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Low Cost FGC Electric Wheelchair

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Abstract

This paper represents the design of an Arduino based gesture controlled automated wheelchair. The design is developed with a gesture recognition system, which allows the physically disabled person to control the wheelchair by slight moment of finger who have issues in hand movement due to ageing or paralysis for joystick-controlled wheelchairs. The design also provides some additional features such as obstacle detection for the safe movement. To implement the design, Arduino Mega2560, ultra-sonic module, and motor controller circuits are used to drive the wheelchair. The designed wheelchair system does require a wearable sensor for obtaining the finger motion to control wheelchair movement (i.e. Accelerometer sensors). The proposed structure is relatively simple and cheaper that can benefit a huge population of ordinary people to have an automated wheelchair.

Keywords: FGC(Finger gesture controlled) electric wheelchair, Arduino, Gesture controlled, Gesture recognition system, Ultrasonic Module

1. Introduction

Wheelchair is the most widely used mechanical device all over the world, which is used by physically disabled patients or aged people to move. For normal wheelchair, the user needs a supporting person or self-assistance by hand to move on. Statistics show that around 650 million people which is about 15% of the world population are suffering from some sort of physical disability [1]. With the growing number of population, the number of physically disabled and elderly patients is also increasing as well as the demand of automated wheelchair exist.

Due to technological development, joystick controlled motorized wheelchairs are widely available throughout the world [3]. In developing and under developing countries, these wheelchairs are neither very much available nor much cost effective [10]. Moreover, for handicapped/paralyzed people having issues with hand movement, this type of wheelchair is not suitable as it makes hard to control the joystick. Furthermore, patients who become very weak due to ageing have weak wrist face the same. Therefore, several researches are still going on to replace the necessity of joystick in controlling wheelchair movement.

The following literature reports that the revolution of automated electric wheelchairs began after the introduction of it back in the middle of 20th century by George Klein for the World War II veterans [2]. In 1986, Arizona State University, U.S developed an autonomous system that used machine vision to identify landmarks and center wheelchair in hallway[3]. TinMan KIPR, U.S. developed and marketed some joystick controlled wheelchairs [3]. At the same time University of Osaka, Japan also developed an automated wheelchair using image processing and some other algorithms [3]. During the end of 20th century and start of 21st century, some more prototypes of automated wheelchair were developed [3]. After that in between 2004-2013, several techniques and

designs have been proposed and developed. Among the most reported techniques are eye movement signal (EOG) controlled, EEG controlled, EMG controlled and tongue-controlled wheelchairs [4-8]. However, the developed techniques necessitate a wearable sensor system and include complex signal processing methods with additional computing devices which are mounted on the wheelchair. Some of the data processing techniques are still on the research level [9].

The proposed technique aims to design a gestor controlled automated wheelchair by using the available technology which reduce the need of extra bulky complex data processing unit (i.e. laptop). The input is given by a wearable gloves containing accelerometer and an Arduino microcontroller that are easily available in the market, cheaper and smaller in size. The remaining parts of the report describe the operation of gesture processing module and the motor controller circuit with an estimated cost analysis.

2. Objective of work

The objective of this project is to analyse and to make a motorized wheelchair based on extensive fact findings and research on existing models, technology used, market scenario and customer requirements. The course of our work begins with the planning phase involving initial research, literature review and background study. It is followed by concept generation phase that includes evaluating customer requirements, outlining specifications and generating concept designs. Next comes the system level design in which product architecture is defined and parts are modelled in CATIA. The fourth phase is detailed design phase where we focus on design for assembly and manufacturing and simulation in virtual environment. In the final phase, we progress towards prototyping and testing a feasible model.

3. Need of project

Approximately 20 million people in our country suffer from various disabilities. About 11 million of them are locomotors disabled. The pervasiveness of locomotive debility is uppermost in India–at 1,046 per 100,000 people in the rural areas and 901 per 100,000 people in the urban populace. Low literacy, unemployment and widespread social stigma are the causes of such disturbing figures. The best way to empower the masses to deal with disabilities is through organizing awareness programs and conveying employable assistances. Government agencies and NGO's are working in the direction of advanced policy and frameworks for the incapacitated. India's wheelchair market is a nascent market with double digit growth rate.

Today in India many people are suffering from disability, there are people whose lower half of the body is paralyzed and this paper reveals the benefit of finger gesture controlled wheel chair using accelerometer as sensor to help the physically disabled people in moving from one place to another just by moving the finger. This Wheelchair will add to the comfort and make the life of people bit easier. Also making this wheelchair easily affordable for middle class people.

4. Technology used

In this Gesture Controlled Wheelchair an ADXL335 accelerometer is used as a sensor implanted to the gloves giving analog signal on moving it in X, Y, Z axis respectively. The accelerometer is connected to HC-05 Bluetooth module that transfers the signal to Arduino uno (I.e. master).

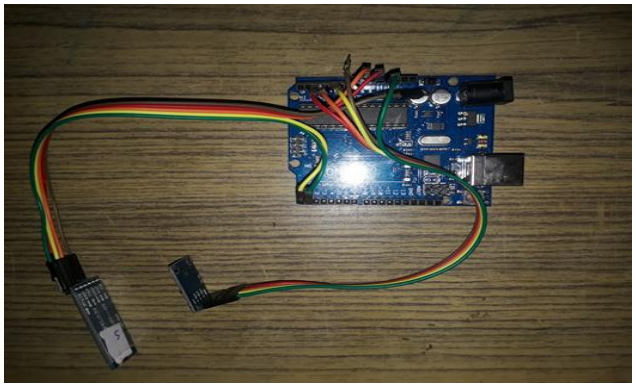
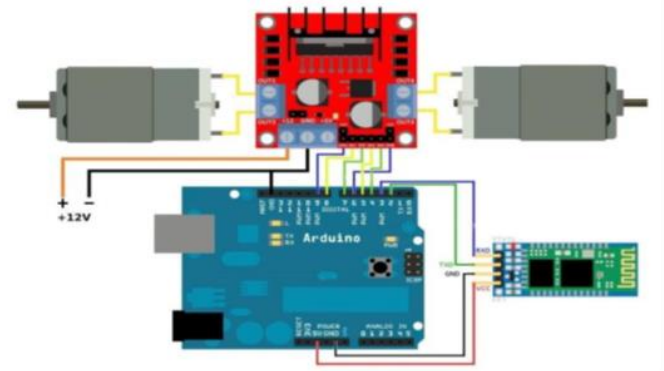


Fig.1. Hand gesture circuit with accelerometer and Bluetooth module

After the signal is being sent. Now the slave receives the signal and is being processed by Arduino Mega. After receiving the input signal Arduino Mega compares the data which is preinstalled in the controller. If the input data matches the preinstalled data then the signal is given to MDDS30. On receiving the signal the

MDDS30 gives signal to DC motors for motion.
To prevent accident, a Ultrasonic sensor (HC-SR04) is connected to the motor driver (MDDS30) which halts the wheelchair when it encounters an obstacle.



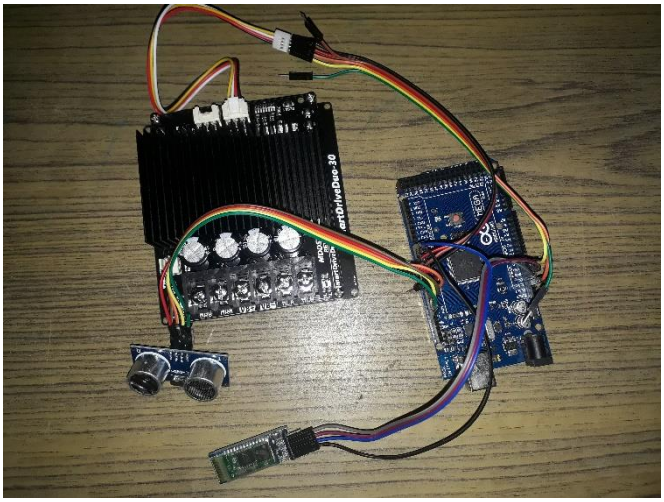


Fig.2. Drive System

5. Motor used

The motor used in the wheelchair is permanent magnet 24-volt DC motor of 17 watt. During no load condition each motor consumes 0.73 ampere current while on full load each motor consumes 9.61 ampere of current. The motor has inbuilt gear to increase the torque, the motor's shaft moves at a speed of 60 rpm. These motors are used in viper of the truck and cars they can work in any hostile terrains, like the mountains or the deserts and advantage of using this motor is that they requires very less maintenance in comparison to other motors.[10]

6. Wheelchair control

The accelerometer (ADXL335) value for the respective configuration of the model can be graphed to find the gesture and the direction of the index finger. The pitch, roll and yaw of each direction are graphed below by experimental data extraction method.

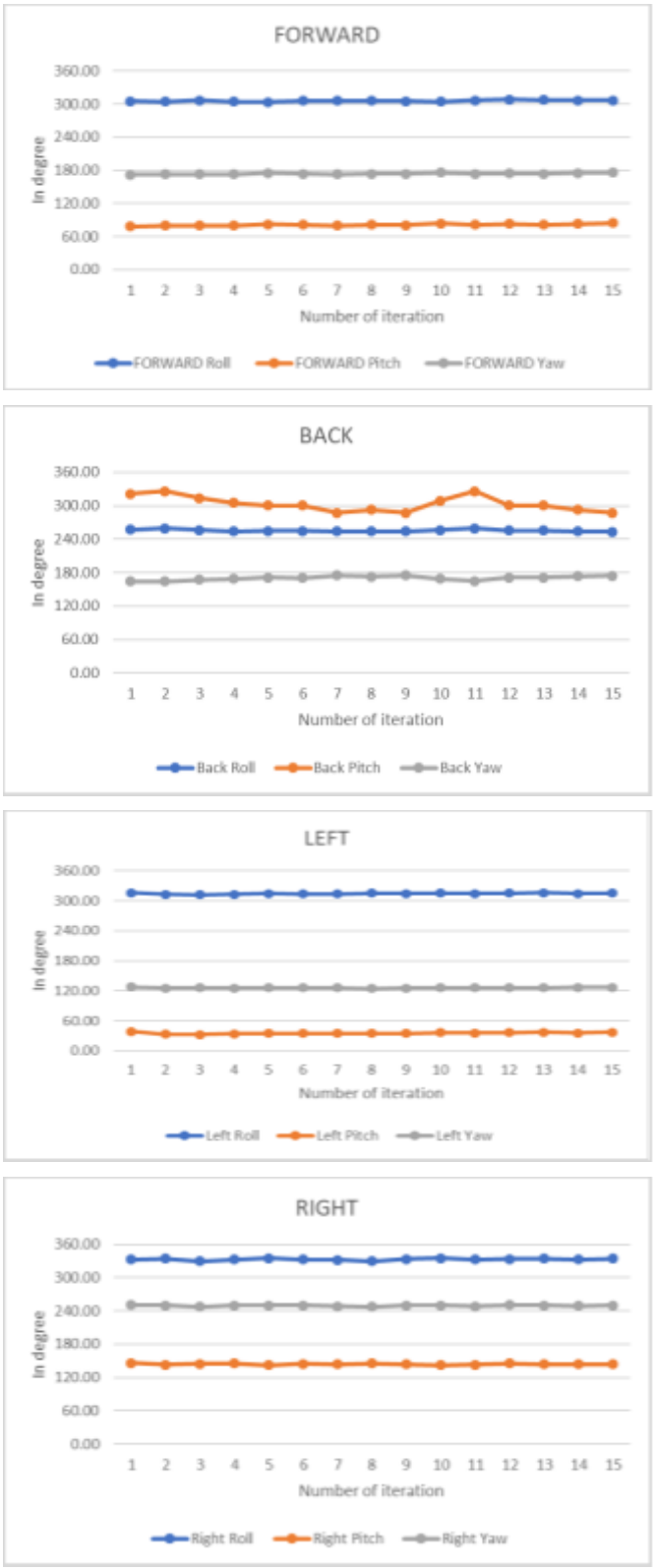


Fig1. The graph represents the direction and the value of roll, pitch and yaw of the index finger

7. Wheelchair design

The wheelchair has been designed using CATIA V5 and the required edition of the original structure is done to obtain a concurrent model. All the design was made to scale.

Fig.3. The CATIA model for the wheelchair

Fig.4.FGC Electric Wheelchair

8. Scope in future

This technique can also be used with speech and brain signal recognition which will be very useful to people whose whole body is paralyzed. Also, by including sensors like IR sensor, ultrasonic sensor, touch sensor the safety of user and wheelchair can be ensured. Further system like GPS system can also be implemented to know pinpoint location of person in wheelchair by using GSM module and an SMS can be sent to predefined number in case of emergency.[10]

Conclusions

As this paper aimed in developing an automated wheelchair for domestic use by middle class people. Gesture controlled was the main focus in its structure and mechanism. All the measures are taken to make wheelchair as cheaper as possible. The design was fabricated for an approximate cost of 24000 INR.

This wheelchair can withstand load of 110Kg and can move at a speed of 7 kmph to 12 kmph. It's very easy for the user to control the wheelchair due to the finger gesture control. Digital Mock-ups of individual parts were developed in CATIA and assembled to form the final product. Wheelchair is embedded with some additional features like movable armrest, after gathering costumer requirements from different subjects.

Acknowledgement

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