SNAPPY WHEELCHAIR

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering.

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APPROVAL

This Project titled "Snappy Wheelchair", submitted by Gunjon Roy ID No: 152-15-5722, Animesh Adhikary ID No: 161-15-931 and Md. Ashraful Alam ID No: 151-15-466 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 10th December, 2019.

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DECLARATION

We hereby declare that this project has been done by us under the supervision of **Tajim Md. Niamat Ullah Akhund, Lecturer, Department of CSE**, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

According to the Bangladesh Bureau of Statistics 2011, almost 8 lac people are physically challenged. Among them, about 1.5 lac are from urban areas and the rest of the people from rural areas. Lots of challenged people need a wheelchair to move. By the Snappy Wheelchair physically challenged person will be benefitted. Physically challenged person can move with it except whole body paralyzed person. Now it has two different controlling system. First one joystick control system and second one flex sensor control system. Challenged person who move only two fingers of their whole body, they also can control the Snappy Wheelchair with flex sensor control system. If anyone can move hand or single leg they can control Snappy wheelchair with joystick control system. And also, if anyone wants twice controlling system at a time he/she also can do it. Who need twice controlling system at a chair they have to press a switch to change one controlling system to another one controlling system. Snappy wheelchair can move forward, forward-left, forward-right, backward, backward-left, backward-right. Snappy Wheelchair save 50% among all of those automated/manual control wheelchairs which are available in the market. So, Snappy Wheelchair designed for those people with middle-class families also can buy and it comes with helpful features.

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Introduction

1.1 Introduction

This wheelchair is designed for physically challenged person. It will save 50% than the current smart wheelchair available in the market. It can be controlled by the user themselves with joystick or flex sensors which are integrated with the wheelchair. Who have only two fingers which are moveable they can also control the wheelchair by flex sensors controlling system.

1.2 Motivation

Bangladesh is a developing country. About 8 lacs of people are physically challenged and not able to buy a fancy Wheelchair. In the childhood of a challenged person family can help to move them but day by day when they getting adult and family can’t able to help them to move. They are also not capable to buy a smart wheelchair to move which available in the market. They usually perambulate by taking their guardian helps which is so painful and also tough. This is what bothered us and then we think about Snappy Wheelchair. Snappy Wheelchair will save more than 50% cost than available smart wheelchair. We think it will be possible for everyone. It integrates a battery, two control systems to move by electric motors. This wheelchair will help a challenged person perambulate themselves.

1.3 Objectives

This are objectives of the project:

- The Wheelchair can be moved 360 degree with Joystick.
- It can be controlled by any two fingers by flex sensors and wheelchair will move.
- A button included on flex mode to go backward.
- Changing controller mode from Joystick to Flex sensor mode.

1.4 Expected Outcome

- ✓ All physically challenged people can control it except full-body paralyzed people.
- ✓ Reducing cost.

CHAPTER 2

Background

2.1 Introduction

New technology brings the easiest method for human beings to reduce our cost and life complexity. Many challenged people are in trouble to move. For not to buy a smart fancy wheelchair. Because it cost too much high price to effort. And also, it is not available in our local market. Snappy Wheelchair will take poor peoples to get introduced with new technology because it is budget-friendly. It provides all the necessary features of a smart wheelchair. It can move forward and backward by both controllers.

2.2 Related Works

In the local market, there is more plenty of wheelchair. But those are a high budget wheelchair and also imported from another country which is actually cost so much.
Costing more than 1 lac people aren't able to buy that chair in every section in our countries people.

- This system was developed to reduce the controlling system to operate the wheelchair. And adding some features or systems to operate the chair for people wide-ranging impairments that limit their access to powered mobility. This nav chair based on a commercial wheelchair. The system is an ultrasonic sensor, the module to make a connection between the joystick and power module of a wheelchair. It is the result of mobile robotics research. This system share control human and machine automobility adapt to human behavior. [1]

- Detection and tracking of eye gait and the head motion were an active area of research. They serve a wide range of serious disabilities bypassing with minimal motor capacity. Various technologies have been proposed and used to implement different algorithms for both eye tracking and head motion detection. The amount of research is still trying to find more sophisticated more efficient applications. [2]

- In this paper the electric wheelchair control with gaze direction and eye blinking. The camera captures the image sequential capture image is interpreted to obtain the gaze direction and eye blinking properties. The eye blinking is used to provide the direction and timing command related to when the wheelchair should move. For safety purposes, when the user does not focus on direction, the wheelchair will stop moving. [3]

- The project-based on eye controlling system is more useful for the disabled persons. In his system controlling of wheelchair carried out based on eye movement. The camera is front-mounted to the user to capture the image of the direction of the eye left or right track of image processing techniques. According to eye wheelchair will move to left or right and forward direction. For safety purposes, the ultrasonic sensor will notify to detect any object.

  The project is very cost-efficient and the Raspberry Pi board allowed to access the system without the display unit. [4]

- Wheelchairs control voice-based project-based. It will work after speech recognition. The user will give commands and identify the wheelchair voice then the program will execute. Wheelchairs do not work on the basis of false speech recognition.

  There is a problem that the wheelchair collides with the wall and the voice command is interrupted by a delay. Then, our system implements CAF to prevent collision avoidance, whereby wheelchairs use two types of sensor information to avoid a wall or obstacle without voice commands. The CAF helps the user to control the wheelchair without any collision on the wall or barrier. [5]

- The project is based on a joy-stick which can control the speed and direction of the wheelchair. The wheelchair can provide a therapeutic effect and also can calibrate to provide lodgings at least three seating structure for a specific user. Such as

  i) Emergency data

  ii) Starting an alarm system

iii) Correcting the height of seats. [6]

- The project is based on finger movement tracking and speech recognition. There are two features in the wheelchair. In the project, a multi-control system is used to control the movement tracking system. And a vocabulary speaker is used to word acknowledgment. There is also used a digital signal processor for isolated word acknowledgment.
  The TMS320C6711DSP kit used for speech acknowledgment.
  There are also switches that are used to select the exact input signal source (Joy-stick or voice controller). [7]

Every section has drawbacks and some restrictions but, in our project, we tried to do our best with the cheapest price product in the market and make it less cost. We believe we can make it more accurate in future.

2.3 Comparative Studies

Purpose: The intention of our project to make a less costly smart wheelchair. So, the poor people of our country can buy it.

Design/Methodology/Approach: To build this project cost a bit than a manual wheelchair, but it has a more positive site than that. So, our plan is to spread this to all over the country with low budget people so they can buy it easily. We will try our best to reduce the cost and give it to them.

Originality/Value: This project actually made for the people who aren't able to buy those fancy wheelchairs. So, we can call it a budget-friendly smart wheelchair.

2.4 Scope of the Problem

- Helping poor physically challenged people to buy it.
- It can be controlled by Guardians.
- It can be controlled by only two fingers.

2.5 Challenges

- Fully paralyzed people can’t use this.
- A bit costly than a normal manual wheelchair.
- Need to recharge the battery.
- This is not a lite weight wheelchair.

CHAPTER 3

Requirement Specification

3.1 Control System Process Modelling

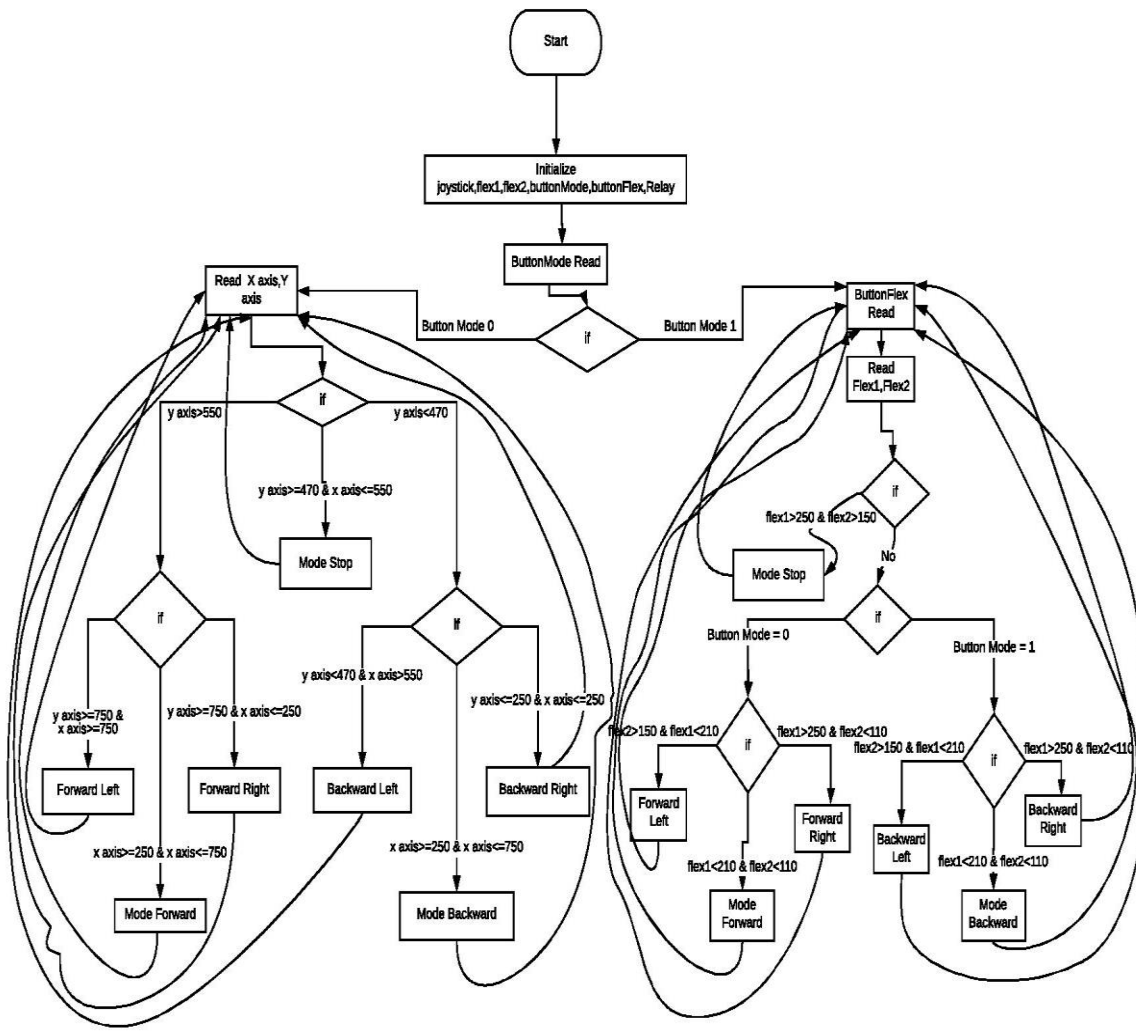

Figure 3.1: Control System Processing Model

3.2 Requirements Collection and Analysis

To complete this project there are some hardware requirement for different purposes. Some are given with shot descriptions and technical information.

3.2.1 GHP 250-Lbs Capacity PVC Mat Steel Frame Manual Wheelchair

GHP 250-lbs Capacity PVC Mat Steel Frame Manual Wheelchair 24 "Front Wheel Provides Comfort and Mobility in an Economic Package" Requires long-term use from temporary, operative use to the user, making the wheelchair easier to move in and out of the wheelchair and wheelchair more secure. There are swing-out wheels for protection On.
However, some customizations have been added to install some tools manually.

Figure 3.2: A manual wheelchair.

3.2.2 Arduino Uno Rev3

Arduino Uno SMD R3 is a microcontroller board based on ATMga328. It has 14 digital input/output pins (can also be used as PWM output), 6 analog inputs, a 16 MHz crystal oscillator, a USB connector, power port, ICSP header, and a button to reset the reset program. It included everything to support the microcontroller.

Figure 3.3: An Arduino Uno Rev3

3.2.3 Arduino Compatible X and Y Axis Joystick Module

This simple arrangement gives us X-axis and Y-axis control for the Arduino project. The board is interfaced with a 5-pin header and provides a small game-pad style joystick. There is also a push button when you lower the stick.

The features are:

X-axis and Y-axis provide analog output.

Push button provides digital output.

Figure 3.4: X-axis & Y-axis Joystick.

3.2.4 Flex Sensor

The flex sensor is a type of sensor that is used to measure the amount of deflection otherwise twisted. The design of this sensor can be done using materials such as plastic and carbon. The carbon surface is arranged in a plastic strip because the sensor resistance will be changed when this strip is removed. Thus, it is named a turning sensor. Since its varying resistance can be directly proportional to the amount of turn, it can also be used as a goniometer.

A typical Flex sensor increases the resistance across the sensor as the ".4" sensor is flexible Sp Patented technology by Spectra Symbol - They claim that these sensors were used on the original Nintendo Power Glove. I love Nintendo Power Glove It's bad!

The resistance of the flex sensor changes when the metallic pads are on the outside of the bend (the inner text of the bend).

The connector is 0.1 "spaced and breadboard friendly.

Figure 3.5: Flex Sensor

3.2.5 8-Channel 12V Relay Module

If anyone wants to switch 8 microcurrent / high voltage loads from a microcontroller, this 12V relay board can do this.

It has a 10A / 250V AC (DC 30V / 10A) rated 8 x 12V relay. Each relay is turned on or off by opt-in digital input that can be directly connected to a microcontroller output pin. It only requires a voltage of about 1.0V to switch inputs but can handle input voltages up to 12V. This makes it ideal for 5V and 3.3V devices.

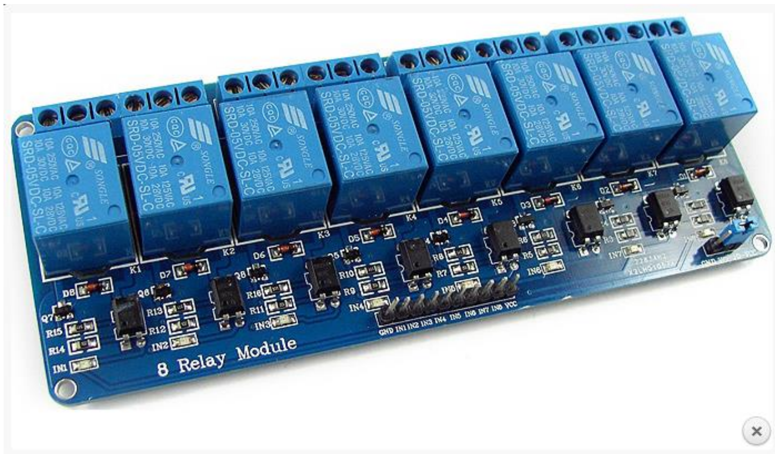

Figure 3.6: 8 Channel 12V Relay

3.2.6 Mini Breadboard

This mini breadboard is a great way to prototype small projects! There is ample space to create and test simple circuits with 3 tie○ points; They are great for breaking the DIP package IC into the jumper cable! If left out of the room, no worries, these mini breadboards can be spread together so that the board extends further. It has a peg and stick adhesive backing as well as two mounting holes for M2 screws so it can be anchored down.

Figure 3.7: Mini Breadboard

3.2.7 MY1016Z3 350W 24V Geared Motor for E Bike

This motor is great for making any type of custom electronic vehicle, whether it's a scooter, electric bike or something that is not ready for the world. This electric motor with gear reduction produces more lower-torque torque than the standard motor.

This motor is capable of rotating clockwise or clockwise by reversing the motor's power wires.

This is a 24V DC motor output 350 watts. And the speed is after 300 rpm reduction and the base speed is 3200 rpm. The current rate is 19.2MP.

Figure 3.8: 24v DC motor.

3.2.8 Power and mode changer Switches

These switches are used to make bridge and build connection.

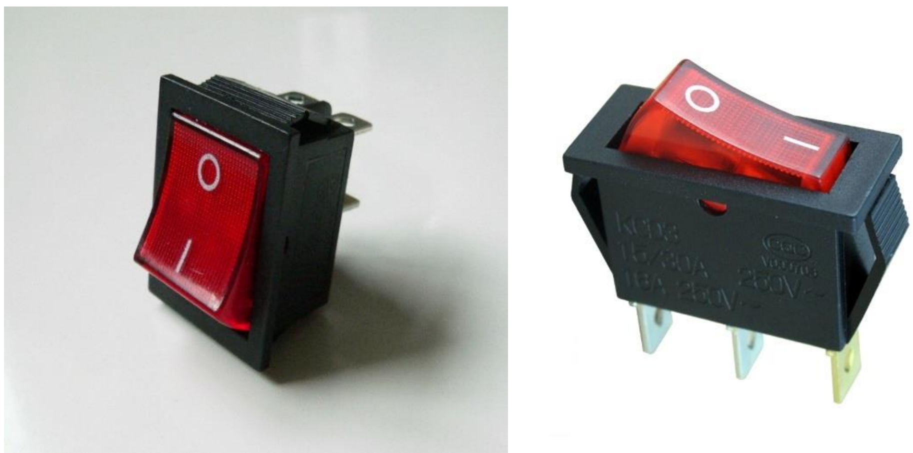

Figure 3.9: Power and mode changer Switches.

3.2.9 12v Battery

This 12v battery motor is used to drive 12v and 80-125 mpg.

This battery provides long-lasting performance and power. This battery is impact resistant, spill-proof and flame retardant. 12-volt, 140 Ah rechargeable sealed lead acid battery - fire retardant compatible or cross-referenced to replace.

Figure 3.10: 12v Battery

3.2.10 9v Battery

9-volt battery, is a common form of battery that was introduced for early transistor radios. It has a rectangular prism shape with rounded edges and a polarized snap connector on top. This type is commonly used in walkie-talkies, watches and smoke detectors.

Figure 3.11: 9v Battery

3.3 Use Case Modelling and Description

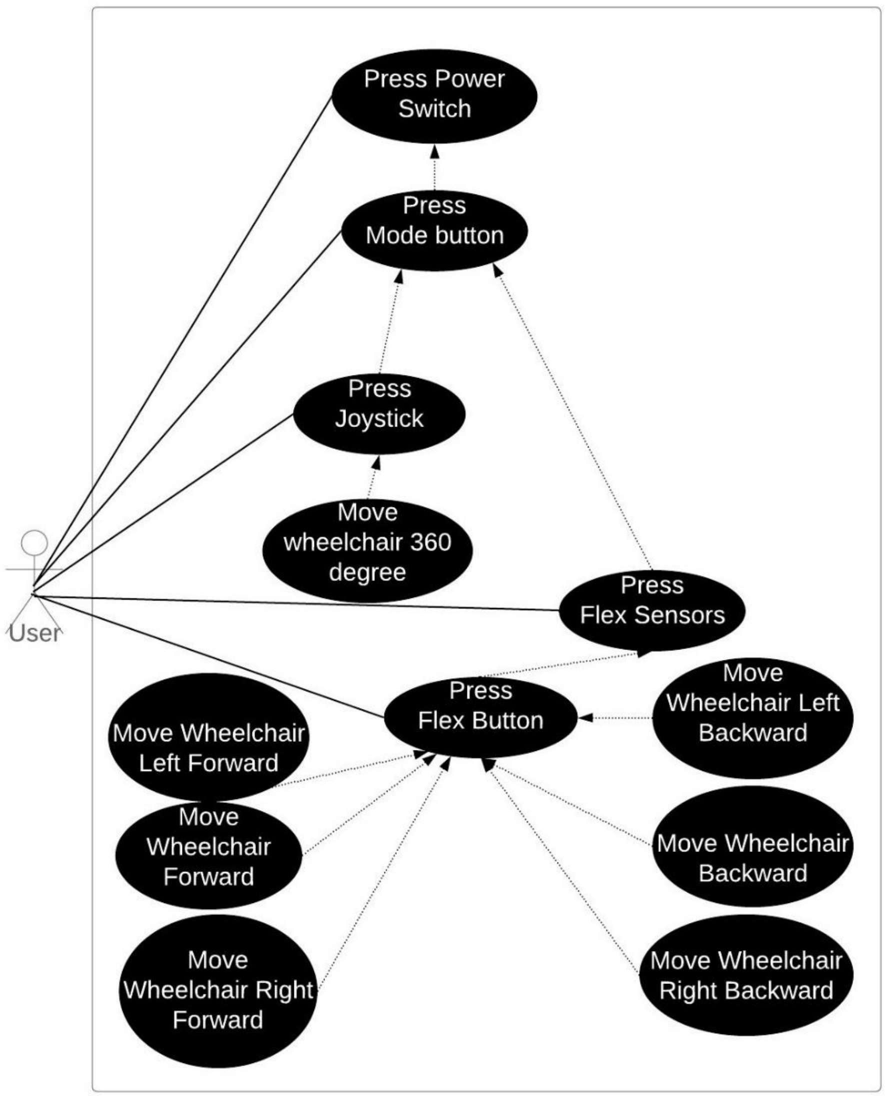

Figure 3.12: Use Case Diagram of Snappy Wheelchair

Description: Over the utilization of the project are working following this graph according to the on-screen character and system.

Actor: User.

Main Flow of the Diagram

The user can control the wheelchair by joystick and flex sensor. But the user has to use the switch to set up the mode in which the user wants to use joystick or flex. If the user switches to joystick mode the only joystick will be work and flex will be stopped. And if the user switch to flex mode only flexes will be work and joystick will stop working. With the flex, there is another switch included for the backward going process. By turning it on/off backward will work and stop. Normally it will work as forward. When it turned on flex will work to backward.

System Flow

The system will work as processing. Depending on the user the system will react what to do regarding user actions.

3.4 Logical Data Model

Logical data modeling is a process of determining and analyzing requirements that companies use and support the business process, including the opportunity for related information systems.

The block diagram model includes the relation of entities, properties, and actions and blocks.

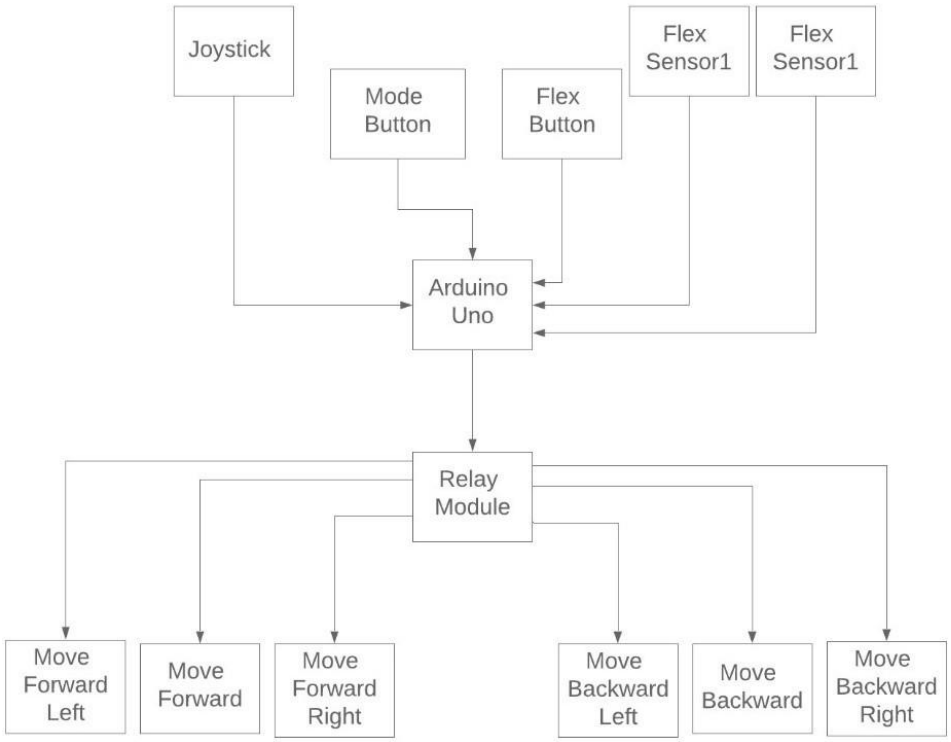

Figure 3.13: Block Diagram of Snappy Wheelchair

3.5 Design Requirements

These are the following thing should keep in mind while building the wheelchair:

Make Wheelchair Simple and Flexible for Users: The wheelchair should be more lite weight and simple minimalistic for users, so the users can run it without any hassle.

Make the System Compatible: The wheelchair should be perfect during the user using it. Even also should compatible with reliability and less cost.

Efficiency

This part is the most important for market. The wheelchair should run and work almost perfectly in minimum time. Even the wheelchair implementation should be less cost efficient.

Maintenance

The wheelchair should be more reliable than any other wheelchair for maintenance and in the local market.

CHAPTER FOUR

Design Specification

4.1 System Design

We have used many hardware and software components to complete our full project. These components are included together to make the circuit that works for our wheelchair.

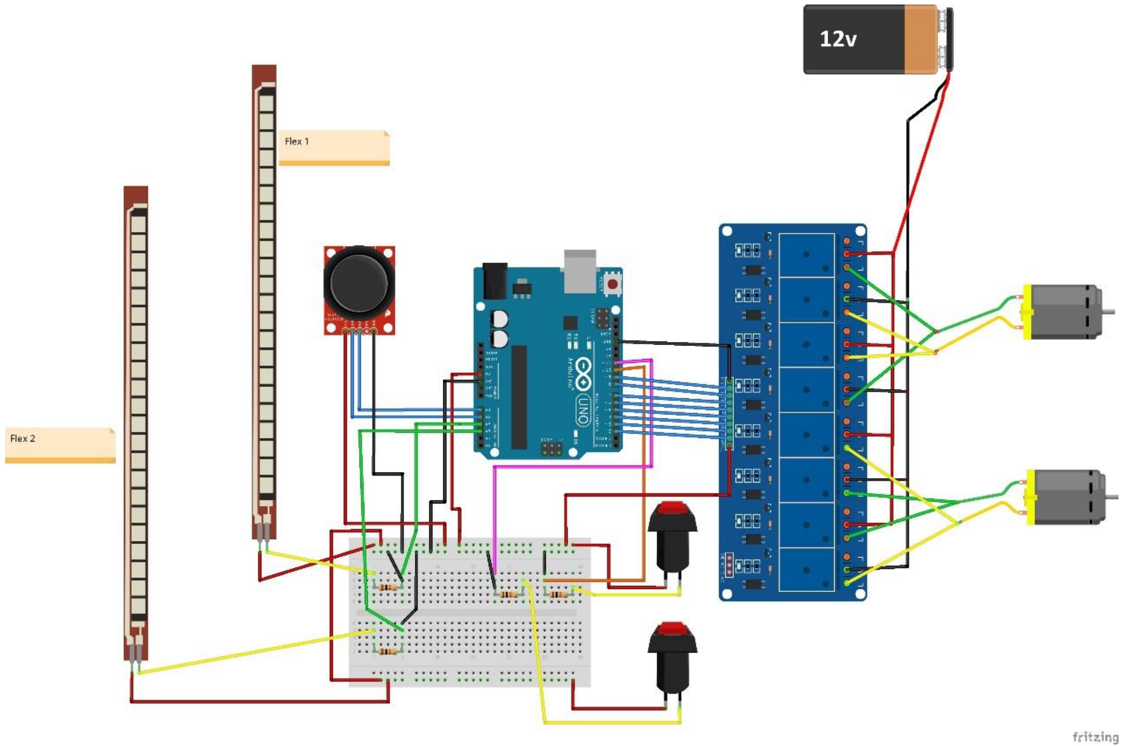

Figure 4.1: Whole System Design Implementation

4.1.1 Joystick System

To run our wheelchair, we have used the joystick to control. It can make the wheelchair move forward, backward, left and right. It usually controls navigation.

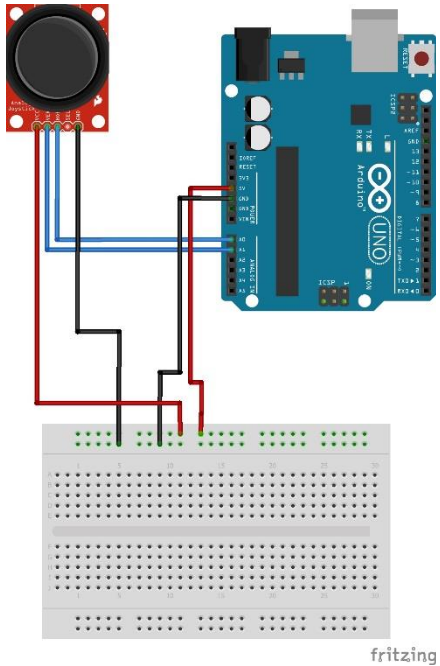

Figure 4.2: Circuit Diagram of Joystick Controller

4.1.2 Flex Sensor System

We have used two flex sensors to control our wheelchair like the joystick. But here it will work a bit different. When we flex both sensors the wheelchair will move means the two motors will get voltage and move. When we will flex one sensor it will only work on a single motor. Other flex will react the same. Here are the different, there is a button. If the switch is turned on the flex will work reverse so the wheelchair will go backward.

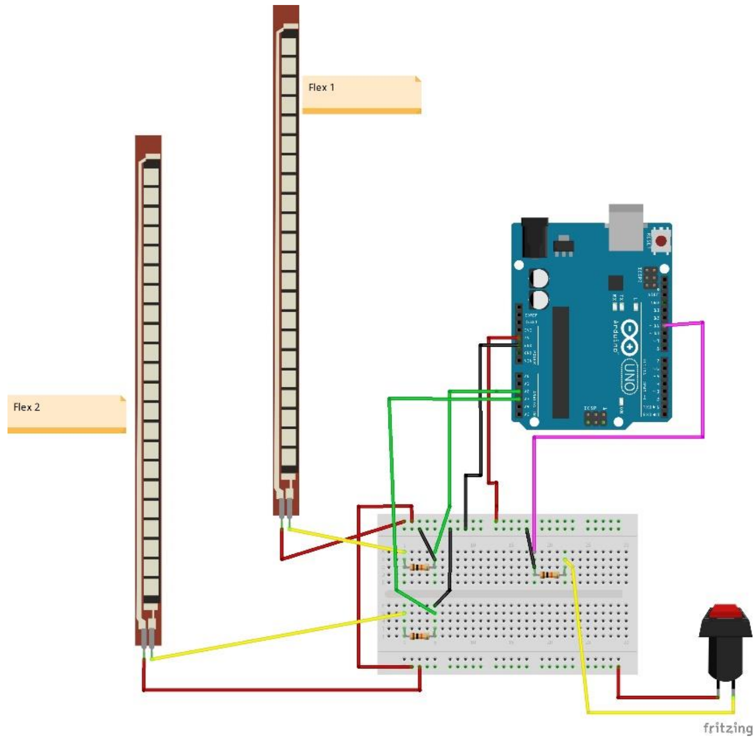

Figure 4.3: Circuit Diagram of Flex Sensor

4.1.3 Button System

Here is the buttons which work for different purposes. One button works for reversing the wheelchair as if it turned on it will go backward. But normally will move to forward. And the other button works as controller mode. Default is set as joystick mode if it turned on it will work for flex sensors and joystick mode will stop.

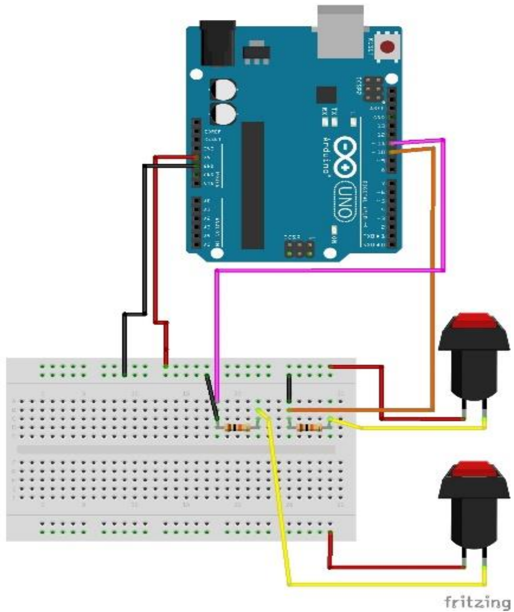

Figure 4.4: Circuit Diagram of Buttons

4.1.4 8-Channel Relay and 12v Battery

This relay mainly works for switching the power voltage from the battery to motors. First, it gets command from the microcontroller and it executes the command and supplies the voltage from battery to motor.

Here 12v battery used to power up the motors.

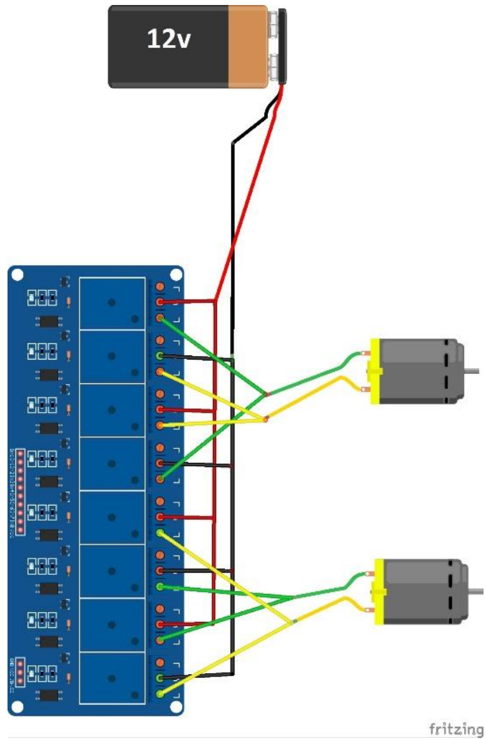

Figure 4.5: Circuit Diagram of 8-Channel Relay and 12v Battery

4.2 Algorithms

Step1: Declare variable of Joystick and Flex sensor for analog and digital pin xAxis, yAxis, Flex1, Flex2 as analog and ButtonMode, ButtonFlex, R9, R8, R7, R6, R5, R4, R3, R2 as digital.

Step2: pinMode setup R9 to R2 as Output;

Step3: Read ButtonMode.

Step4: if ButtonMode=1

Step5:
```
Read ButtonFlex, Flex1, Flex2
if Flex1>250 and Flex2>150
    Wheelchair in neutral mode.
    go to step6.
if ButtonFlex=1
    if Flex1<210 and Flex2>150
        Wheelchair in left-Backward mode.
        go to step6.
    if Flex1>250 and Flex2<110
        Wheelchair in right-Backward mode.
        go to step6.
    if Flex1>210 and Flex2<110
        Wheelchair in Backward mode.
        go to step6.

if ButtonFlex = 0 then
    if Flex1<210 and Flex2>150
        Wheelchair in left-Forward mode.
        go to step6.
    if Flex1>250 and Flex2<110
        Wheelchair in right-Forward mode.
        go to step6.
    if Flex1>210 and Flex2<110
        Wheelchair in Forward mode.
        go to step6.
```

Step6: if ButtonMode=0

Step7:
```
Read xAxis, yAxis.
    if xAxis <= 550 and yAxis >= 470
        Wheelchair in neutral mode.
        go to step7.
    if yAxis > 550
        if yAxis >= 750 and xAxis >= 750
            Wheelchair in left-Forward mode.
            go to step7.
        if yAxis >= 750 and xAxis <= 250
            Wheelchair in right-Forward mode.
            go to step7.
        if xAxis >= 250 and xAxis <= 750
            Wheelchair in Forward mode.
```

```
                go to step7.
if yAxis < 470
        if yAxis < 470 and xAxis > 550
                Wheelchair in left-Backward mode.
                go to step7.
        if yAxis <= 250 and xAxis <= 250
                Wheelchair in right-Backward mode.
                go to step7.
        if xAxis >= 250 and xAxis <= 750
                Wheelchair in Backward mode.
                go to step7.
```

CHAPTER 5

Implementation and Testing

Implementation

We have been working for the last one year to implement this project. In this wheelchair, we are trying to put a lot of features. At the beginning of the project, we build a prototype wheelchair then now we make it larger, it is now transportable up to 130kg.

For implementation which types of electronic accessories devices needed that implementation and what were their results that's described below.

5.1 Implementation of Joystick: Uses of joystick for passing analog signal in the Arduino. Then Arduino send digital signal to the system to move wheelchair forward, left-forward, right-forward, backward, left-backward, and right-backward.

Test result**:** We were testing joystick controlling system for 100 times, it gives us 91% accuracy.

Figure 5.1: Installed Joystick.

5.2 Implementation of Flex Sensors: Flex sensors are used for passing analog signal in the Arduino and Arduino send digital signal to the system to move the wheelchair forward, left-forward, right-forward, backward, left-backward, right-backward.

Test result**:** We were testing flex sensors controlling system for 100 times, it gives us 93% accuracy.

Figure 5.2: Installed Flex Sensors.

5.3 Implementation of Power Switch: Power switch uses to system on-off.

Test result: The test result accuracy 99%.

5.4 Implementation of Mode controlling switch: Mode controlling switch uses to shifting joystick control system to flex sensors control system and reverse of it.

Test result: The test result accuracy 99%.

5.5 Implementation of Flex sensors mode controlling switch: Flex sensors mode controlling switch uses to shifting forward-backward mode in flex sensors controlling system.

Test result: The test result accuracy 98%.

Figure 5.3: Installed Switches.

And here is the final output of our Snappy Wheelchair.

Figure 5.4: A Compete Snappy Wheelchair

CHAPTER 6

Conclusion and Future Scope

6.1 Discussion and Conclusion

Snappy wheelchair gives a wide range of facility that a physically challenged person need to move anywhere without the help of others. A challenged person pleasantly work with this for his longing plan. As a smart wheelchair, this gives all the facilities that ought to accommodate a physically challenged person request. Future work on this wheelchair is to advance this wheelchair all-inclusive for make more interesting and more useful wheelchair in this nation and furthermore the world.

6.2 Scope for Further Development

i) Using GPS system for tracking the location of the wheelchair.

ii) Controlling with android application.

iii) Controlling with EMG sensor by which physically challenged person can control this wheelchair with any sensing part of body.

References

Conference/Journal Papers:

[1] Levine, S.P., Bell, D.A., Jaros, L.A., Simpson, R.C., Koren, Y. and Borenstein, J., 1999. The NavChair assistive wheelchair navigation system. *IEEE transactions on rehabilitation engineering*, *7*(4), pp.443-451, September 2019.

[2] Al-Rahayfeh, A. and Faezipour, M., 2013. Eye tracking and head movement detection: A state-of-art survey. *IEEE journal of translational engineering in health and medicine*, *1*, pp.2100212-2100212, September 2019

[3] Purwanto, D., Mardiyanto, R. and Arai, K., 2009. Electric wheelchair control with gaze direction and eye blinking. *Artificial Life and Robotics*, *14*(3), p.397, September 2019.

[4] Patel, S.N. and Prakash, V., 2015, March. Autonomous camera based eye controlled wheelchair system using raspberry-pi. In *2015 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS)* (pp. 1-6). IEEE, October 2019

[5] Murai, A., Mizuguchi, M., Nishimori, M., Saitoh, T., Osaki, T. and Konishi, R., 2009, August. Voice activated wheelchair with collision avoidance using sensor information. In *2009 ICCAS-SICE* (pp. 4232-4237). IEEE, October 2019.

[6] Coleman, R., Coleman and Raquel, 2000. *Multi-feature automated wheelchair*. U.S. Patent 6,154,690, October 2019.

[7] Wallam, F. and Asif, M., 2011. Dynamic finger movement tracking and voicecommands based smart wheelchair. International Journal of Computer and Electrical Engineering, 3(4), p.497, October 2019.

Appendix

Pseudo Code

Step1: Start

Step2: Declare variable for analog and digital pin

xAxis <-A0, yAxis <- A1, Flex1 <- A3, Flex3 <- A4, ButtonMode <- 10, ButtonFlex <-11, R9 <- 9, R8 <- 8, R7 <- 7, R6 <- 6, R5 <- 5, R4 <- 4, R3 <- 3, R2 <- 2;

Step3: pinMode setup

R9 to R2<-Output;

Step4: Loop 0 to infinity

Step5: Read ButtonMode <- digitalread;

Step6: if ButtonMode = 1 then

Step7: Read ButtonFlex <- digitalread;

Step8: Read Flex1 <- analogread, Flex2 <- analogread;

Step9: if Flex1>250 and Flex2>150 then

R9 <- LOW;
R8 <- LOW;
R7 <- LOW;
R6 <- LOW; //Neutral
R5 <- LOW;
R4 <- LOW;
R3 <- LOW;
R2 <- LOW;

end if

Step10: if ButtonMode = 1 then

Step11: if Flex1<210 and Flex2>150 then

R9 <- LOW;
R8 <- LOW;
R7 <- HIGH;

R6 <- HIGH; //left-Backward

R5 <- LOW;

R4 <- LOW;

R3 <- LOW;

R2 <- LOW;

end if

Step12: if Flex1>250 and Flex2<110 then

R9 <- LOW;

R8 <- LOW;

R7 <- LOW;

R6 <- LOW; //right-Backward

R5 <- LOW;

R4 <- LOW;

R3 <- HIGH;

R2 <- HIGH;

end if

Step13: if Flex1>210 and Flex2<110 then

R9 <- LOW;

R8 <- LOW;

R7 <- HIGH;

R6 <- HIGH; //Backward

R5 <- LOW;

R4 <- LOW;

R3 <- HIGH;

R2 <- HIGH;

end if

Step14: else if ButtonMode = 0 then

if Flex1<210 and Flex2>150 then

R9 <- HIGH;

R8 <- HIGH;

R7 <- LOW;

R6 <- LOW; //left-Forward

R5 <- LOW;

R4 <- LOW;

R3 <- LOW;

R2 <- LOW;

end if

Step15: if Flex1>250 and Flex2<110 then

R9 <- LOW;

R8 <- LOW;

R7 <- LOW;

R6 <- LOW; //right-Forward

R5 <- HIGH;

R4 <- HIGH;

R3 <- LOW;

R2 <- LOW;

end if

Step16: if Flex1>210 and Flex2<110 then

R9 <- HIGH;

R8 <- HIGH;

R7 <- LOW;

R6 <- LOW; //Forward

R5 <- HIGH;

R4 <- HIGH;

R3 <- LOW;

R2 <- LOW;

end if

end if

Step17: if ButtonMode = 0 then

Read xAxis <- analogread, yAxis <- analogread;

if xAxis <= 550 and yAxis >= 470 then

R9 <- LOW;

```
                R8 <- LOW;
                R7 <- LOW;
                R6 <- LOW; //Neutral
                R5 <- LOW;
                R4 <- LOW;
                R3 <- LOW;
                R2 <- LOW;
            end if
```

Step18:
```
        if yAxis > 550 then
                if yAxis >= 750 and xAxis >= 750 then
                    R9 <- HIGH;
                    R8 <- HIGH;
                    R7 <- LOW;
                    R6 <- LOW; //left-Forward
                    R5 <- LOW;
                    R4 <- LOW;
                    R3 <- LOW;
                    R2 <- LOW;
                end if
```

Step19:
```
                if yAxis >= 750 and xAxis <= 250 then
                    R9 <- LOW;
                    R8 <- LOW;
                    R7 <- LOW;
                    R6 <- LOW; //right-Forward
                    R5 <- HIGH;
                    R4 <- HIGH;
                    R3 <- LOW;
                    R2 <- LOW;
                end if
```

Step20:
```
                if xAxis >= 250 and xAxis <= 750 then
                    R9 <- HIGH;
```

```
                                R8 <- HIGH;
                                R7 <- LOW;
                                R6 <- LOW; //Forward
                                R5 <- HIGH;
                                R4 <- HIGH;
                                R3 <- LOW;
                                R2 <- LOW;
                        end if
                end if
Step21:         if yAxis < 470 then
Step22:                 if yAxis < 470 and xAxis > 550 then
                                R9 <- LOW;
                                R8 <- LOW;
                                R7 <- HIGH;
                                R6 <- HIGH; //left-Backward
                                R5 <- LOW;
                                R4 <- LOW;
                                R3 <- LOW;
                                R2 <- LOW;
                        end if
Step23:                 if yAxis <= 250 and xAxis <= 250 then
                                R9 <- LOW;
                                R8 <- LOW;
                                R7 <- LOW;
                                R6 <- LOW; //right-Backward
                                R5 <- LOW;
                                R4 <- LOW;
                                R3 <- HIGH;
                                R2 <- HIGH;
                        end if
Step24:                 if xAxis >= 250 and xAxis <= 750 then
```

```
                    R9 <- LOW;
                    R8 <- LOW;
                    R7 <- HIGH;
                    R6 <- HIGH; //Backward
                    R5 <- LOW;
                    R4 <- LOW;
                    R3 <- HIGH;
                    R2 <- HIGH;
                end if
            end if
        end if
    end if
```