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Accelerometer Control of a Smart Wheelchair for the Automated Transport and Retrieval System

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Abstract **– The recent development promises a wide scope in developing a smart wheelchair. Today's world works on automation. Everything around us is getting automated. Considering the increase in demand of automation, we are designing a complete automated accelerometer based device control. This article presents a smart wheelchair which controls the wheelchair using accelerometer. It measures the linear acceleration in the x, y, z directions based on the movement the device. In this system, by just showing some head gesture which will be sensed by accelerometer. In this project, we are designing a system which will respond to our head gesture. The system comprises of an accelerometer mounted on operator's head.**

Keywords **– Wheelchair, Accelerometer, IR Sensor, DC Motor Driver, Physically Handicapped.**

I. INTRODUCTION

According to a study conducted the patients who are involved in physical injuries and disabilities in the world are shown in the fig. 1. This figure approximates to 6 million people worldwide and has increased by 33% from previous estimation [1]. The causes of Paralysis are mainly due to spinal cord injury stated in the figure.

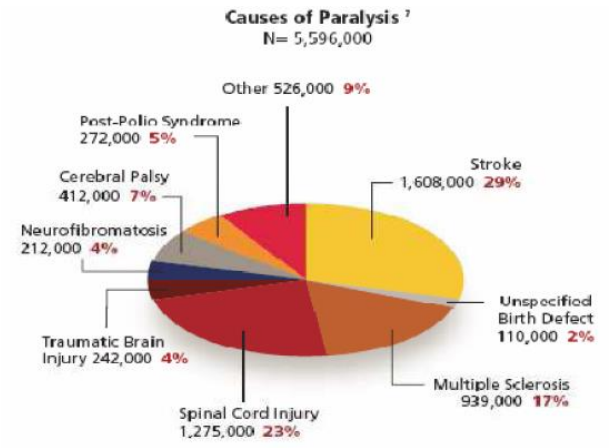

Fig.1. Pie chart showing the causes of paralysis

In [1] which it shares the vehicle control decisions by joystick, obstacle avoidance by ultrasonic sensor, safe object approach protection for the patient includes security of the patient on the wheel chair, the maintenance of a straight path and other navigational issues. In [2] This proposal is of a concept of the wheelchair which consists of two camera which are used to sense the width of the corridors. This concept enables an economic assembly in any wheelchair that enables a smart system for automated motion which can be controlled by accelerometer. The concept particularly mentions 3 axis accelerometer, LCD display, DC motor driver, two way switches, IR sensor and an ARM 7-based processing unit .To avoid accident we have added a pulse rate sensor that can be set-up to the wheelchair. Generally the pulse rate of an ordinary person is 72 bits/min. If the pulse rate increases or decreases nearby 72 bits/min then the signal will make the wheelchair to halt immediately at current position and it will activate the alarm system. This will tend others to know about the situation and position of the patient. In this project, we are designing a system which will respond to our head gesture. The Line follower is designed for the blind patients to relocate from one place to other. IR sensor will sense the path and will follow accordingly. The system is programmed in such a manner that by showing some predefined head gesture the load interfaced will be controlled by the accelerometer accordingly.

II. SYSTEM DESCRIPTION

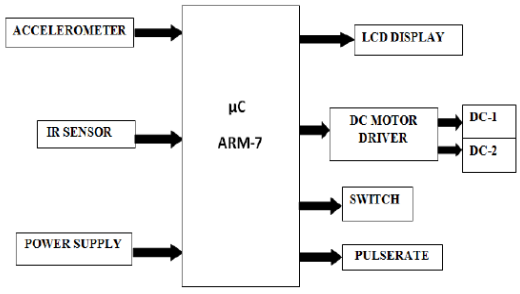

Fig.2. System diagram

III. Related Work

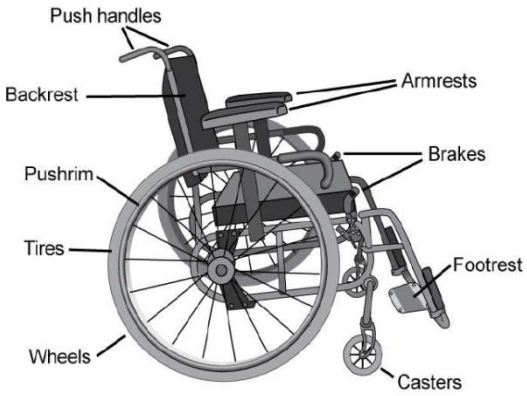

Fig.3. A design concept of a hand-operated wheelchair.

The paper consist proposal of a smart accelerometer based wheelchair. Fig. 3 shows the design concept of the hand operated actual wheelchair. The above proposed concept is that it takes advantage of the 3 axis accelerometer technology enabling patients to move their wheelchair by just tilting the accelerometer or the head gestures. The execution for this concept is controlled by an ARM processor for powering a basic DC motor for directional motion for the wheels. The ARM processor is preprogrammed to take a decision for any given input. The ARM processor outputs its decision to motor driver to move forward or backward, turn left or right, target identification. The power supply can be achieved by rechargeable battery which is also charged using the alternator during the motion of the wheels. As it is observed generally, the pulse rate of an ordinary person is 72 bits/min. So to avoid this problem and with the aim of preventing such accidents, it is proposed to develop a highly efficient automatic system. If the pulse rate increases or decreases nearby 72 bits/min then the signal will make the wheelchair to halt immediately at current position and it will activate the alarm system. This will tend others to know about the situation and position of the patient. Thus the detection of patient will be known to others and will help in eliminating the risk of accidents from occurring. It is the main sensor used to relocate from one place to another.

IV. Literature Survey

Several approaches [2-3] have been presented on the concept of the wheelchair with different ideas. The various approaches were done in [2] which were as it shares the vehicle control decisions by joystick, obstacle avoidance by ultrasonic sensor, safe object approach protection for the patient includes security of the patient on the wheel chair, the maintenance of a straight path and other navigational issues. [2] It is well suited to the joystick but less suited to the voice control.

Accordingly to study a dynamic model and design a suitable dynamic controller is useful for increasing the tracking performance in a real situation. [2] It consists of a navigation system of line tracer. This application of the technology it is used for the blind person by selecting the destination and the patient can reach the destination. [2] This proposal consists of two mode; (1) Manual mode (2) Automatic mode. In manual mode joystick is used to navigate and relocate in left and right direction. In Y direction will result in the variation of speed. In Automatic mode two camera are used to sense the width of the corridors. This proposal has drawback as it consist of a color cameras which obtains images and transmits them to an on-board laptop computer. So the wheelchair tends to be very bulky and hence it is costly. [4] Used Voice control system to control the locomotion of the wheelchair. They store the default commands in the PIC IC (micro controller) by the usage this commands the wheelchair can move. Change in the words restricts the wheelchair movement. They used eyebrow muscle activity to obtain required signal. By using the signal the wheelchair movement has been controlled as the movement of the eyebrow was not easier so it had some difficulties. [5] Used head and finger movement for wheelchair locomotion. In finger movement they use flex sensor, placed on the finger. It is analog resistors usually in the form of strip long vary resistance. Due to the bending of finger the resistance varies which controls the locomotion of the wheelchair. Bending the sensor at one point more than 90 may permanently damage the sensor which is a main drawback.

V. Methodology

The methodology used for the project is the Accelerometer technology for making the project innovative in it.

A. Accelerometer:

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic caused by moving or vibrating the accelerometer.

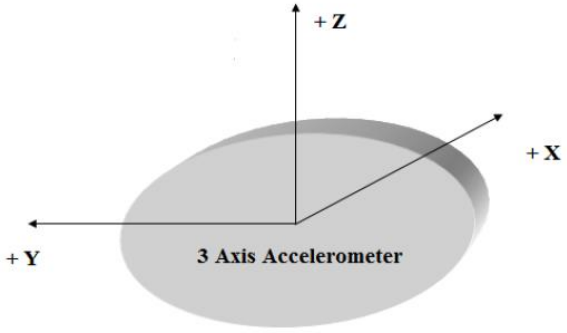

Fig.4. shows the 3 axis accelerometer

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The ADXL335 is a small, thin, low power, complete accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package.

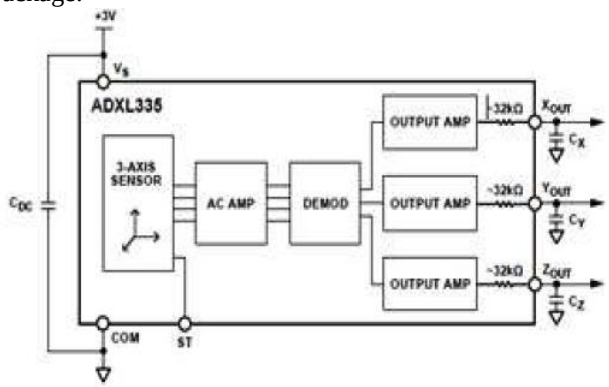

Fig.4. Block diagram of ADXL335

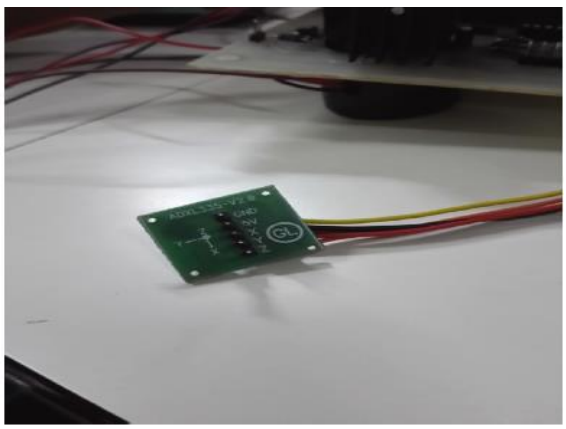

Fig.5. ADXL335 Accelerometer.

B. Tilt Sensing Using a 3-AxisAccelerometer

Accelerometers are sensitive to both linear acceleration the local gravitational field. The former provides on taps; while the latter provides information on the accelerometer orientation which allows wheelchair to to move accordingly. This application note documents the mathematics of orientation determination using a three accelerometer. The techniques are applicable to both digital accelerometers and, after signal digitization, to accelerometers. For convenience, it is assumed accelerometer is mounted on head any product with an embedded three- axis accelerometer.

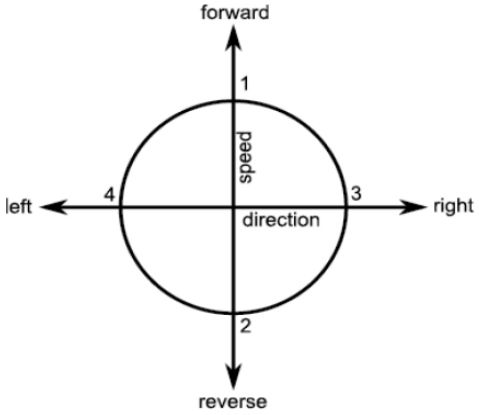

Fig.6. Joystick's axes interpretation: 1) full speed forward, 2) full speed reverse, 3) full speed clockwise spin, 4) full speed counterclockwise spin.

C. Physical simplified Module Using Accelerometer

It consists of a three-axis accelerometer sensor MMA7660FFC with sensitivity +/-1.5g, with digital output. It is interfaced to the control unit by I^2C (Inter Integrated circuit) protocol. It is low cost and has high shocks survivability (10,000 g). It has low current consumption (0.4 micro Amp) and low power consumption analog voltage (2.4v-3.6v) and digital voltage (1.71v- 3.6v) > It has an auto sleep / wake feature for low power consumption. Tilt orientation detection can be done accurately. [6] scale Accelerometer consists of a M g-cell and a signal conditioning ASIC contained in a single package. The sensing element is sealed hermetically at the wafer level using a bulk micro machined cap wafer. The g- cell is a mechanical structure formed from semiconductor materials (polysilicon) using masking and etching processes. The sensor can be modeled as a movable beam that moves between two mechanically fixed beams as shown in Fig 7. Two gaps are formed. One being between the movable beam and the first stationary beam and the second between the movable beam and the second stationary beam. The ASIC uses switched capacitor techniques to measure the g-cell capacitors and extract the acceleration data from the difference between the two capacitors. The ASIC also signal conditions and filters (switched capacitor) the signal, providing a digital output that is proportional to acceleration.

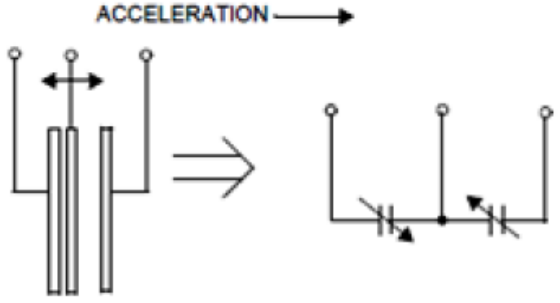

Fig.7. Physical Simplified model of accelerometer

D. LPC2138 ARM 7 microcontroller IC

ARM 7 IC is the heart of the smart automated wheelchair. A LPC2138 ARM 7 IC is a programmable device [7] that can be used to perform any arithmetic and logic operations. The difference between a microcontroller 8051 and a ARM 7 IC is the availability of internal memory to store the program code and it can function as a standalone controller. The need for ARM 7 IC in this concept design involves receiving data from the working of servo or DC motors. Also ARM 7 has Von Neumann architecture.

The ARM 7 IC is a 64-bit microprocessor based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ARM 7 IC achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

It is programmed in such a way to control the servo and DC motors. It is also the cheapest and most widely used controller. As we employ only simple operations this controller is sufficient. The main reason for employing this controller is its low power consumption and ease in the coding. The supply is drawn from the batteries which are used to run the motors. The output of the controller just indicates the motors that are to be activated are. The output ports are coupled to motors via the relays and based upon the controller output, the corresponding motor rotates to move the wheel chair in the desired direction

E. DC Motor:

This motor follows linear laws of operation and because of this it is easier to fully exploit its characteristics compared to synchronous or asynchronous motors. Many applications call for a high start-up torque. The D.C. motor, by its very nature, has a high torque vs. falling speed characteristic and this enables it to deal with high starting torques and to absorb sudden rises in load easily. The speed of the motor adjusts to the load. Furthermore, the D.C. motor is an ideal way of achieving the miniaturization designers are constantly seeking because the efficiency it gives is high compared with other designs. The specifications of the DC motor as per the market and technical specification surveyed by us are 12v DC, 90 W,10 RPM having a weight of 200kg which will be very efficient and reliable for the weight of any patient of any age to for the starting torque.

F. IR SENSOR

An infrared sensor [8] [9] is an electronic device that emits and/or detects infrared radiation in order to sense some aspect of its surroundings. Infrared sensors can measure the heat of an object, as well as detect motion. Many of these types of sensors only measure infrared radiation, rather than emitting it, and thus are known as passive infrared (PIR) sensors.

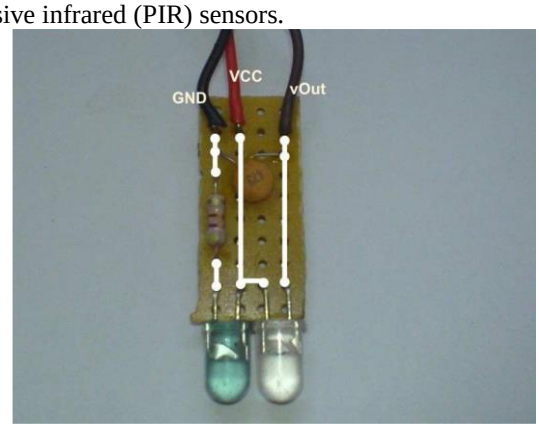

Fig.8. IR sensor

VI. RESULTS

Here the various results obtained in different stages of the work can be. As it is a combination of different modules, they have been checked individually. And the results are as shown below on LCD display.

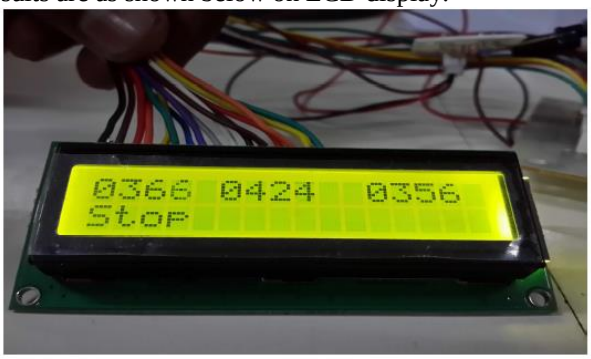

Fig.9. Co ordinate x, y, z values respectively of the accelerometer when not tilted

Fig.10. Co ordinate x, y, z values respectively of the accelerometer when tilted in forward direction.

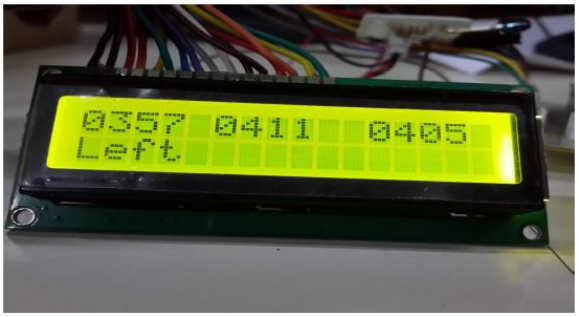

Fig.11. Co ordinate x, y, z values respectively of the accelerometer when tilted in left direction.

Fig.12. Co ordinate x, y, z values respectively of the accelerometer when tilted in right direction.

Fig.13. Co ordinate x, y, z values respectively of the accelerometer when tilted in backward direction

VII. ADVANTAGES

- The use of accelerometer makes the system user-friendly.
- Can be made compatible for all normal wheelchairs.
- Eliminates the use of wires to control.
- Accelerometer gives accurate data.
- Efficient way for wheel chair navigation less time delays.
- Quick response time fully automate system.
- Robust system, low power requirement.

VI. CONCLUSION

As the accelerometer based automated system has been presented which would be very helpful for physically challenged persons and for the persons who cannot move their body except head. Also those who are blind can switch to path follower mode and can relocate from one place to other. Recent improvements in the development of the smart wheelchair are making lives easier for everybody. Our work is to control Wheelchair by accelerometer where the wheelchair is programmed to reacts according to the motion of accelerometer (forward, reverse, stop, left and right) and use path follower for those people who cannot see. The movement is recognized by ADXL335 is used to control the motion of the Wheelchair. Also the accelerometer sensor is calibrated such that it produces particular analog voltage for a corresponding tilt.IR sensor is used for the path follower hence eradicating the issue of the blind people and physically disabled patients.

FUTURE SCOPE

The goals of this project were purposely kept within what was believed to be attainable within the allotted timeline. As such, many improvements can be made upon this initial design. That being said, it is felt that this design represents a functioning miniature scale model which could be replicated to a much larger scale.

- Automatically recharging the battery using alternator during movement of the the wheelchair.
- Various security systems for the patient can be impended which can alarm the nearby people if when required.
- Also by using voice recognition system, this project can be implanted.

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