIC Controller. The MEMS 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: MEMS sensor, DC Motor Driver, PIC Controller.

I. INTRODUCTION

According to a study conducted by Christopher & Dana Reeve Foundation, nearly every 1 person in 50 is suffering from paralysis due to damaging of nervous system. This figure approximates to 6 million people worldwide and has increased by 33 percent from previous estimation. Quadriplegics are persons who are not able to move their body except head [1]. 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.

In this project we intend to construct a cost effective design to build wheel chair for quadriplegic people who find it difficult to move independently. Another significant requirement is that a wheelchair has to respond rapidly and operate efficiently to the commands of the user, independently of the method used for giving these commands. For human-machine interaction human motion recognition is also used. 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 MEMS motion sensor which is interfaced with DC motors. The prototype of the wheelchair is built using a PIC micro-Controller, chosen for its low cost, in addition to its features of easy erasing and programming. Automation is the most often spelled term in the field of electronics [1]. The anxiety for automation brought much advancement in the existing technologies. One among the technologies, which had greater developments, is the MEMS ACCELEROMETER SENSOR. These had greater importance than any other technologies due its user-friendly nature. MEMS ACCELEROMETER 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 [2].

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. This Microcontroller is capable of communicating with input and output modules [3]. The controller is interfaced with dc motors through relay driver circuit. The dc motors are fixed to the wheel chair to control the direction of the wheel chair.

II. PROPOSED MODEL

The Wheelchair operates with head or hand movement, taking motion as an input signal for the movement of wheelchair in a particular direction. An Accelerometer (Motion Sensor) is used to track these motions. This sensor is fitted to cap on head. The variations of the sensor are trapped and those signals are fed as inputs to the micro -controller.

Now based on these variations the micro-controller is programmed to take decisions which in turn control the movement of wheelchair.

- When person tilt his head in forward direction, chair will move in forward direction.
- If person tilt his head in backward direction above, chair will move in backward direction.
- If person tilt his head in left direction above, chair will move in left direction.
- If person tilt his head in right direction above, chair will move in right direction.

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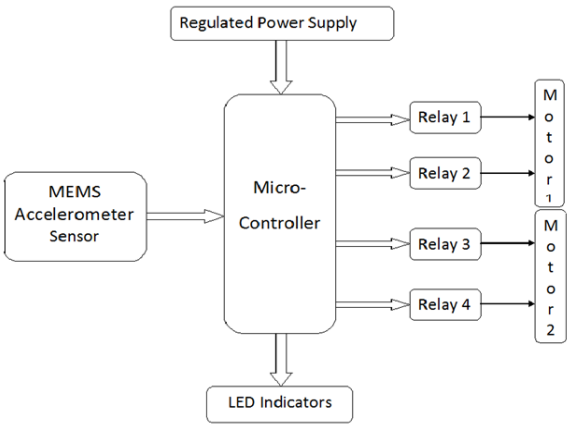
Truth Table representing the direction of rotation of motors is as shown below:

POSITION	MOTOR – 1	MOTOR – 2
FORWARD	CLOCK WISE	CLOCK WISE
REVERSE	ANTI-CLOCK WISE	ANTI-CLOCK WISE
RIGHT	CLOCK WISE	ANTI-CLOCK WISE
LEFT	ANTI-CLOCK WISE	CLOCK WISE

BLOCK DIAGRAM:



HARDWARE DEVELOPMENT:

- **MEMS Accelerometer Sensor:**

In this project wheelchair is operated using head motion and to sense the head motion MEMS accelerometer is being used. Micro Electro Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. Because of their small size and weight, accelerometers are fixed in the cap to sense the head movement. In this model we are using MMA7260Q accelerometer, which is 3axis accelerometer**.** The MMA7260Q operates on 2.2 to 3.6VDC, and uses very less current (500uA). It has three analog outputs, one for each axis. Acceleration on each axis generates a voltage from 0 to approximately 3.3V [4][5].

- **PIC Microcontroller:**

The PIC16F73 CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C73B/74B/76/77, PIC16F873/874/876/877 devices. It features 200ns instruction execution, self programming, an LCD, 2 Comparators, 8 channels of 8-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port. The major blocks of PIC Microcontroller are program memory (flash), EEPROM, RAM, CISC, RISC, Central Processing Unit, Free-Run Timer, ports.

- **Regulated Power Supply:**

A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The components mainly used in power supply kit are 230V as mains, step down transformer, bridge rectifier (diodes)**,** capacitor filter**,** voltage regulator(IC 7805)**,** resistor**,** LED (light emitting diode).

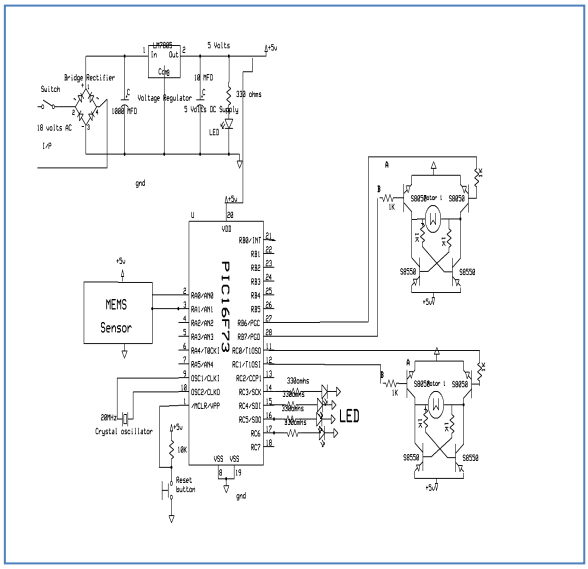
- **DC Motor Driver:**

Relay Driver Circuit is designed to control the load. The load here is motor to drive the wheels of the wheel chair. The motor is turned 'ON' and 'OFF' through the relay. A relay is nothing but electromagnetic switching device which consists of three pins namely common, normally closed and normally open.

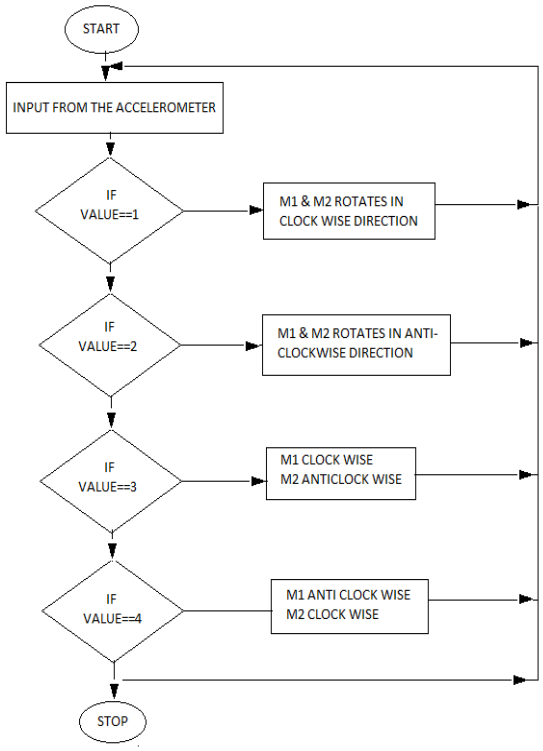
- **DC Motor:**

Here the Motor used for driving the wheel-chair is Johnson Motor. The advantage of these kind of motor is they are light in weight, consumes less power and is highly efficient to drive loads of minimum 5Kgs. These also can be easily driven using Solar energy (Photo-Voltaic Panels).

CIRCUIT DIAGRAM:



FLOW CHART:



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FUTURE SCOPE:

- This project can be extended by using a heart beat sensors to this system. Heart beat sensor continuously monitors the heart rate, which can be designed such that alarm horns if the heart level goes beyond set level.
- We can make a wheelchair which can be operated by a wireless remote. Output of sensor can be applied to wireless transmitter circuit and can received at wheelchair circuit by receiver circuitry. So wireless operation can reduce wiring arrangements.
- Instead of using acceleration motion (Head Movement) we can use eye retina using optical sensor to move wheelchair in different direction. Using retina movement we would be able to drive a wheelchair.
- We can use voice command IC to interface our voice signals with microcontroller. The voice stored in IC could be sufficient to analyze speakers voice Command [6].
- Researchers are going on development of handicap wheelchair using nervous system of human. By including GPS, position of the wheelchair can also be known. Wheel chair can be fitted with direct mind reader.
- The designed wheelchair can be extended using solar panels which is more efficient. Solar panel itself energizes the wheelchair. But only the drawback is setup of panel and also weight of chair increases.

III. CONCLUSION

In the race of man versus machine, head motion controlled system comes as an example of companionship of man and machine. In this paper a technique of head motion recognition is used to enable wheelchair control for quadriplegics. This system gives independent movement and a psychological advantage of being independent. To avoid physical hardship an accelerometer is used due to which the slight movement of head turns the wheelchair into the desired direction. Some training is essential to use the accelerometer as its quite sensitive but in the end there could not be a better use of technology for an individual who is deprived of the same physical strength. A prototype of this system is experimentally tested. A larger number of errors appeared when the user makes free head motions which can be reduced to a certain extent using an enable switch. It is designed to be characterized by low price and higher reliability.

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