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A Smart Wheelchair Prototype Based On Hand Gesture Control

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Abstract: Wheelchair has been an important assistive device and the demand are ever rising because of the increasing physically handicapped and old age populations. The recent development in the robotics artificial intelligence extends vast scope for developing the more advanced and intelligent one to overcome limitations of the existing traditional wheelchairs. The prototype smart wheelchair were present on this paper using hardware implementation with the help of simple hand gesture which is comprises of an accelerometer mounted on the hand glove senses the tilt angle of the user hand movements and transmits control signal to the receiver mounted on wheelchair. This will interpret the movement accordingly required by user. The wheelchair control unit is developed by integration of ATMEGA328 microcontroller with Arduino UNO. The wheelchair is developed to allow peoples to move safely and put reliability in accomplishment of some important tasks in daily life.

Key words: *Smart Wheelchair; Hand Gestures; Accelerator; Arduino UNO*

INTRODUCTION

In recent time, overall of peoples in the world, approximately 1.85% of them require a wheelchair especially from the group of elderly and disabled people. With the world population keep increasing each day, there is an additional need for wheelchairs every day. Wheelchair is the best device in assisting people to enhance their personal mobility in everyday life. So that, elderly and disabled persons can find it convenient to move and maneuver around using the help of a wheelchair which can either be pushed by another individual or propelled either by physical force manually or electronically. As we know, traditional wheelchairs have some limitations in context to flexibility, bulkiness and limited functions [1]. Here, we are approaching in a smart way to allow the users to use the movement of hand gestures and synchronize them with the movement of the wheelchair. This kind of wheelchair can be use with such an ease on all kinds of conditions and terrains in a comfortably handling without giving much problems.

Most of us already heard about an alternative for an electric wheelchair that controlled by a joystick. Although this kind of electric powered wheelchair is a much improvised machine and an easily controlled device, but it might not help for some severely disabled person. Some common observation and also experience shows that a joystick requires a relatively large force to control it with bare hands alone. Contemplating constrains and the incredible cost of wheelchairs accessible in the market, this venture depicts the plan of a practical and a less demanding to-control wheelchair. In this project, we present an approach method for controlling to move a mechanized wheelchair just by the gestures of fingers. The venture in this beginning time was restricted to control of the wheelchair by the signals created by one hand. It goes for consolidating the present day methods for wheelchair elements and control and in the meantime making it savvy, with the goal that it is reasonable to the regular masses.

RESEARCH RATIONALE

Melaka Polytechnic is just a small institution with a small campus. For diploma students in the Electrical Engineering Department, many subjects were taught over a period of three years and mostly all of them were carried out in classroom for theory class and in laboratory for practical works. Between learning process in class and laboratory, none of them were found sufficient enough in giving a good example of applications based on theory that have been learned because almost all equipment in laboratory were just a trainers and panels kit. Hence, this prototype of a smart wheelchair based on hand gesture was introduced to complement classroom and laboratory teaching in providing the extra application needed on the basis that

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self-learning could enhance the understanding of students.

This project aims to find out whether the *A Smart Wheelchair Prototype Based On Hand Gesture Control* was able to help students in applying some basic concept of certain electrical subject related. So that eventually it could help to improve their overall understanding and increase their knowledge in learning process.

REVIEW OF RELATED LITERATURE

The advance of technology in the field of Wheelchair innovation is at its age. It's not astounding to see that a great deal of work has been done in the field of wheelchair innovation. Initially there were the manual wheelchairs' then the electric fueled wheelchairs and now there are Smart Wheelchairs. The outline of a 'Motorized Chair' that vehicles human inside the limits of a house is accounted for by Desai and Endrele [2]. A 'Motorized Chair' comprises of a seat with the two engines and a joystick controller. A microcontroller yields the speed and course to the engines. Most wheelchairs are controlled from their back wheels. The front wheels react and pivot in understanding to the back wheels. As the controller is moved, the smaller scale controller detects the development, do the counts for power and heading and the engines move as needs be. An engine control circuit controls the speed and the course of pivot of engines.

The principal glove model was produced in Massachusetts Institute of Technology (MIT) in 1977. The principal glove to utilize numerous sensors was offered by the "Computerized Entry Data Glove‟ which was created by Gary Grimes in 1983. It utilized diverse sensors mounted on a cloth [2]. For motion of gesture acknowledgment one of the main items that came in the market was Nintendo's power glove which was discharged in 1989. These days many projects are creating in the premise of hand motion innovation. Wheelchair in view of hand gesture innovation is a standout amongst the most mainstream extends these days [3]. Additionally the data gloves are growing like never before some time recently.

H. Kazerooni et al. [5] give an account of the improvement of a gadget called 'The Magic Glove'. The 'Magic Glove' is a glove with an extensive variety of utilizations in the field of applied instrumentations. The glove measures the force applied by the wearer of a material handling robot. Once the force is detected and measured, it is communicated to the controller. The capacity of the enchantment glove is to enable the client to apply an insignificant constrain of force on an object while transporting it starting with one place then onto the next. The human itself or the wearer of the gloves just mimics the actions to be done, while the real lifting and setting is left for the actuator to be finished. Radio Frequency (RF) innovation is utilized to transit the signals from the glove to the microcontroller. Zimmerman et al. [6] additionally give an account of the advancement of a comparative hand to machine interface device. It is basically a glove that gives and provides ongoing signal of real-time gesture, position and data of orientations.

Different methods for the progression of wheelchair innovation have been examined and analyzed herewith. It is evident that the control of a wheelchair can be additionally enhanced by the blend of various advancements, for example, the consolidation of an instrumented glove, subsequently trading the requirement for joysticks and making a free controller, which is less demanding to-control and convenient in the meantime, for the end user.

RESEARCH DESIGN AND DATA GATHERING PROCEDURES

This research comprises of an exhaustive report of studies, analysis and also the control law used to handle this smart wheelchair. Additionally, included in the methodology is a study about the working of the Micro Electro-Mechanical System (MEMS) known as accelerator sensor. MEMS is the integration of mechanical components, sensors, actuators, and electronic hardware on a typical silicon substrate through micro fabrication technology. An accelerometer is an electromechanical device that measures the forces of acceleration or the speeding up strengths. MEMS accelerometer is a solitary chip with little size and minimal effort in cost. In view of their little size and weight, accelerometers are easily joined to the fingertips and back of the hand of the user [4].

In this system, it comprises of two main parts, a transmitter part and a receiver part. In transmitter part the hand motion is perceived by the sensor, advanced yield of digital signal is transmitted to the controller and after that transmitted to recipient side of receiver by the RF transmitter. Fig. 1 demonstrates the piece diagram of the transmitter unit. Similar information is gotten at receiver side by the RF beneficiary. DC Motors which are interfaced to the controller by the motor driver controls the bearing of the wheelchair movement. Fig. 2 demonstrates the diagram of the beneficiary unit.

A. Transmitter on Hand-Glove

The accelerator ADXL335 sensor mounted to the hand glove will initiates the process of sensing the tilt angle of the user hand movements and provides an analog output and must be converted to digital output. For this purpose four channel LM324 comparator circuit is used. By setting the reference voltage, the digital signal is received and the signal is sent to the encoder HT12E to encode data in a series. Then the data is sent to the receiver circuit using a RF transmitter.

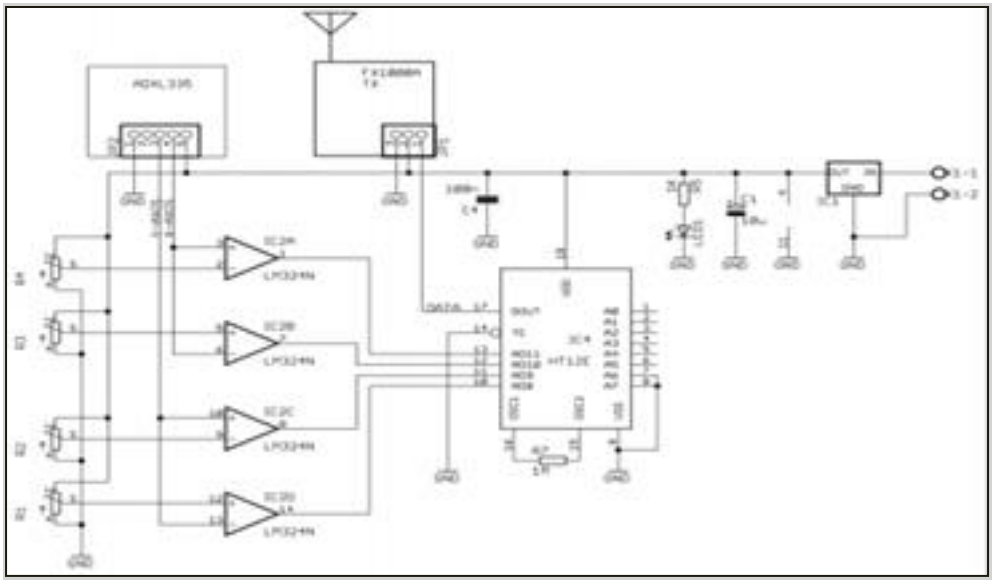

Figure 1. Transmitter Circuit Diagram

Accelerometer (ADXL335) is a low power thin 3-axis accelerometer with the signal conditioned voltage outputs device which senses the tilt and gesture of any movements including human. The user has to select the bandwidth of the accelerometer using the Cx, Cy and Cz capacitors at the Xout, Yout and Zout pins. The bandwidth can be selected to suit the application desired, with a range of 0.5Hz to 1500Hz for the X and Y axes, and a range of 0.5 Hz to 550Hz for the Z axis. The Operating voltage of ADXL335 is 3V and it operates within 1.8-3.6V and also the sensitivity at Xout, Yout, Zout is 3V. The ADXL335 has no external filter to consume signals noise and it Operating Temperature range is -40 to 85 ° [6].

B. Receiver on Wheelchair

In the receiver circuit, the RF receiver is used in receiving signal data and then sent them to the decoder HT12D. The decoder will converts the serial data into parallel and then reading it using Arduino ATMEGA328 microcontroller. Transmission through RF is superior to IR (infrared) as a result of many reasons. Right off the bat, motions through RF can travel through bigger separations of distances making it reasonable for long range applications. Likewise, while IR for the most part works in observable pathway mode, RF signals can travel notwithstanding when there is a deterrent between transmitter and collector. Next, RF transmission is more solid and dependable than IR transmission. RF correspondence utilizes a particular recurrence of frequency not at all like IR signals which are influenced by other IR radiating sources.

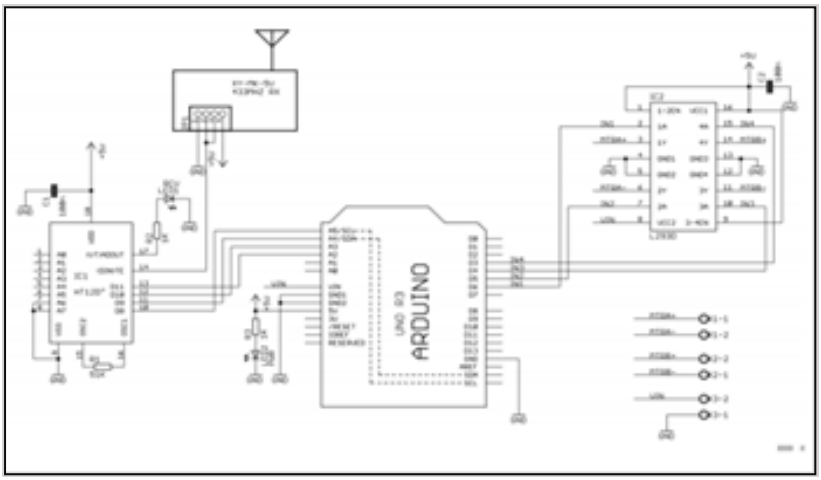

Figure 2. Receiver Circuit Diagram

C. Concept

The concept of this project is based on hand gesture technology in order to remote wireless wheelchair. Firstly, the accelerometer detected hand gestures then the analog signal transmitted to microcontroller. After processing the signal, the microcontroller will send the data to wireless module and transmitted the signal to receiver. The microcontroller will recognize the signals from wireless module in the getting reception apparatus and sent it to the motors via motor drives. Then the wheels rotated by the direction of the hand gestures to move the wheelchair accordingly. The accelerometer basically has three axes. Thus, the wheelchair can move in three directions of axis, X, Y and Z. But the most important of this project is to control the wireless wheelchair using hand gestures. The flowchart of this wheelchair control system as shown in Figure 3.

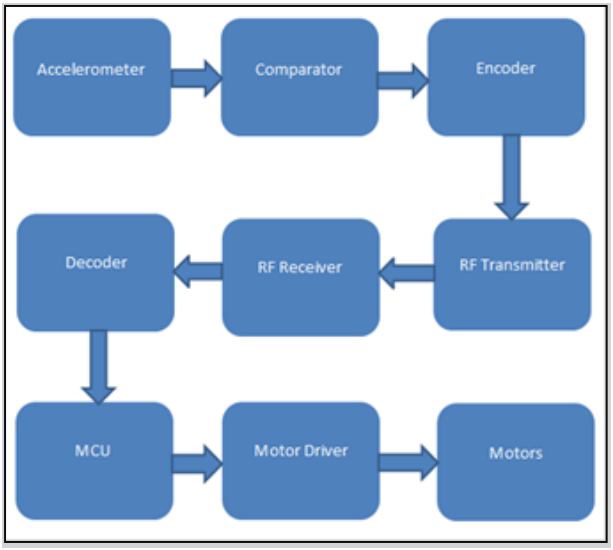

Figure 3. Flowchart of Wheelchair Control System

DATA ANALYSIS

The point of this venture result is the sensor is proficient to distinguish the tilt and makes utilization of the accelerometer to alter the course of the wheelchair relying upon tilt. In the event that the tilt is to the correct right side then the wheelchair moves right way or if the tilt is to another side then the wheelchair moves left way. Wheelchair developments can be controlled in Forward, Reverse, Left and Right heading as appeared in the Table 1.

Hand Gesture	**Input From Arduino**				**Direction**
	D1	D2	D3	D4	
Stable 0^0	0	0	0	0	No Movement
Bend To Right 45^0	0	0	0	1	Right Movement
Bend To Left 45^0	0	0	1	0	Left Movement
Bend To Backward 45^0	1	0	0	0	Reverse Movement
Bend To Forward 45^0	0	1	0	0	Forward Movement

Table 1. Algorithm Setting For Wheelchair Direction

Table 1 shown the control algorithm for the wheelchair and in order to explore that , a simple system for wheelchair control based on the recognition of the gestures, performed by the arm of the user has been designed. The system memorizes the same arm posture for further referencing to it as the stable gesture or "neutral position" after the recognition of the start gesture. The wheelchair is driven by the electric motors during the gesture of control mode. The motors do not work and the wheelchair does not move when the arm is in a neutral position.

The wheelchair movement direction can be set by moving user hand away from the neutral position. To rotates the wheelchair to the right, the hand of the user need to move to the right. To rotate the wheelchair to the left, the hand of the user need to move to the left. Bend the hand to backward causes reverse wheelchair movement, while the bending of the arm to forward causes a forward movement. The wheelchair direction can be controlled easily by changing the position of the user's hand. The wheelchair stops when the hand of user returns to the neutral position.

RESEARCH FINDINGS

During the test, the wheelchair would move right or left when the hand were bent around 300 to 450. The maximum speed of the wheelchair is around 10 m/s. This prototype will having difficulty to move forward when facing with obstacle and collision of the route. Moreover the braking system is only depends on the hand to move forward and backward. When tests are done on a flat road, there are not many problems faced by the wheelchair. But there is a problem when the test is done on a downhill road where the brake system needs to be streamlined again. Likewise the problem occurred on the downhill road this problem will be investigated and corrected in further study.

The prototype model on this smart wheelchair is shown in Figure 4.

Figure 4. Prototype Model of Smart Wheelchair

REFLECTION AND CONCLUSION

A design and development to facilitate disable peoples was an extremely encouraging thing. The use of intelligence and equipment skills in engineering can help people towards a good quality of life. In this paper, a smart wheelchair prototype based on hand gesture control was proposed and has been developed in order to assist and give alternative better control to people with severe disabilities. In addition to hand gesture movements, to improve the project various methods can also be used such as foot, head, even body or eye movement. Further research will overcome the problems of the system braking for this wheelchair.

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