Supervised Machine Learning Model for Head Motion Recognition Wheelchair

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ABSTRACT

The challenging problem faced by the paralyzed people is their independent mobility. They need an external help to perform their daily activities. Electric wheelchairs are designed to aid paraplegics. Unfortunately, these cannot be used by persons with higher degree of impairment, such as quadriplegics, i.e. persons that, due to age or illness, cannot move any of the body parts, except of the head. The main objective of this project is to provide an automated system for disabled people. The wheel chair will work based on the head movement of the user. The recognized gestures are used to generate motion control commands to the controller so that it can control the motion of the wheel chair according to the user intention. Design and development of Head motion-controlled wheelchair has been achieved using accelerometer sensors and PIC microcontroller. The system is implemented practically and works well. The ACCELEROMETER 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.

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

“This chapter will brief you about the project we have been working on. It describes about the difficulties faced by handicapped people. Through our knowledge and under the guidance of our mentor, we would like to help the people and work for the betterment of our society.”

1.1 INTRODUCTION

Handicapped people, who are not able to either speak, hear or are Quadriplegics and Tetraplegics. 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. It can also appear as a consequence of accidents or age.

The patients with such severe disabilities are not able to perform their everyday actions, such as: feeding, toilette usage and movement through space. Depending on the severity of the disability, a patient can retain freedom of movement to a certain level by using different medical devices.

There are two types of medical devices that enable independent movement for a handicapped person. Those are exoscelets and wheelchairs. As we concentrate on wheelchairs, these contain electronic systems to enable and improve person’s movement ability both in outdoor and indoor conditions. Electronic systems, such as sensors, actuators, communication modules and signal processing units, are used to recognize the activity that the patient is trying to perform and help him carry it out in coordination with the commands given.

Wheelchair operation is based on navigation, which, in this case, is defined as safe transport from the starting point to a given destination. The wheelchair is a more general medical device and a much simpler one. Thus, the wheelchairs are used more often. Nevertheless, only patients with healthy upper extremities (paraplegics) can successfully operate standard electric wheelchairs

1.2 BASIC OF PROJECT

We are trying to make life easier for a paralytic person or a person with any kind of disability. A microcontroller system that enables standard electric wheelchair control by head motion and through speech recognition is developed. A prototype of the system is implemented and experimentally tested. The patients who cannot use any of their extremities (quadriplegics) cannot operate these. Electronic systems in common for all these projects are sensors, signal processing units, software that translates user's commands into medical device actions.

These solutions are motion controlled wheelchair. User can control the device via voice commands. Besides these, wheelchair control is also possible by head motion, eye movement, electromyographic (EMG) sensors and electroencephalogram (EEG) i.e. human machine interaction. We are trying to make life easier for a paralytic person or a person with any kind of disability. A microcontroller system that enables standard electric wheelchair control by head motion and through speech recognition is developed.

A prototype of the system is implemented and experimentally tested. The patients who cannot use any of their extremities (quadriplegics) cannot operate these. Electronic systems in common for all these projects are sensors, signal processing units, software that translates user's commands into medical device actions. These solutions are motion controlled wheelchair. User can control the device via voice commands. Besides these, wheelchair control is also possible by head motion, eye movement, electromyographic (EMG) sensors and electroencephalogram (EEG) i.e. human machine interaction.

1.3 LITERATURE OVERVIEW

The progress in the field of smart wheelchair technology is at its peak. A lot of work has been done by the pioneers in the field of smart wheelchair technology. Wheelchair technology has evolved from manual wheelchairs to electric wheelchairs and then finally to robotic wheelchairs. The most effective control signal can be taken from the eyes, voice, tongue, hands and brain. Some of such methods are:

Rafael Barea, Luciano Boquete, Manuel Mazo developed a wheelchair for mobility impaired individual controlled by the eye movement within the socket based on electrooculography. An acquisition system captures electrooculograms and the continuous wavelet transform and neural network are analysed in real time using a microcontroller-based platform running the Linux operating system. The proposed navigation system cannot work properly in dim environment and the eye size of an individual also contributes to proper navigation. The itching or irritations sensation could develop after long use.

The control signal for quadriplegic individuals can be taken from tongue.X. Huo, J. Wang, and M. Ghovanloo[5] developed the Tongue Drive System (TDS). By using a magnet and magnetic sensors it drives the wheelchair by detecting tongue motion. The proposed navigation system requires tongue to be pierced. Individuals should avoid inserting Ferromagnetic objects into their mouth and the magnetic tracer should be removed if the user is undergoing MRI. It's quite uncomfortable to talk to individuals with the magnetic tracer in the mouth. One of the most effective control signals is the users voice. M. B. Kumaran and A. P. Renold developed a robotic wheelchair controlled and driven using voice recognition. The proposed system cannot be used by dumps. It is not effective in a noisy environment.

N. Shinde and K. George designed a robotic wheelchair controlled and driven by brain waves and eye blinks of the user are presented for wheelchair locomotion Brain impulse varies from person to person and needs to be calibrated for proper locomotion. Aleksandar Pajkanovic, Branko Dokic designed a robotic wheelchair controlled using head motion. The prototype consists of the digital system (an accelerometer and a microcontroller) and a mechanical actuator.

1.4 MOTIVATION

We know that it is difficult for a disable person to move independently. They face many problems, but mobility is a major issue. We are engineers, we make lives easy, we work for the society, we want to make a difference. It would be great if we could help the needy one and work for the betterment of society. Under the guidance of our mentor and project co-ordinator, we wish to contribute our work in this specific field. This project will not only help the needed ones but will also help others, who are looking forward to work in the similar field. We are representing this on a prototype, it's made by using MATLAB 2019a, Jupyter/Spyder, servo motor, Arduino Uno and connecting wires.

We hope our efforts and hard work will make someone's life beautiful and more happening. Easing of the technology use, affordability and familiarity indicate that gesture-based user interface can open new opportunity for elderly and disable people.

1.5 ORGANIZATION OF PROJECT REPORT

- **Chapter – 1**

  INTRODUCTION

This chapter will brief you about the project we have been working on. It describes about the difficulties faced by handicapped people. Through our knowledge and under the guidance of our mentor, we would like to help the people and work for the betterment of our society. We are trying to make life easier for a paralytic person or a person with any kind of disability. A microcontroller system that enables standard electric wheelchair control by head motion is developed. A prototype of the system is implemented and experimentally tested. The patients who cannot use any of their extremities (quadriplegics) cannot operate these. Electronic systems in common for all these projects are sensors, signal processing units, software that translates user's commands into medical device actions.

- **Chapter - 2**

  METHODOLOGY ADOPTED

It is here to tell you about the tools and techniques used and implemented in this project. We tried to keep the cost as low as possible. We used Arduino Uno to perform hardware functionalities, Accelerometer (MPU6050) to obtain the position, Microphone to get the input in audio format, MATLAB, Jupyter/Spyder and Arduino IDE software to burn the program on Arduino chip. We used machine learning to make the chair smart in its own way. The algorithm used is bagged trees with the accuracy of 96.8%. Head motion recognition is based on the force measurements yielded by an accelerometer attached to the head. As mentioned, there are only four members of the motion set, which represent head leaned in four possible directions. This means that the algorithm needs to estimate when the head is leaned in one of the four directions. In other words, it is sufficient to read only the accelerometer data of two axes: in this case, X and Y. It is specifically implemented for the people who want to ease their movement by the motion of their head.

- **Chapter - 3**

  DESIGN AND RESULT ANALYSIS

This chapter brief about the designing of our circuit for the project. We describe how the Arduino Uno is connected to the servo motor (Micro servo 9g – SG90) and Accelerometer (MPU6050). The result obtained by performing our project are presented below. Results that we got from Head Motion Recognition. First, we connect ground of servo motor to ground pin of Arduino Uno. Then we connect the Vcc of servo motor to 5v pin of Arduino Uno. At last we connect the supply of servo motor to D9 of Arduino Uno. The performed experiment showed very good results. But compared our results we ideal situations. We got an accuracy of 96.8% which was quite remarkable. We built the model in Jupyter Notebook/Spyder which made the base work easier. Also, the fact that in this series we considered the worst-case scenario (down-up-down) has to be accounted. Such motions should be avoided and the user should take care of the command time frame. So, slower motions when no command is intended are suggested.

- **Chapter – 4**

  MERITS, DEMERITS AND APPLICATIONS

The idea implemented in this project has its pros and cons like every other project. Merits and Demerits of the projects are discussed below. The applications of the projects are also explained here.

- **Chapter – 5**

CONCLUSION AND FUTURE SCOPE

The conclusion of the project is stated below. It is what we thought of the project and how it may change the life of people. We are engineers, our objective is to make one's life better and we are happy that we are able to achieve it. The wheelchair is fully capable of moving in accordance to the head gesture given by the person who is using the wheel chair. Certain improvisation and improvement can be done to make the wheelchair more reachable to those whose whole body is paralyzed. Within this paper a novel technique of head motion recognition is used to enable wheelchair control for quadriplegics. The technique is implemented as an algorithm of microcontroller system.

CHAPTER 2: METHODOLOGY ADOPTED

"Here to tell you about the tools and techniques used and implemented in this project. We tried to keep the cost as low as possible. We used Arduino Uno to perform hardware functionalities, Accelerometer (MPU6050) to obtain the position, Microphone to get the input in audio format, MATLAB, Jupyter Notebook/Spyder and Arduino IDE software to burn the program on Arduino chip. We used machine learning to make the chair smart in its own way. The algorithm used is bagged trees with the accuracy of 96.86%."

The MOTION RECOGNITION WHEELCHAIR is implemented through several steps of operation. In this, a microcontroller system that enables standard electric wheelchair control by head motion is developed. We started with MATLAB as there were lack of resources. We gradually shifted half of our project to ARDUINO IDE. Further the model was built on Jupyter Notebook/Spyder.

HEAD MOTION: Since a set of possible motions in this case is very small, the number of available commands is also very limited. Thus, the control system that we propose allows the user to give only four different commands: "forward", "backward", "left" and "right". This means that the set of motions to be recognized has only four members.

The meaning of each of the commands is relative and depends on the present wheelchair state. Namely, we define five different wheelchair states: "state of still", "moving forward", "moving backward", "rotating left" and "rotating right". If the wheelchair is in the "state of still", the command "forward" will put it in the state "moving forward", and the command "backward" will put it in the state "moving backward". On the other hand, if the wheelchair is in the state "moving forward", the command "backward" will put it in the state "state of still", i.e. stop the wheelchair. Analogously, if the wheelchair are in the state “moving backward”, the command “forward” will stop it. Head motion recognition is based on the force measurements yielded by an accelerometer attached to the head. As mentioned, there are only four members of the motion set, which represent head leaned in four possible directions. This means that the algorithm needs to estimate when the head is leaned in one of the four directions. In other words, it is sufficient to read only the accelerometer data of two axes: in this case, X and Y. The thresholds are accelerometer output values that the user defined at system startup. These represent the angles in all four directions by which the head needs to be leaned in order to issue a command to the system. These thresholds define borders of a region in three-dimensional space and the algorithm operation is based on estimating the head position relative to this region. In Fig 1, Fig 2 and Fig 3 we are describing the position of accelerometer, different state of motion and positive and negative threshold.

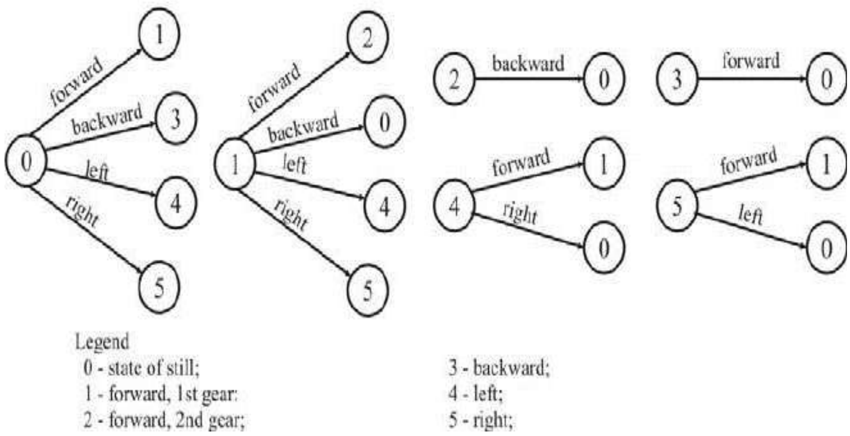


FIGURE 1 DESCRIPTION OF MOTION OF WHEELCHAIR WHILE HEAD MOVES

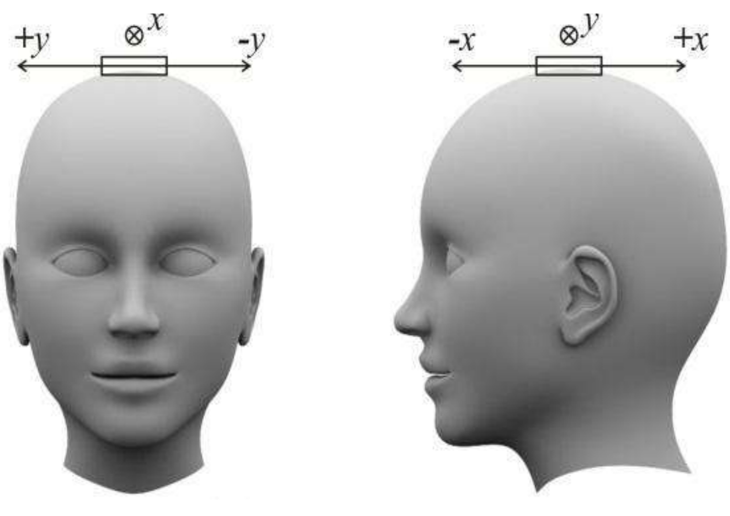


FIGURE 2 POSITION OF ACCELEROMETER

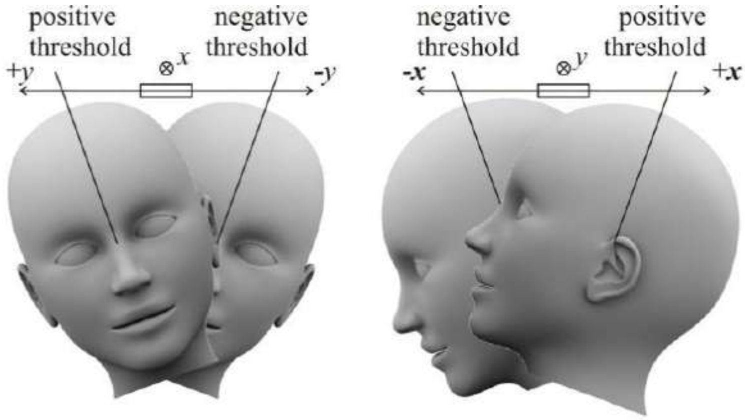


FIGURE 3 HEAD MOVEMENT TO OBTAIN THE THRESHOLD.

2.1 HARDWARE DESCRIPTION

2.1.1 ARDUINO UNO

Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins.

It is an open-source platform, means the boards and software are readily available and anyone can modify and optimize the boards for better functionality.

- Arduino Uno comes with USB interface i.e. USB port is added on the board to develop serial communication with the computer.
- Atmega328 microcontroller is placed on the board that comes with a number of features like timers, counters, interrupts, PWM, CPU, I/O pins and based on a 16MHz clock that helps in producing more frequency and number of instructions per cycle.

The software used for Arduino devices is called IDE (Integrated Development Environment) which is free to use and required some basic skills to learn it. It can be programmed using C and C++ language. Some people get confused between Microcontroller and Arduino. While former is just an on system 40 pin chip that comes with a built-in microprocessor and later is a board that comes with the microcontroller in the base of the board, bootloader and allows easy access to input-output pins and makes uploading or burning of the program very easy. As shown in Fig 4.

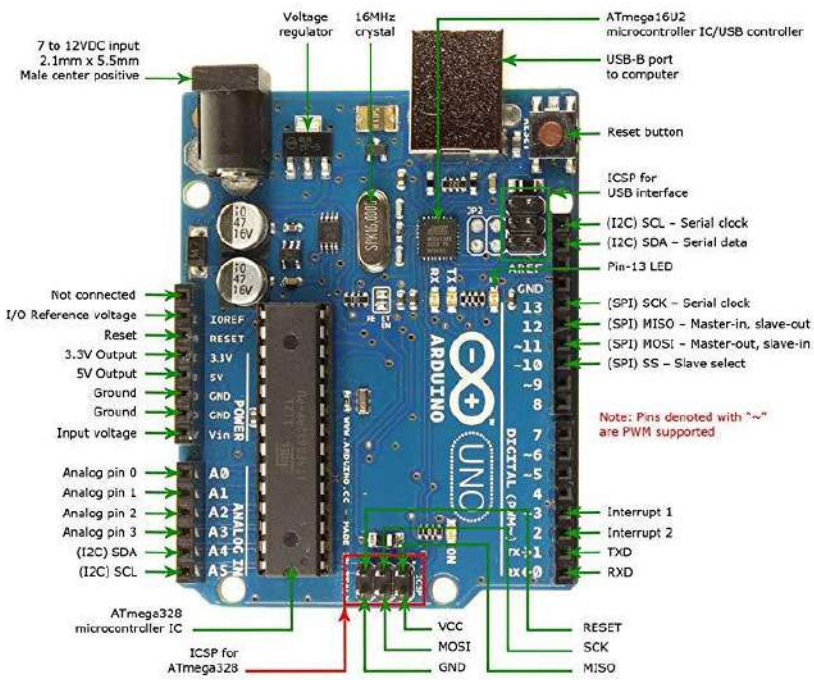


FIGURE 4 ARDUINO UNO CIRCUIT

2.1.2 ACCELEROMETER- MPU6050

The MPU6050 IMU is also called six-axis motion tracking device or 6 DoF (six Degrees of Freedom) device, because of its 6 outputs, or the 3 accelerometer outputs and the 3-gyroscope output. The MPU-6050 incorporates InvenSense's MotionFusion and run-time calibration firmware that enables manufacturers to eliminate the costly and complex selection, qualification, and system level integration of discrete devices in motion-enabled products, guaranteeing that sensor fusion algorithms and calibration procedures deliver optimal performance for consumers[1].

The MPU-6050 devices combine a 3-axis gyroscope and a 3-axis accelerometer on the same silicon die, together with an onboard Digital Motion Processor (DMP), which processes complex 6-axis Motion Fusion algorithms. The device can access external magnetometers or other sensors through an auxiliary master I²C bus, allowing the devices to gather a full set of sensor data without intervention from the system processor. The devices are offered in a 4 mm x 4 mm x 0.9 mm QFN package. As shown in Fig 5.

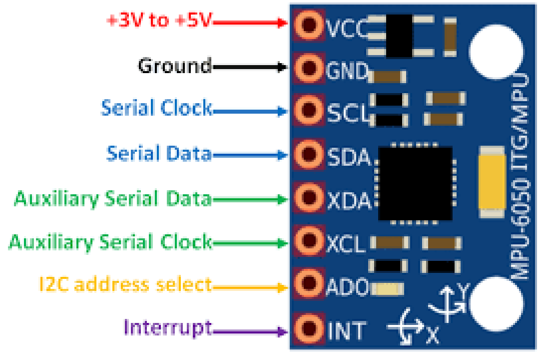


FIGURE 5 MPU6050 PIN DIAGRAM

2.1.3 SERVO MOTOR - Micro servo 9g – SG90

Servo motors are high torque motors which are commonly used in robotics and several other applications due to the fact that it's easy to control their rotation. Servo motors have a geared output shaft which can be electrically controlled to turn one (1) degree at a time. For the sake of control, unlike normal DC motors, servo motors usually have an additional pin asides the two power pins (Vcc and GND) which is the signal pin. The signal pin is used to control the servo motor, turning its shaft to any desired angle.MG90S Metal Gear, MG995 High Torque Metal Gear, VTS-08A Analog Servo Tower Pro SG-90. As shown in Fig 6.

Features

- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed is 0.1s/60°
- Gear Type: Plastic
- Rotation : 0°-180°

Applications

- ✓ Used as actuators in many robots like Biped Robot, Hexapod, robotic arm etc..
- ✓ Commonly used for steering system in RC toys
- ✓ Robots where position control is required without feedback
- ✓ Less weight hence used in multi DOF robots like humanoid robots

FIGURE 6 SERVO MOTOR

2.2 MATLAB Code for Accelerometer

Here we have written the code to collect the data for training a model. We are training the model to detect in which direction movement of wheelchair will take place. According to the movement of head the wheelchair will move.

The mpu6050 object reads acceleration and angular velocity using the InvenSense MPU-6050 sensor. The MPU-6050 is a 6 degree of freedom (DOF) inertial measurement unit (IMU) used to read acceleration and angular velocity in all three dimensions. The mpu6050 object represents a connection to the device on the Arduino® hardware I2C bus. Attach an MPU-6050 sensor to the I2C pins on the Arduino hardware. You can read the data from your sensor in MATLAB using the object functions. Before you use the mpu6050 object, create an Arduino object using Arduino and set its properties. When you create the Arduino object, make sure that you include the I2C library. For more information, see Connect to Arduino Hardware.

2.2.1 Trained Model of Head Motion Dataset

CREATION

imu = mpu6050(a) creates a sensor object with default property values. The object represents the connection to the sensor on the Arduino hardware, a. Arduino hardware connection created using Arduino, specified as an object.

1. Create MPU-6050 Sensor Connection
2. Create an Arduino object and include the I2C library. Or, you can explicitly specify it in the Libraries Name-Value pair while creating the Arduino object. Create the sensor object.
3. Create MPU-6050 Sensor Connection (with Sensor Fusion and Tracking Toolbox)
4. Create a sensor object with properties available only with the Sensor Fusion and Tracking Toolbox. As shown in Fig 7.

TABLE 1 OBJECT FUNCTIONS

readAcceleration	**Read one sample of acceleration from sensor**
readAngularVelocity	Read one sample of angular velocity from sensor
read	Read acceleration, angular velocity, magnetic field, time, and overrun data
release	Release the IMU object
flush	Flush the host buffer
info	Read output data rate and bandwidth setting of sensor

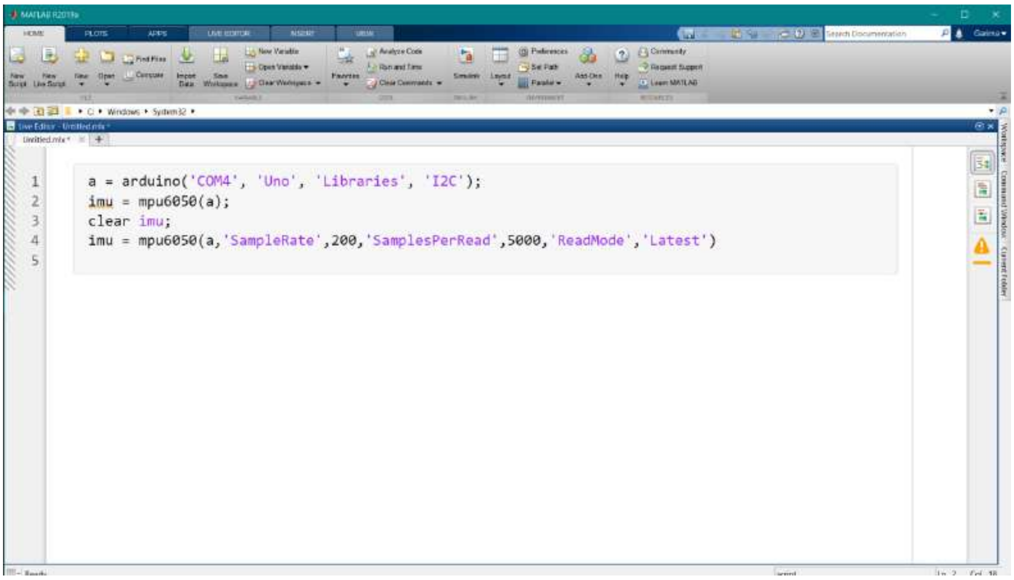


FIGURE 7 THE CODE IN LIVE SCRIPT IN MATLAB

2.3 Collection of Data through Accelerometer

Here we are collecting the data by moving the Accelerometer(MPU 6050). This data is recorded in MATLAB Workspace in the form of Numerical array.

2.3.1 Connection of Arduino Hardware

An arduino object represents a connection to Arduino® hardware. Use the arduino function to connect Arduino hardware to MATLAB®. After you create the object, you can program your hardware and use custom add-on libraries directly from MATLAB using the object functions.

STEP 1 - Download the “MATLAB Support Package for Arduino Hardware” add-ons from the MATLAB toolstrip. Setting up the MATLAB support package for Arduino Hardware. In Fig 8 we are installing the USB driver for Arduino in MATLAB.

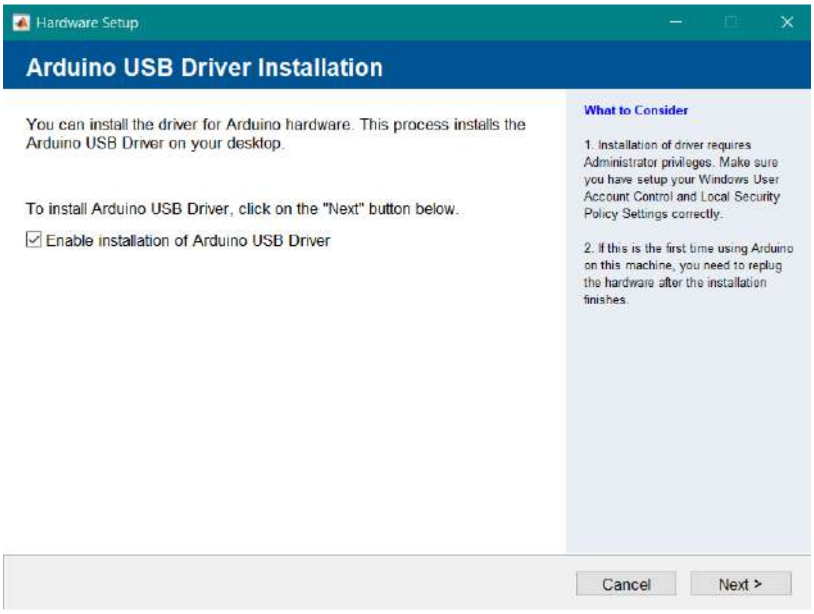


FIGURE 8 ARDUINO USB DRIVER INSTALLATION

In Fig 9 we did the Arduino hardware setup i.e. we configured our Arduino with MATLAB.

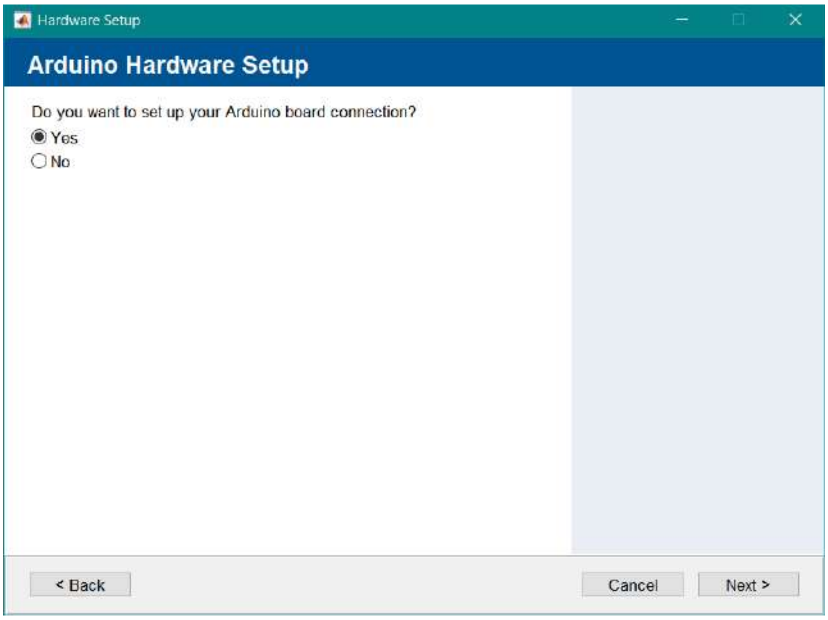


FIGURE 9 ARDUINO HARDWARE SETUP

In Fig 10 we connected the host Arduino Hardware with the host computer via USB port.

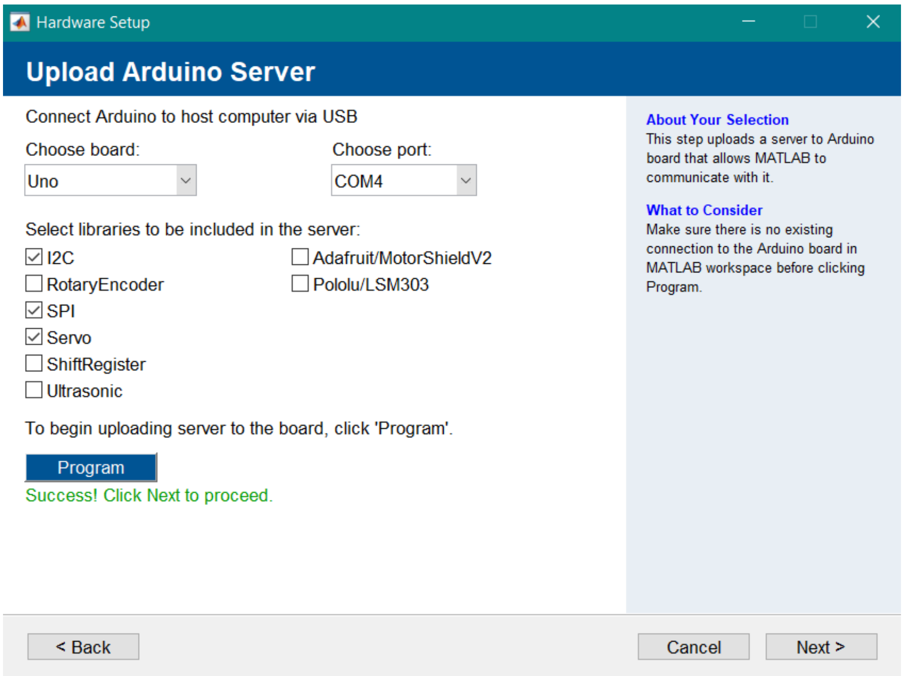


FIGURE 10 UPLOAD ARDUINO SERVER

In Fig 11 we tested the Arduino connection by running a test program including the libraries on the Arduino Uno..

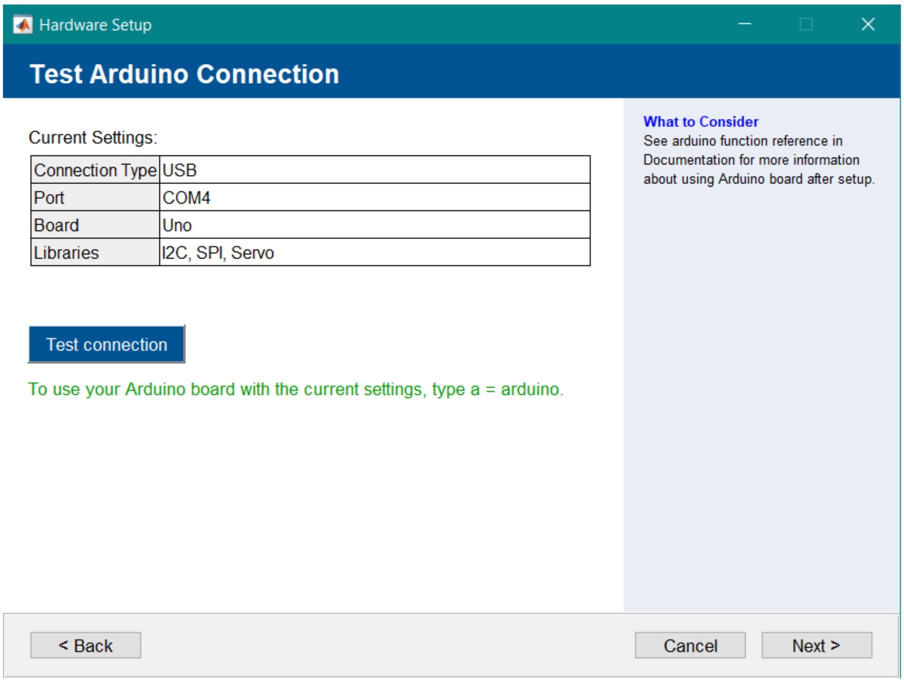


FIGURE 11 TEST ARDUINO CONNECTION

STEP 2

a = arduino recreates the last successful connection to the Arduino hardware. If there is no last successful connection or that connection failed, it creates a connection to the first official Arduino hardware connected to your host computer via USB.

a = arduino(port, board) creates a connection to Arduino hardware on the specified serial port. The serial port can be either a USB serial port or the Adafruit® EZ-Link Bluetooth® serial port, depending on how you have configured the Arduino hardware.

PORT – Hardware port

Hardware port that your Arduino is connected to, specified as a character vector or string array. The port can be a USB serial port or the Adafruit EZ-Link Bluetooth serial port, depending on how you have configured the Arduino hardware. To identify the USB serial port number, see Find Arduino Port on Windows, Mac, and Linux. To identify the Bluetooth device address or serial port, see pair a Bluetooth Device and Retrieve the Bluetooth Device Address. This argument can be specified on its own if connected via USB serial port, or with a board name. Example: a = arduino('COM4')

BOARD - Name of the Arduino enabled board, specified as a character vector or string array. This argument must be specified with a valid serial port, IP address, Bluetooth address, or Bluetooth name[2].

a = arduino('COM5','Uno') creates a connection to an Arduino Uno board using port 5.

'LIBRARIES' — Name of Arduino library

Name of the Arduino library, specified as the comma-separated pair consisting of 'Libraries' and a character vector or a cell array of character vectors. Libraries installed by default extend the Arduino environment.

This collection of data is shown in Fig 12 and Fig 13.

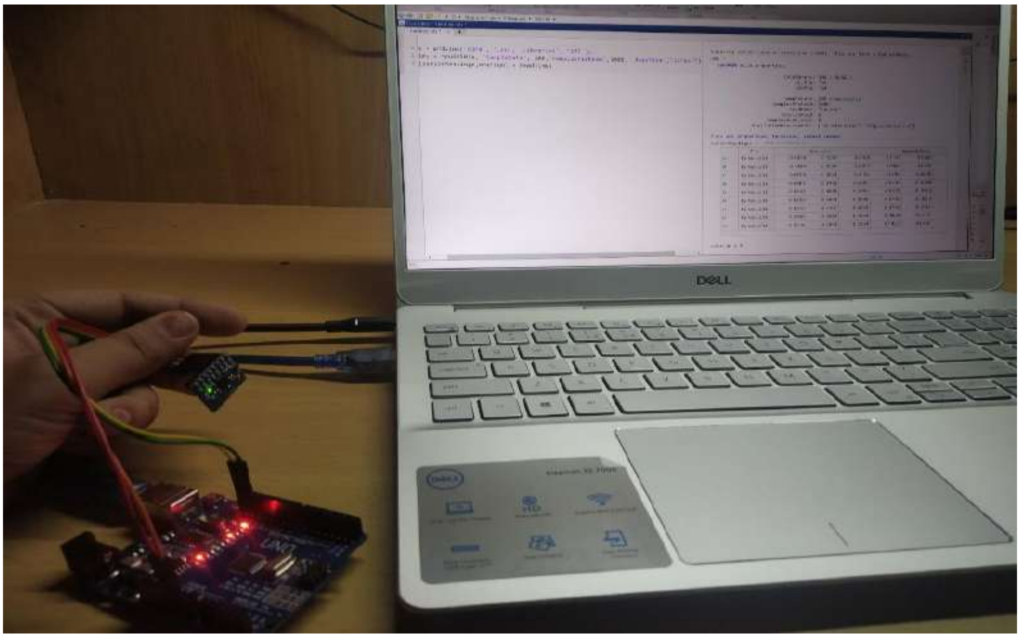


FIGURE 12 LIVE READINGS TAKEN WHILE TAKING THE READINGS

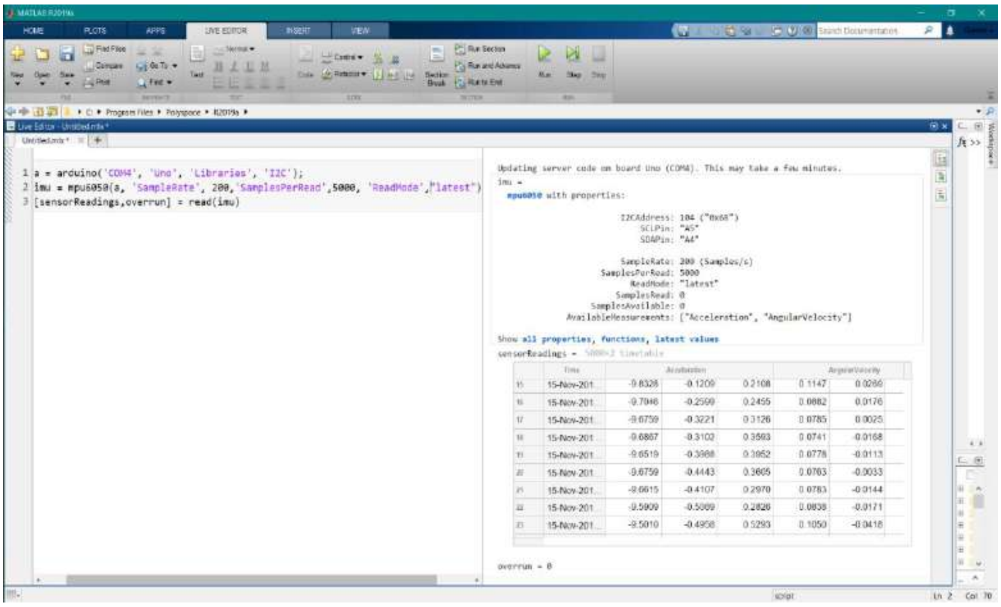


FIGURE 13 READING OBTAINED BY WRITING THE CODE ON LIVE SCRIPT

2.4 Visualizing the Dataset

Usually, to check the features with best dependency we form a correlation matrix.

CORRELATION MATRIX

A **correlation matrix** is a table showing **correlation** coefficients between variables. Each cell in the table shows the **correlation** between two variables. So more the value either positive or negative better is the correlation between two features. As we can see in figure 14 the correlation of x-axis and z-axis with directions is -0.51 and -0.67 respectively which is considered a strong correlation.

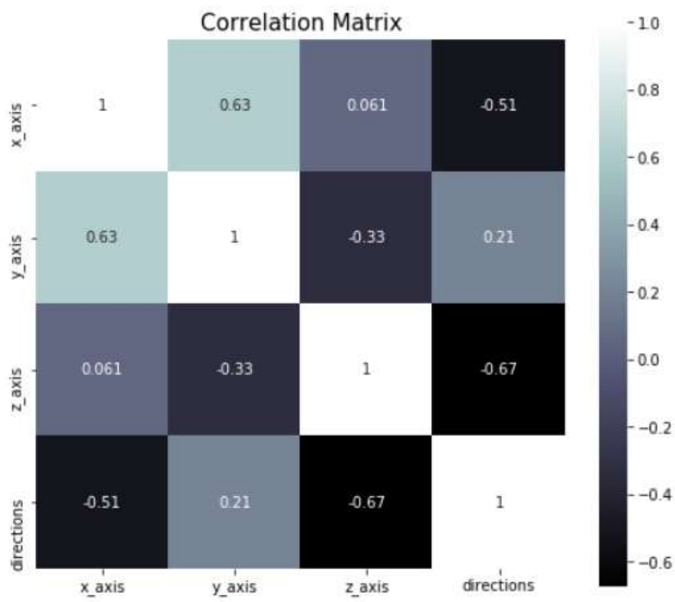


FIGURE 14 CORRELATION MATRIX

SCATTER PLOT

A **scatter plot** (aka **scatter** chart, **scatter graph**) uses dots to represent values for two different numeric variables. The position of each dot on the horizontal and vertical axis indicates values for an individual data point. **Scatter plots** are used to observe relationships between variables.

Here, in figure 15 we have plotted scatter plot which represent the relationship of x, y and z axis with following directions – right, left, forward, backward.

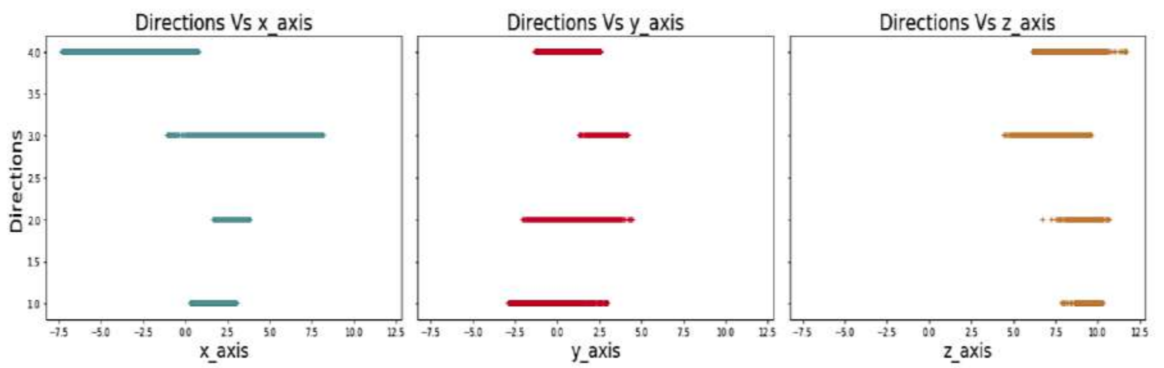
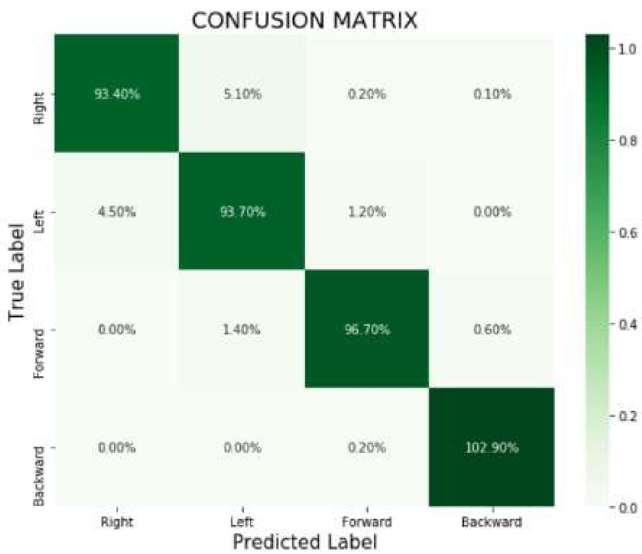


FIGURE 15 SCATTER PLOT

2.5 Building Machine Learning Model

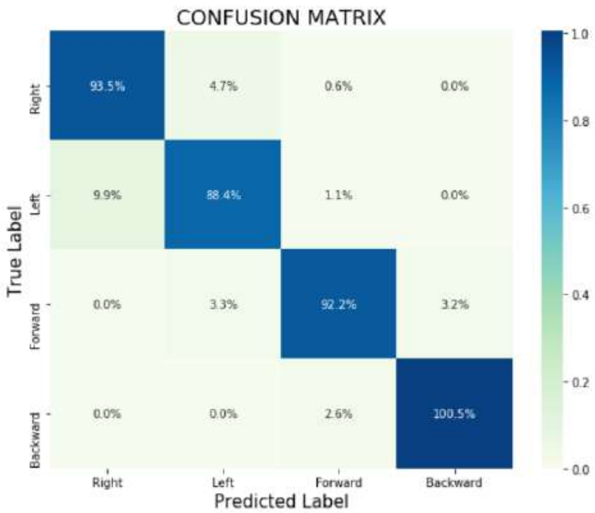
As we Know, that this is a typical classification dataset. So we applied following machine learning algorithms and visualized their confusion matrix:

- Ensemble Bagged Trees
- Quadratic Discriminant Analysis
- Linear Discriminant Analysis
- K Nearest Neighbor
- Naïve Bayes
- Adaboost
- Decision Trees



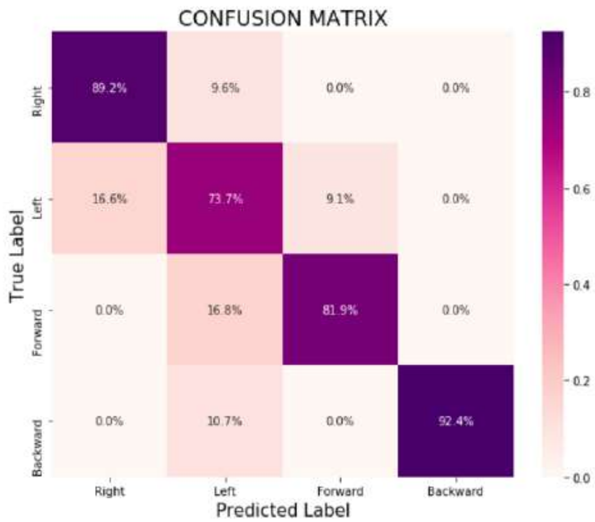
The true positive prediction for :
Right – 93.40%
Left – 93.70%
Forward – 96.70%
Backward – 100%

FIGURE 16 CF OF ENSEMBLE BAGGED TREE



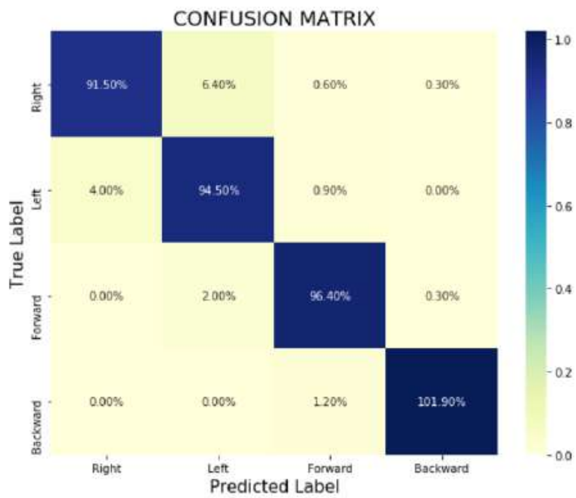
The true positive prediction for :
Right – 93.50%
Left – 88.4%
Forward – 92.2%
Backward – 100%

FIGURE 17 CF OF QUADRATIC DISCRIMINANT ANALYSIS



The true positive prediction for :
Right – 89.20%
Left – 73.7%
Forward – 81.9%
Backward – 92.4%

FIGURE 18 CF OF LINEAR DISCRIMINANT ANALYSIS



The true positive prediction for :
Right – 91.50%
Left – 94.50%
Forward – 96.40%
Backward – 100%

FIGURE 19 CF OF K NEAREST NEIGHBOR

FIGURE 20 CF OF NAIVE BAYES

The true positive prediction for :
Right – 95.4%
Left – 71.90%
Forward – 86.70%
Backward – 99.7%

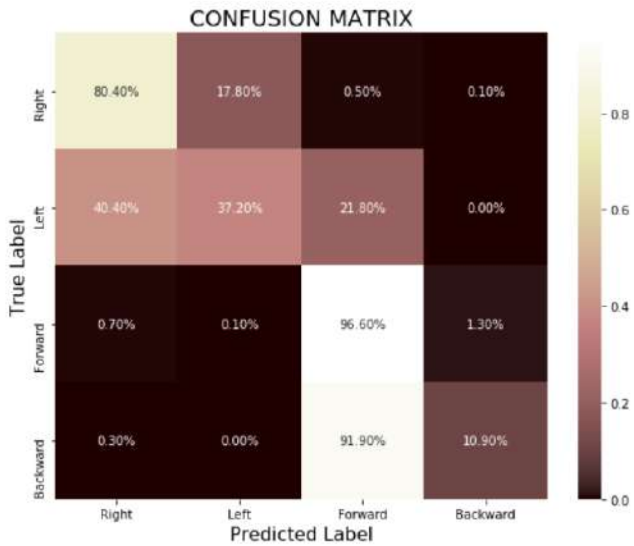


FIGURE 21 CF OF ADABOOST

The true positive prediction for :
Right – 80.40%
Left – 37.20%
Forward – 96.60%
Backward – 10.90%

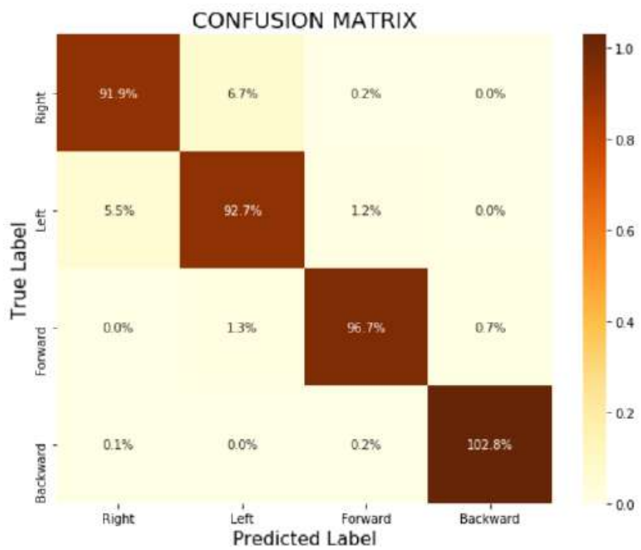


FIGURE 22 CF OF DECISION TREES

The true positive prediction for :
Right – 91.90%
Left – 92.70%
Forward – 96.70%
Backward – 100%

2.6 ARDUINO IDE for Servo Motor

Here, we have built a machine learning model in Jupyter Notebook and saved it in the working directory. Then we uploaded the model to ARDUINO to move the Servo Motor forward, backward, left and right. We wrote Servo motor code to move the Wheelchair. This is how we perform movement of wheelchair with the help of head motion.

CHAPTER 3: DESIGNING AND RESULT ANALYSIS

"This chapter brief about the designing of our circuit for the project. We describe how the Arduino Uno is connected to the servo motor(Micro servo 9g – SG90) and Accelerometer(MPU6050). The result obtained by performing our project are presented below. Results that we got from Head Motion Recognition."

3.1 DESIGNING

In figure 23 and 24 we have shown the step by step approach of hardware and software used.

3.1.1 SOFTWARE BLOCK DIAGRAM

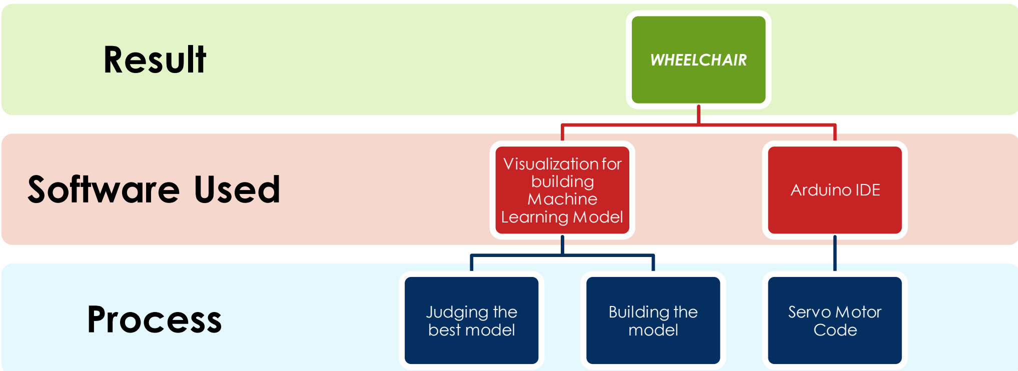


FIGURE 23 FLOWCHART - SOFTWARE

3.1.2 HARDWARE BLOCK DIAGRAM

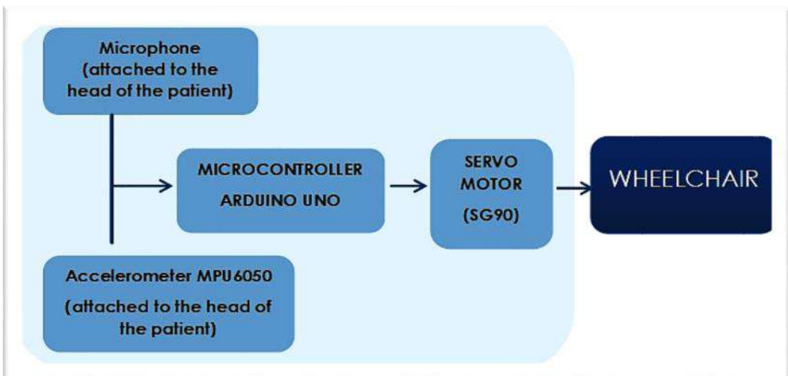


FIGURE 24 FLOWACHART – HARDWARE

3.1.2 CIRCUIT OF ACCELEROMETER AND ARDUINO UNO

First we ensure all the pins are properly connected.

Connect Arduino to COM4 port
Vcc - 5v
GND - GND
SCL - A4
SDA - A5
As shown in Fig 25.

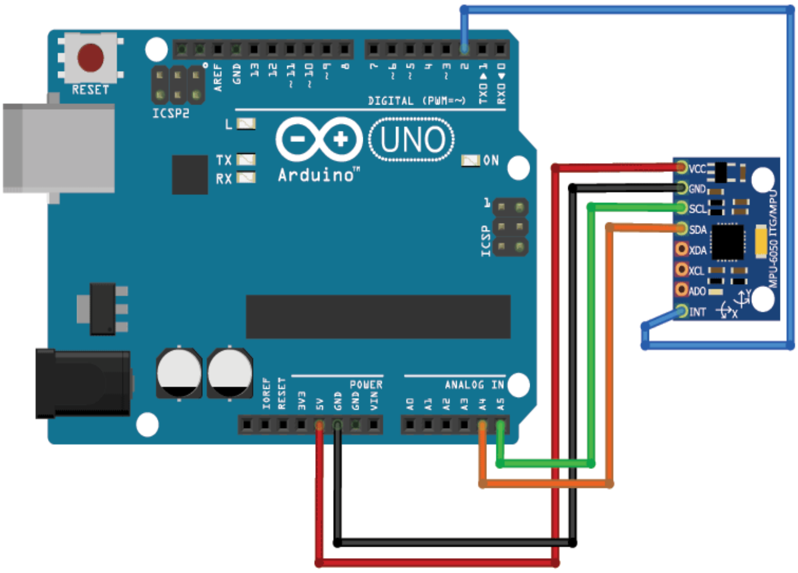


FIGURE 25 ACCELEROMETER AND ARDUINO UNO CONNECTIONS

3.1.3 CIRCUIT OF SERVO MOTOR AND ARDUINO UNO

First we connect ground of servo motor to ground pin of Arduino Uno. Then we connect the Vcc of servo motor to 5v pin of Arduino Uno. At last we connect the supply of servo motor to D9 of Arduino Uno. As shown in fig. 26.

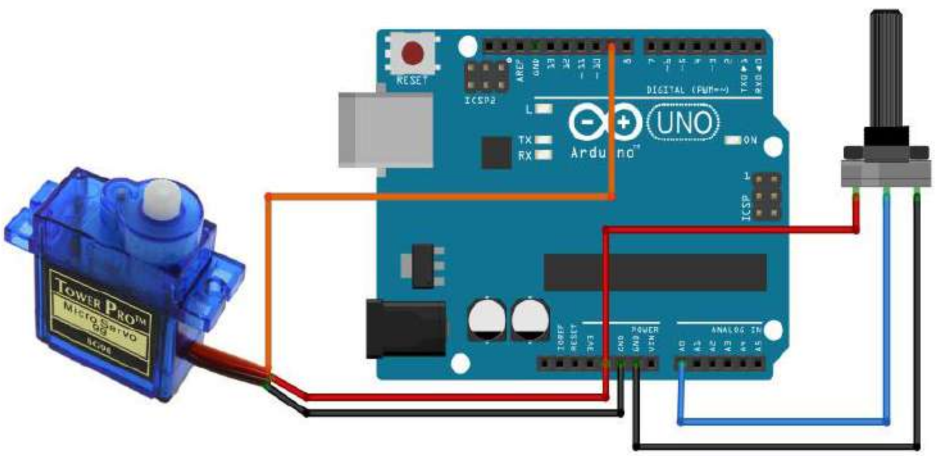


FIGURE 26 SERVO MOTOR AND ARDUINO UNO

3.2 RESULT ANALYSIS

In this experiment, we made a complete demonstrative model to show that wheelchair can be moved through movement of head and speech recognition. The technique is implemented as an algorithm of microcontroller system. A prototype of this system is experimentally tested. The performed experiment showed very good results. On comparing our results in ideal situations, we got an accuracy of **96.8%** which was quite remarkable. We built the model in Jupyter Notebook/Spyder which made the base work easier. The researches performed in [1 – 4]; show that the psychological condition of the patient greatly influences his ability to control the wheelchair. Taking into account these researches, we can conclude that some errors in our experiment emerged because the examinees were controlling the wheelchair in a very unusual way and in a very narrow indoor environment without any kind of protection. Also, the fact that in this series we considered the worst-case scenario (down-up-down) has to be accounted. Such motions should be avoided and the user should take care of the command time frame. So, slower motions when no command is intended are suggested.

CHAPTER 4: MERITS, DEMERITS AND APPLICATIONS

"The idea implemented in this projects has its pros and cons like every other project. Merits and Demerits of the projects are discussed below. The applications of the projects are also explained here."

4.1 MERITS

1. Easy to use, as the system is easy to operate. Anyone can use it with ease and it provides good compatibility.
2. Easy to deploy, it can be deployed on any wheelchair.
3. Low in cost, as it can be deployed on any wheelchair, it will make any wheelchair a smart wheelchair.
4. Eco-friendly, the chair uses electric signals.
5. User friendly.

4.2 DEMERITS

1. Wired connections, the connections can be wireless as well, but in this system, we have used wired connections. So, it may be chaotic.
2. Sudden motion is also considered, motion like yawning, sneezing, coughing, etc. will also be considered.
3. Different person may have different angle of motion, head motion might be restricted up to an angle for some people. It may vary, which might cause problems.
4. Training data might differ, as the data is the main source of motion. If the data is not correct, the motion performed by the chair might be wrong.

4.3 APPLICATIONS

1. It can be used in home.
2. It can be used in hospitals.
3. It can be implemented to achieve an assistant less wheelchair.
4. It is easy to design and manufacture, because we don't have to make any changes in the wheelchair, we only have to add this motion-controlled system.
5. It uses Arduino, which make it affordable.

CHAPTER 5: CONCLUSIONS AND FUTURE SCOPE

"The conclusion of the project is stated below. It is what we thought of the project and how it may change the life of people. We are engineers, our objective is to make one's life better and we are happy that we are able to achieve it."

5.1 CONCLUSION

This survey is the accomplishment of the task where HEAD MOTION CONTROLLED user interface for elderly and disable people has been. From this survey it has been identified that elderly and disable needs more technology support using their nature behaviour, considering their limitations. We can use affordable technology for daily activities. The wheelchair is fully capable of moving in accordance to the head gesture given by the person who is using the wheel chair. Certain improvisation and improvement can be done to make the wheelchair more reachable to those whose whole body is paralyzed. Certain eyes gesture or brain signals reader can be imparted on the wheelchair system so as to make it better.

	Model	Cross-Val Score	Train-Test Score
0	Bagged Trees	96.8683	96.450
1	Boosted Trees	77.59	56.275
2	K Nearest Neighbors	90.45	96.075
3	Decision Trees	88.4	96.300
4	Support Vector Machine - Linear	86.37	NaN
5	Support Vector Machine - Sigmoid	75.84	NaN
6	Support Vector Machine - Poly	88.555	NaN
7	Support Vector Machine - RBF	88.47	NaN
8	Linear Discriminant Analysis	NaN	84.300
9	Quadractic Discriminant Analysis	Nan	93.650
10	Naive Baiyes	NaN	88.425

FIGURE 27 ACCURACY

We have obtained accuracy scores for 10 classification algorithms in which Ensemble Bagged Trees outperformed all the others both in cross-validation and train-test methods. As shown in figure 27 the ensembled bagged trees has an accuracy of 96.8683%.

For now, it works for all kind of disabled or elderly person, and even for those patients whose whole body is paralysed but still head movement is possible.

5.2 FUTURE SCOPE

Technologies developed based on gesture are now really affordable and converged with familiar and popular technologies like TV, large screen. It's ubiquitous and nonintrusive as we can install a camera or remote with the TV. From this paper we can see the trends of gesture-controlled communication systems. Easing of the technology use, affordability and familiarity indicate that gesture-based user interface can open new opportunity for elderly and disable people. That can act as motor kill switch. Within this paper a novel technique of head motion recognition is used to enable wheelchair control for quadriplegics. The technique is implemented as an algorithm of microcontroller system. A prototype of this system is experimentally tested. The performed experiment showed very good results. The prototype consists of an electronic and a mechanical part. It is designed to be characterized by low price and high level of modularity. Namely, it can be used with several different types of standard electric wheelchairs. In future work we plan to complete the inertial navigational system by including the gyroscope. We assume that the usage of the additional sensor would improve the ability of the system to recognize the user's commands. Also, the experiments to test the applicability of this system in real conditions are needed: (1) integrate the control of the wheelchair motors and repeat the experiment performed in this paper and (2) when the system becomes.

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