DOUBLE SELF-BALANCING ROBOT

Technical Report · November 2020

DOI: 10.13140/RG.2.2.14414.48965

Muhammad Faizan Qureshi
Usman Institute of Technology

USMAN INSTITUTE OF TECHNOLOGY

Affiliated with NED University of Engineering & Technology, Karachi

Department of Electrical Engineering

B.E. Electrical (Electronics Engineering)

FINAL YEAR PROJECT REPORT

Batch-2016

DOUBLE SELF-BALANCING ROBOT

By

Muhammad Faizan	16B-181-EL
Hasnain Raza	16B-182-EL
Ahmed Raza	16B-185-EL

Supervised by

Engr. Zia Ud Din (Assistant Professor)

ST-13, Block 7, Gulshan-e-Iqbal, Abul Hasan Isphahani Road, Opposite Safari Park, P.O. Box 75300, Karachi, Pakistan. Phone: 34978274-5; 34994305; 34982476; http://www.uit.edu

DECLARATION

We hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at USMAN INSTITUTE OF TECHNOLOGY or other institutions.

Student Name (Student ID):	Muhammad Faizan (16B-181-EL)
Signature:	___________________________
Student Name (Student ID):	Hasnain Raza (16B-182-EL)
Signature:	___________________________
Student Name (Student ID):	Ahmed Raza (16B-185-EL)
Signature:	___________________________
Date:	___________________________

ACKNOWLEDGEMENT

First, the whole praise to ALMIGHTY ALLAH, the creator of the universe, and anything in this universe. He made us super creatures, blessed us to accomplish this work. We are very thankful to our parents and teachers, our inspirations and mentors, whose energy and efforts bring us to this level. We want to thank the Department of Electrical Engineering, Usman Institute of Technology, Karachi for providing us a golden opportunity by accepting and approving our project in the first instance. It is our radiant sentiment to place on record our best regards, deepest sense of gratitude to **Engr. Zia Ud Din**, our project advisor, and the Assistant Professor in the Department of Electrical Engineering, Usman Institute of Technology, who helped us to turn an idea into reality with true results. Bearing in mind previously we are using this opportunity to express our deepest gratitude and special thanks to **Dr. Syed Talha Ahsan**, Head of Electrical Department, and **Engr. Atif Fareed**, In charge of Final Year Projects, who encouraged us to go ahead with our project. Without the guidance and counsel of these people, it would be impossible for us to complete this project.

DOUBLE SELF-BALANCING ROBOT

ABSTRACT

This report focuses on a project in which one self-balancing robot balances on the top of another self-balancing robot. This project is based on the Particle Robot Theory that states about the Modular Approach in the field of Robotics resulting in more stable and efficient robots in the future. The system uses a PID controller to minimize the error between the current value and the targeted value. The project is the illustration of an Inverted Pendulum which is a very complex classical engineering problem. This project gives a whole new dimension to control systems working in anonymous conditions.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

MAPPING OF PROGRAM LEARNING OUTCOMES (PLOs)

Chapters 1 through 4 and Appendix A & Appendix B	PLO-(x)-Communication PLO-(viii)-Ethics PLO-(ix) Individual & Teamwork PLO-(iv)-Investigation
Chapter 01 – Introduction	PLO-(ii)- Problem Analysis
Chapter 02 – Methodology	PLO-(iv)-Investigation
Chapter 03 – Implementation	PLO-(iii)-Design/Development of Solution PLO-(v)-Modern Tool Usage

CHAPTER # 01

INTRODUCTION

The field of advanced robotics has ruled the brains of individuals around the globe. It was the dream of humans to create such a machine that replicates them in every aspect of daily life. Such a machine that reflects their thoughts, gestures, postures, and perform daily life activities. Development in this field for the last couple of decades has transformed dreams into reality. The utilization of productive microcontrollers and sensitive sensors has helped so much in accomplishing this achievement. Presently robots can be found in our day by day life. Robots are utilized on creation lines in plants, showed up as wise machines to do a particular task, or utilized as business items.

Wheeled portable robots have a huge preferred position over humanoid type robots, in that they are quicker and can even more effectively change direction while moving, and this makes them extremely valuable for a few applications. Among wheeled robots, two self-balancing robots, the Segway and Ninebot, have gotten well known and are utilized for driving or as transportation material. Also, self-balancing wheeled robots are currently used as a service robot platform. The characteristically self-balancing robot is unsteady, and it would move around the wheels' rotation axis without outside control, and sooner or later it will fall. The robot returns to the right position if motor driving occurs in the right direction. The robot is normally unsteady although it has numerous favors over the statically stable multi-wheeled robots. A unique electromechanical system wherein the robot must be founded on balances itself onto a couple of wheels while standing tall. If the base on which the robot stand is not stable or the platform is not balanced, the robot tends to fall off from the vertical axis. This time a gyro chip is expected to give the PID controller about the angular position of the base of one self-balancing robot. The robot must be work upon any surface dependent on two motors developed with wheel one for each.

The self-balancing robot gets adjusted on a couple of wheels having the necessary hold giving adequate contact. For keeping up the vertical axis two things must be done, one is estimating the tendency point and the other is controlling of engines to push forward or in reverse to maintain 0˚angle with the vertical axis. For measuring the angle, two sensors, an accelerometer, and a gyroscope are used. The accelerometer can sense either static or dynamic forces of acceleration and the Gyroscope measures the angular velocity.

In this project, we are going to balance one self-balancing robot on top of another self-balancing robot. This project is the illustration of an Inverted Pendulum and Particle Robotic Theory.

1.1. Problem Statement

Till now we do not have a modular approach in the field of robotics. The problem faced in the last few years that we have a single unit/system to do all the work and if we faced any malfunctioning in this unit/system we have to replace the whole unit/system but now we are trying to overcome this problem by implementing the modular approach. A modular approach in the field of robotics results in small robots to perform the same task which was taken by the single unit/system.[1]

1.2. Literature Review

There are many research papers and articles related to the project and its operations. In one of the articles “Particle robot - works as a cluster of simple units,” it states that in the future there will be multiple units of systems that will work in form of clusters to perform any task and to achieve the target. Particle robot theory also states about the modular approach in the field of robotics resulting in more stable and efficient robots in the future. Also in another research paper

“Self-balancing robot implementing the inverted pendulum concept” through this article we got the idea that we implement two robots in a way that will act as inverted pendulum theory or it shows the illustration of an inverted pendulum.[2]

1.3. Aims and Objective

The aim and objective of our project are to design and implement a double self-balancing robot that would bring many attributes and aspects of robots in it. It would be a fully automatic system that will vary its direction and position automatically be sensing its surroundings and whenever it would be like going unstable it will automatically make itself stable with the help of sensors and controllers. Also, our objective was to attain the concept of particle robotics theory in our project to perform any huge task in form of clusters.

CHAPTER # 02

METHODOLOGY

2.1. Hardware Detail

2.1.1. Arduino Mega

The Arduino Mega is a controller dependent on the ATmega1280 (datasheet). It consists of 54 computerized input/output pins (out of which 14 can be utilized to generate PWM output), 16 analog inputs, 4 UARTs (hardware sequential ports), a 16 MHz crystal oscillator, a USB port, a power jack, an ICSP header, and a button to reset the whole system. It contains all the requirements to help the microcontroller; essentially associate it to a PC with a USB port or power it with an AC-to-DC connector or battery to begin.

Figure 1: Arduino Mega

Table 1: Specs of Arduino Mega

Microcontroller	ATmega1280
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	128 KB
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

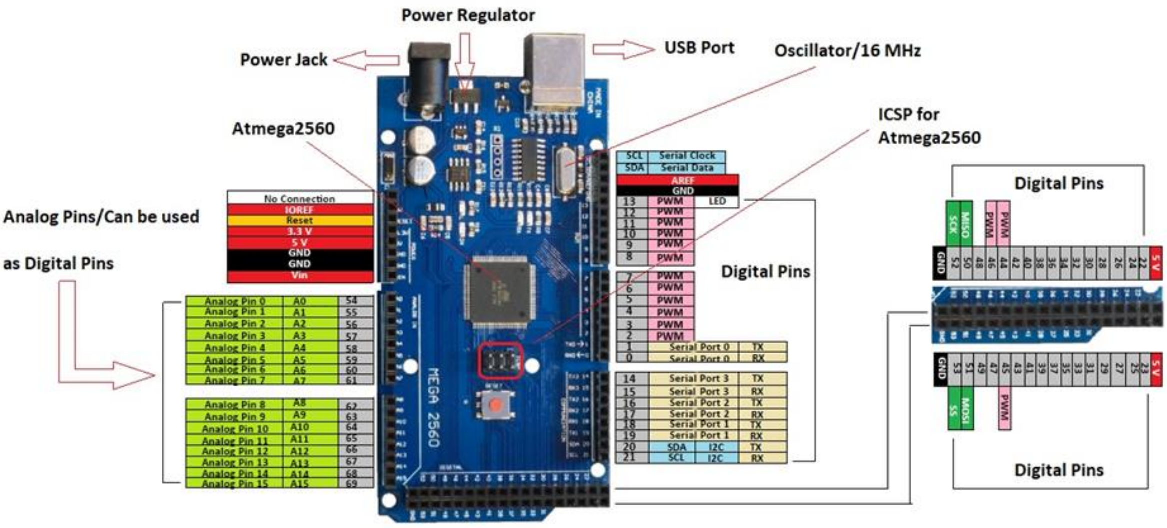

Figure 2: Pinout of Arduino Mega

2.1.2. MPU 6050

MPU-6050 is utilized because of its DMP ability. It can handle the Raw Accelerometer and Gyro esteems to give the Yaw, Pitch, and Roll. It incredibly diminishes the calculation overhead. MPU6050 is fundamentally a sensor for movement handling gadgets. It is the world's first six measurement movements GPS device. It was intended for ease and superior exhibitions cell phones, tablets, and wearable sensors. It is fit for handling nine-axis calculations, it catches movement in X, Y, and Z-axis at a similar time. MPU6050 is utilized in various modern projects and electronic gadgets to control and recognize the 3D movement of various objects.

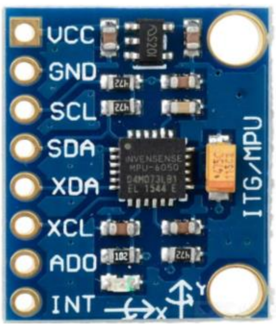

Figure 3: MPU-6050

- MPU6050 is a Micro Electro-mechanical system (MEMS), it comprises of three-axis accelerometer and three-axis gyro sensor. It causes us to gauge speed, direction, quickening, displacement, and other movements like features.
- MPU6050 comprises of Digital Motion Processor (DMP), which has the property to explain complex problems.
- MPU6050 comprises a 16-bit analog to digital converter equipment. Because of this element, it catches the three-axis movement simultaneously.
- This module has some well-known highlights which are effectively open, because of its simple accessibility it tends to be utilized with a popular microcontroller like Arduino.
- This module utilizes the I2C module for interfacing with Arduino.
- MPU6050 is more affordable, Its principle highlight is that it can easily merge with accelerometer and gyro.

Table 2: Pinout of MPU-6050

MPU6050 Pinout		
Pin	**Pin Name**	**Description**
01	Vcc	This pin is used for Supply Voltage. Its input voltage is +3 to + 5V.
02	GND	This pin use for ground
03	SCL	This pin is used for clock pulse for I2C compunction
04	SDA	This pin is used for transferring data through I2C communication.
05	Auxiliary Serial Data (XDA)	It can be used for other interfaced other I2C modules with MPU6050.
06	Auxiliary Serial Clock (XCL)	It can also be used for other interfaced other I2C modules with MPU6050.
07	AD0	If more than one MPU6050 is used in a single MCU, then this pin can be used to vary the address.
08	interrupt (int)	This pin is used to indicate that data is available for MCU to read.

2.1.3. Motor Driver

A motor driver is a gadget or group of gadgets, which is utilized to control in a foreordained manner the operational presentation of an electric motor. The motor driver makes the controller compatible with the control of motors by boosting its power. The motor driver we are using in this project is TB6612FNG.

Figure 4: TB6612FNG

- Double H-bridge motor driver is the driver which can drive two DC motor or one bipolar stepper motor
- Suggested motor voltage (VMOT): 4.5 V to 13.5 V (can work down to 2.5 V with derated execution)
- Output consistent current: 1 A for every channel (can be resembled to convey 2 A continuous)
- Maximum PWM frequency: 100 kHz
- A built-in feature of a thermal shutdown circuit
- Filtering capacitors on both supply lines
- Reverse-power protection on the motor supply

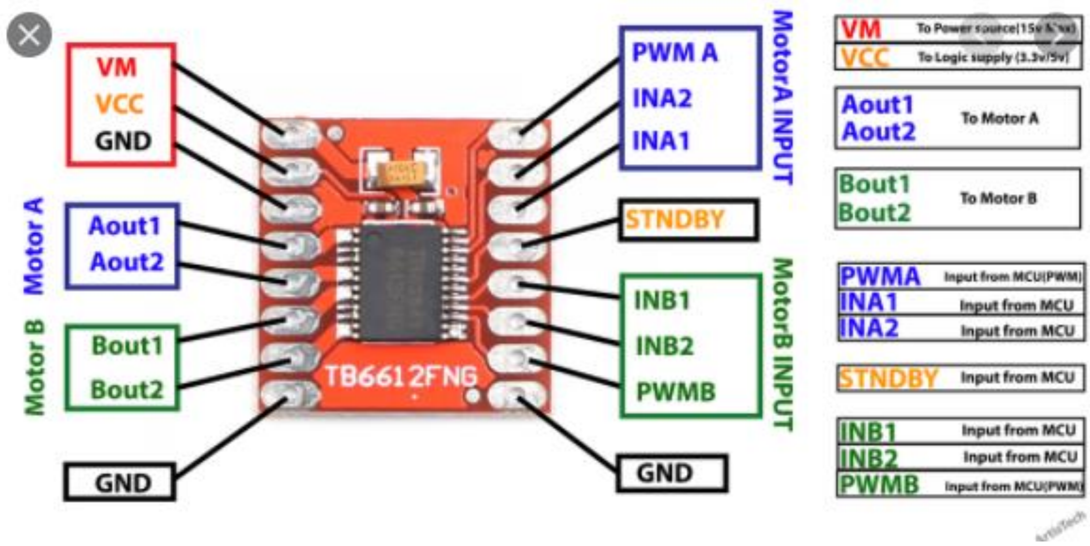

Figure 5: Pinout of Tb6612FNG

2.1.4. Motors and Wheels

Motors are an essential component for providing stability. We use Encoder motors of 12v and 280 rpm in this project.

Figure 6: Wheels and Motors

Table 3: Technical Specs of Motor and Wheel

Rated Voltage	DC 12V
Speed	280 RPM
Wire	6 Wires
Wire Length	19cm
Shaft Type	D-Shape
Shaft Size	4mm x 9.5mm/ 0.16in x 0.37in(D*L)
Motor Size	25mm x 70mm/ 0.98in x 2.77in(D*L)
Wheel Size	65mm x 26mm/ 2.56in x 1.03in(D*T)

Figure 7: Pinout of Encoder

- 2 terminal connectors
- Cylindrical gear motor with a 6 different ways encoder.
- 6 Ways: C1 Encoder with two-phase A and B
- Motor Power supplies Negative and Positive
- Encoder Power supplies Negative and Positive.
- Extraordinary substitution for the corroded or harmed DC gear motor on the machine.

2.1.5. Battery

Lithium-ion polymer batteries are appropriate for this sort of use. To supply the fundamental power the motor demands and the vital power for the right flexibly of all the components of the PCB, a LiPo battery of 3.7V and 2200mah will be utilized.

Figure 8: Lithium-Ion Battery

2.1.6. Acrylic Sheet

Figure 9: Acrylic Sheet

It is used for the body of the robot.

2.2. Software Detail

2.2.1. Arduino IDE

The Arduino integrated development environment (IDE) is a cross-stage application (for Windows, macOS, Linux) which is written in the well-known programming language Java. It is utilized to compose and transfer programs to Arduino compatible boards, yet besides, with the assistance of outsider centers, other merchant advancement boards.

Arduino IDE is a lightweight, cross-stage application that acquaints programming with beginners. It has both an online editor and an on-premise application, for users to have the option of whether they want to save their sketches on the cloud or locally on their computers.

While Arduino IDE is profoundly evaluated by users as indicated by usability, it is additionally fit for performing complex processes without burdening computing resources.

With Arduino IDE, users can without much stretch access contributed libraries and get modern help for the most recent Arduino boards, so they can make portrays that are sponsored by the freshest form of the IDE.

2.3. Block Diagram

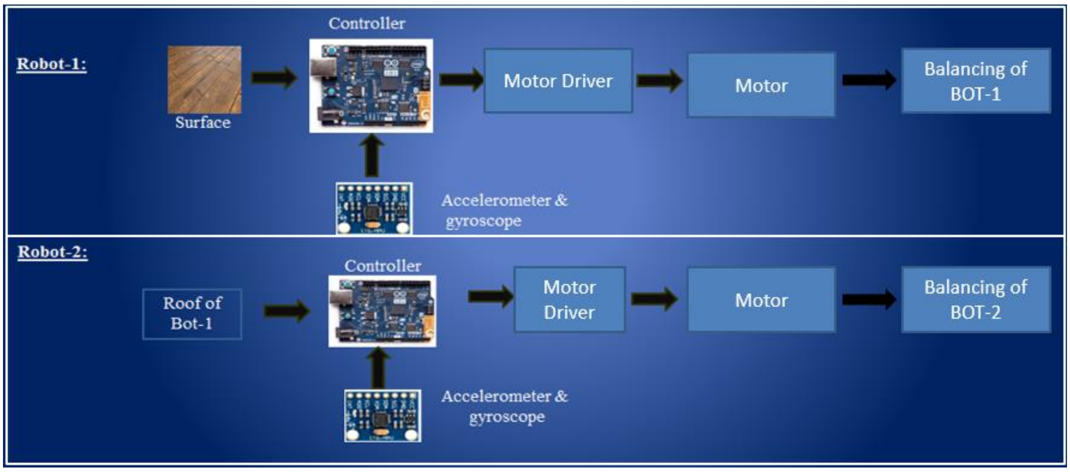

Figure 10: Complete Block Diagram

CHAPTER # 03

IMPLEMENTATION

3.1. Details of Hardware Implementation

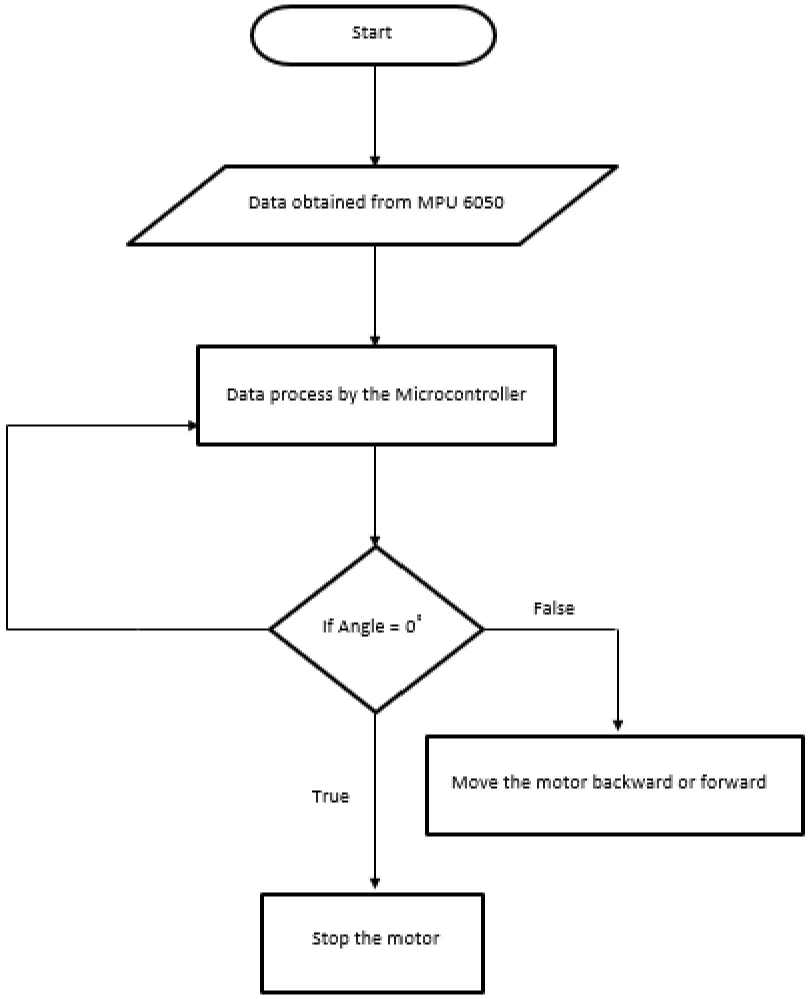

Figure 11: Flow Chart of the project

3.1.1. Structural Implementation

At first, we implemented the structure of our project (DSB) robot. For the first bot, we took acrylic sheets for creating the base of the first bot, and on that base, we placed a lithium-ion battery on it. After placing the battery now moving one step forward we placed one more acrylic sheet with the help of a separator on the top of the base. Now on that sheet, we placed our controller (Arduino mega), gyro sensor, and motor driver on that floor. After creating that sheet now we placed one more sheet also with the help of a separator for making the roof of the first bot. So that our second bot can be placed on that roof of the first one. For the structure of the second bot, the same implantation will be applied as explained above.

3.1.2. Sensor Module

Mpu6050 is the sensor we are using in our project to measure the tilted position and to measure the speed that how rapidly both robots are shifting their positions. The purpose behind choosing that sensor is because this mpu6050 is the package of gyroscope and accelerometer. If we talk about the implementation of a gyro from this package so gyro is giving us the data of tilt positioning data and orientation data of the bot to the controller. Similarly, the accelerometer is working in a way that it is giving us the data of the bot that at what speed and what time it is taking to change and to shift its position and angle.

3.1.3. Control Unit

Arduino Mega is the main central processing unit in our project DSB robot. It is the controller at which all the decisions are being taken by receiving input from the sensor mpu6050 and based on that input (receiving from sensor mpu6050) it gives command through the program running on the controller to the motor driver whether to move forward or backward depends on the tilted position of the bot and the data receiving through sensor so the driver will now operate the motors after receiving commands from the controller. Thus we can say that Arduino mega is the main central processing unit of this project.[5]

3.1.4 Driver Module

We are using motor driver TB6612FNG in our project. The mechanism of the motor driver in our project is that it makes the encoder of the motor compatible with the controller that how it will communicate with the controller and what type of data and how the data will be provided to the driver through the controller. That is why the motor driver is the most essential component in our project to drive the motors in a way that what speed does the motors need to move forward or backward like what kind of input the driver is receiving through a controller and based on that input motor driver will now give the command and operates the motor with a particular speed based on what bit of data, a driver is receiving from the controller. So, therefore, for transmitting the output of the controller towards the motor we have to use the driver for it which helps us to first receive that data from the controller and transmit it towards the motors.

3.1.5 Encoder motors:

Encoder motors are very sensitive which defines a prescribed position. Now if we just talk about encoder, so it operates in such a way that it gives us the data that at what direction (clockwise or anticlockwise) and speed these motors are functioning. This is how the encoder of the motors gives us the prescribed position of the motors. That was our purpose behind using that motor because it shows us the position and speed(rpm) of the motor that at what degree our motor is now been located so when the new input will be received from the driver it will get back to the targeted position. The encoder is working as a feedback system in our project receiving data from motors and transmitting it towards the driver then the driver gives the command to bring that motors to the targeted position.

3.2. Details of Software Implementation

The computer program that's being utilized is Arduino IDE to program the ATmega1280 Microcontroller and MPU6050 Sensor. When the system is turned on, the MPU6050 sensor obtains information from the accelerometer and gyroscope within the form of a combined three points which decide the resultant inclination point and orientation of the robot. The obtained information is then passed through a Kalman Filter that calculates and clears any noise or outside distortions and interferer within the information signal. The information is then exchanged through an I2C communication transport to the microcontroller. The microcontroller gives the command to the motor driver which alters the direction of the motor to perform the self-balancing operation whether it may be forward or backward.[3]

3.3. Schematic Diagram

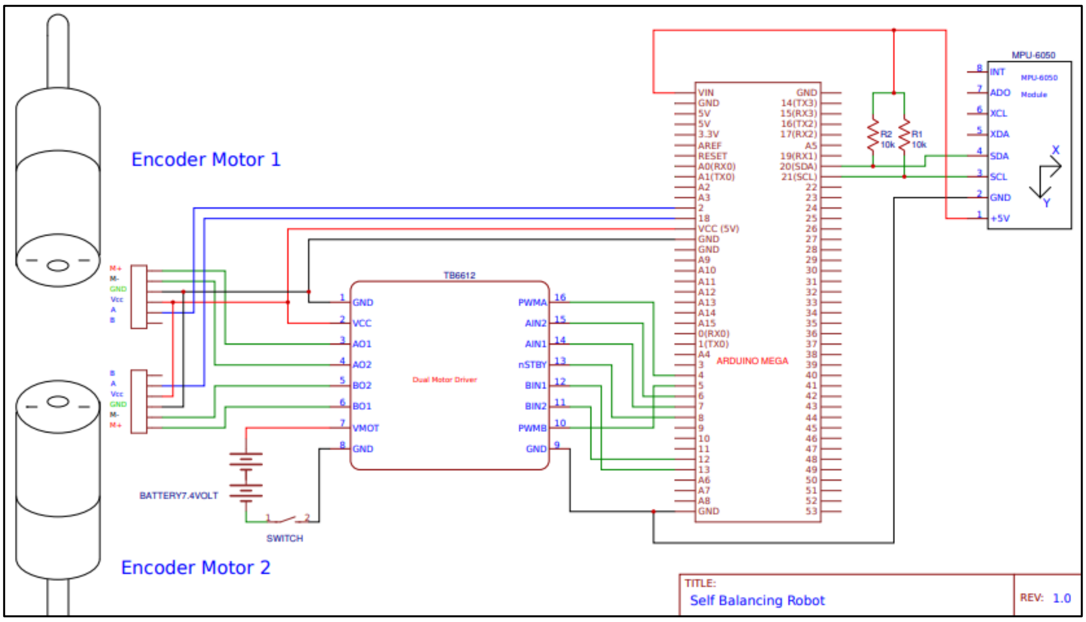

Figure 12: Circuit Diagram

CHAPTER # 04

PROJECT CHARACTERIZATION

4.1. Results

The output we have achieved is the Double Self-Balancing Robot succeeding in the balance of one robot on another robot (placed on the roof of the first robot). The outcome of our project is to synchronize the unstable systems to perform several tasks using the application of particle robotic theory. Which operates through lithium ion batteries which can energize through an ordinary module charger on a double self-balancing robot has a self-balancing activity which can keep the operator from any kinds of fall harm.

4.2. Analysis

The analysis of our project tells the advantages and motivations behind all the components and functions on which the double self-balancing robot is worked. We used encoder motors in our project because it gives us much better efficiency instead of stepper motors also the encoder motors are light weighted motors as compared to stepper motors.

For driving out the motors the system uses the motor driver named TB6612FNG to gain much more stability than L293D which is not compatible with our project as its resolution was not like what we desired for the robot because we want to gain much more stability which we can't get from L293D. As indicated by the examination, the double self-balancing robot has numerous remarkable highlights than a single self-balancing robot.

4.3. Conclusion

This paper has presented a design and implements a Proportional Integral Derivative (PID) controller on a Double self-balance (DSB) robot. It was illustrated that the DSB robot that is capable of balancing one robot onto another and can follow the desired trajectory is realized. This was done using Arduino, and other off-the-shelves parts to make it affordable, easier for maintenance and improvement. These robots can make a balanced and controlled body in the first part and after making the fusion they will produce one single controlled by balancing one robot onto another. The PID controller was planned and created progressively. The significance of controlling the PID gains to the exhibition of the controller has been demonstrated tentatively.[4]

4.4. Future Recommendations

Our project is from the future created on an innovative idea of a modular approach, that in future particle robots will perform in a way of clusters to perform some big task. So, therefore, the future recommendation of our project can be that first gain more stability of both the bots and then placed more than two or more number of bots onto another and start taking more task related to height and also related to moving stuff from one place to another from them.

REFERENCES

[1] "Particle robot - works as a cluster of simple units" Rob Matheson | MIT News Office March 20, 2019.

[2] Iulian Matesica, Mihai Nicolae, Liliana Barbulescu, Ana-Maria Margeruseanu, "Self-balancing robot implementing the inverted pendulum concept," in 15th RoEduNet Conference: Networking in Education and Research, Bucharest, Romania, 2016.

[3] C. Gonzalez, I. Alvarado, D. Munoz La Pena, "Low-cost two-wheels self-balancing robot for control education," in 20th International Federation of Automatic Control World Congress, IFAC, Sevilla, Spain, 2017, pp 9174-9179.

[4] Felix Grasser, Aldo D Arrigo, Silvio Colombi, Alfred Ruffer, "A Mobile Inverted Pendulum," IEEE Trans. Electronics, vol. 49, no. 1, pp. 107-114, Feb 2002.

[5] Jingtao Li, Xueshan Gao, Qiang Huang, Matsumoto, "Controller design of a two-wheeled inverted pendulum mobile robot," in ICMA 2009 IEEE International Conference on Mechatronics and Automation, Takamatsu, Japan, 2009, pp 220-250.

APPENDIX A: Complex Engineering Problem

Appendix A1: Range of Resources

The fundamental idea of diversified resources is to make the ideal item more effective and inventive utilizing numerous spaces to make quality items and use less time utilization. In our project Double Self balancing robot (DSBR), the major components which are being used such as the encoder motor, motor driver TB6612FNG, Arduino mega as a controller, MPU 6050 sensor, etc.

The different domains in the project are determined, for example, the encoder motors that are being used to defines a prescribed position it operates in such a way that it gives us the data that in what direction (clockwise or anticlockwise) and speed these motors are functioning. This is how the encoder of the motors gives us the prescribed position of the motors whereas Arduino mega is the main central processing unit in our project DSB robot. It is the controller at which all the decisions are being taken. Mpu6050 is the sensor we are using in our project to measure the tilted position and to measure the speed that how rapidly both robots are shifting their positions. The purpose behind choosing that sensor is because this mpu6050 is the package of gyroscope and accelerometer. We are using motor driver TB6612FNG in our project, it makes the encoder of the motor compatible with the controller that how it will communicate with the controller, and what type of data and how the data will be provided. The programming which is utilized to command the microcontroller and accumulate information from the sensor can be considered as a software domain. Hence, the task is made out of hardware, electrical, and programming area working which shows why the diversified resources are important to create or produce any sort of project.

Table 4: Range of Resources

Human Resource			
S. No.	Discipline	Resource	Description
1	Engineering	Hardware/ Electrical	Assembly of electrical components
2	Engineering	Software Implementation	Coding of the project
Material/Equipment			
S. No.	Discipline	Resource	Description
1	Electrical	Encoder motors	Encoder motors are very sensitive which defines a prescribed position.
2	Electrical	Motor Driver	We are using motor driver TB6612FNG in our project, it makes the encoder of the motor compatible with the controller that how it will communicate with the controller and what type of data and how the data will be provided
3	Electrical	MPU6050 Sensor	Mpu6050 is the sensor we are using to measure the tilted position and to measure the speed that how rapidly both robots are shifting their positions
4	Electrical	Arduino Mega(Microcontroller)	Used to fetch data from the sensor and give commands to the motor controller.
5	Electrical	Lithium-ion batteries	Used as the power supply source to operate.
Reference Literature			
S. No.	Discipline	Resource	Description
1	Engineering	Article	One of the article related to double inverted pendulum gives us an idea of a double self-balancing robot
2	Engineering	Article	One of the articles based on the Particle Robotics Theory that states the Modular Approach in the field of Robotics resulting in more stable and efficient robots in the future.

Appendix A2: Innovation

Initially, it was designed as a self-balancing robot, but to accumulate advancement, we designed a double self-balancing robot in which one bot will balance itself on the top of another and also achieve the objective of gaining more stability than the previous one. Our project aims to design and implement a double self-balancing robot that would bring many attributes and aspects of robotics in it.

The idea which was enabled in our project is about the application of inverted pendulum working in anonymous conditions in which the upper stick balance itself on the top of the lower stick provided a properly controlled environment.

This project is based on the Particle Robot Theory that states about the Modular Approach in the field of Robotics resulting in more stable and efficient robots in the future. Today we are simulating the working of the human body as a type of robot called Humanoids. These robots perfectly simulate the muscular operation of the human body.

We are combining the existing approach in such a way that according to particle robot theory of modular approach we design two self-balancing bots and from control system application we design our bots in such a way that the one bot will balance itself on the top of another.

Some of the unique recourses which are being utilized in our project are Encoder motors which very sensitive and define a prescribed position, Mpu6050 sensor to measure the tilted position, and to measure the speed that how rapidly both robots are shifting their positions.

Appendix A3: Level of Interaction

Numerous issues arise during the implementation phase of the project such as the tuning of PID algorithm and sensor perimeters to control the speed and direction of the motor, the coding of the controller Arduino mega causing bugs and errors during the implementation, these types of issue arise when different components of dependent perimeters are combined in a single compact project. These issues can be resolved by combining and working on the components utilized in the project through the relevant basic knowledge of the system. These problems can be technical, human, and they can be addressed through observations and discussions with experts in the relevant fields related to the project.

Appendix A4: Consequences to Society and Environment

The field of advanced mechanics has ruled the brains of individuals around the globe. It was the fantasy of people to make such a machine that reproduces them in each part of everyday life. Advancement in this field for the most recent few decades has changed dreams into the real world. The utilization of proficient microcontrollers and touchy sensors has helped a great deal in accomplishing this achievement. Presently robots can be found in our daily life. Robots are utilized on creation lines in processing plants, showed up as intelligent machines to do a particular task, or utilized as business items. Till now we don't have a modular approach in the field of robotics. The issue looked in the most recent couple of years that we have single unit/framework to accomplish all the work and if we confronted any failing in this unit/framework we need to supplant the entire unit/framework yet now we are attempting to defeat this issue by implementing the modular approach. A modular approach in the field of robotics results in tiny robots to play out a similar undertaking that was taken by the single unit/framework.

Appendix A5: Familiarity

The familiarity of the project mainly relies on the ideas and fundamental information learned in the university courses. The university encourages the fundamental idea building procedures, for example, moral methods of examining an issue and building up an answer, instructing the aptitudes to handle any targets and issues under any kinds of pressure, for example, restricted period, restricted assets utilization, etc. The final year project is the final assessment of the apparent multitude of ideas and aptitudes learned in the university period which helps in better comprehension of performing functional work and picking up involvement with the V field. The project helps in growing the attitude and information as it does not just require the necessities in the particular field yet different fields and domains additionally play a significant role in the implementation of the task in this way giving a thought of which kind of work and aptitudes are needed in expert work. The difficulty which is experienced during the usage stage, for example, time management, restricted assets, differentiated points of view, etc. It discloses to us how expert morals and basic reasoning plays a significant job while working in the respective field. In our project, major components that were used, their basic knowledge concept and working were taught in the university's courses making it easy to learn and understand to use them in the project.

APPENDIX B: TURNITIN REPORT

How to Interpret Originality Report (Guidelines)?

1. Similarity index of the originality report is showing matches of submitted work with internet content. It is not verdict that document with high similarity index is plagiarized.
2. Similarity index is based on percentage of matched text out of total number of words in the document.
3. Instructor/Faculty member has to verify each and every similarity index for potential clue of plagiarism.
4. If similarities in the document are significant then scholar/student may be guided accordingly or case may be reported on the basis of that evidence.
5. The similarities in the document may contain matches with author's previous work; it may be ignored if it is the same work.
6. Bibliography and quoted material may be excluded after verifying. It is important to note that too much quoted material is not desired as per policy.
7. Common phrases and proper nouns also appear as similarities in the report, therefore every instructor/faculty member should ignore matches returned from them.
8. Originality report will show similarities from three major sources: internet, periodicals and student repository. Similarities returned from student repository may be ignored if it is authors own same work. Similarities from Student repository helps in detecting collusion in the documents.
9. The graphs, tables, formulae and other pictorial material is not matched through the service therefore, it will only offer similarities with only text.
10. The instructor/faculty member supervising students/scholars can give verdict of plagiarism after interpreting report. The report will be used as evidence of the report.