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One Wheeled Self Balancing Bike

A.R.Kare[1], Dhanraj Nimbolkar[2], Vishal Patil[3], Prasad Vyavahare[4], Anirudha Lanjewar[5]

Department of Electrical Engineering, NBNSSOEPune 411041, Maharashtra, India
Corresponding Author: dhanrajnimbolkar@gmail.com

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Abstract: *A robot which is a replica of human sized bike is being created by a uni wheeled self balncing bike. Regular sized vehicle having 2 or 4 wheels, are easy to stabilized and relatively huge in size. A conventional auto bot utilizes a four rotating wheels with four motors in motion, but one wheeled self balancing bot required only one wheel with single motor in motion. It is used mostly to covershorter intervals. In uni-wheeled self-balancing bot, the human weight which would come on the bike and the bike angle play a important role in controlling the entire movement. Are supported by inverted pendulum principal theory. There is need of an active control for the system so that it would be stable.*

Key Word: *Uni-wheel mobiled robot; Gyroscopic effect; Synchronization; Two left and right wheels; Gyro cycle*

I. Introduction

This introductory chapter presents the objectives, Scope and Methodology of a project. Our goal is to develop a Self- Balancing Uni-Wheeled Robot which will eliminate the Power Consumption of running to Motors, having the capacity to maintain its balance in one direction & which is efficient for fast movement on flat ground. Uni-wheeled or self-balancing robot is an unstable dynamic system distant from other four wheeled stable robots which are in equilibrium state. When there is unstable motion, the robot is free to fall in forward or backward direction without any application of force. The balancing of robot in an equilibrium state with 90º upright positions it means it is a self-balance. This project includes working on the inverted pendulum concept. For making it real, we are using Arduino Uno to build the self-balancing robot and to measure a current tilt angle, the inertial measurement unit MPU6050 is being used. A PID controller is able to control the pendulum angle of robot. For the future scope, the Raspberry Pi will help us to determine the surrounding conditions through live streaming and with the help of this camera the search and rescue operations will be performed. Sending in devastating areas were conventional bike is not able run easily. Rapid first aid services. Also the major part is to revolutionary change in food and goods delivery also, also help to traffic police transport in its actual human size vehicle. Segway is the most popular application of the self-balancing uni-wheeled robot. It is quickly available in market since 2011 and is additionally termed as a "Human Transporter".

II. Technical Aspect

Self-balancing operation:

A two-wheeled robot is naturally unstable. Hence, dedicated control strategies are not just essential for jumping, but also for standing still and driving. The Inverted Pendulum Principle occurs with the mathematical modelling of generally unbalanced system. Then the utilization of the same is done for development and implementation of an appropriate stable system, which is flexible and reaching to the objective timely and successfully.

Invert pendulum therme:

For the development of authentic and efficient system with a one wheeled balancing robot, the comprehension of the parameter which are included in the system is important. Presentation of those are often gained by a mathematical model. This theory is usually referred to as Cart and Pole theory. Though the one wheeled self-balancing robot doesn't directly differentiate between the Cart and Pole. In the system model, the cart even up to the wheels when the pole and equalizes to the robot's chassis. The focus of the IP principle is to stay the wheels below the center of the robot chassis cumulus in stable position. If the robot disposition to lean forward, then to take care of steadiness, the wheel movement will in the forward direction to return below the chassis and same for backward movement. The robot will simply diminish if this is not operated.

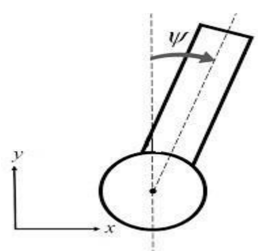

Figure no 1: Simplified sketch showing the tilt angle, ψ and the position x

III. Controlling Unit

1. **PID controller** is a control algorithm which is used to maintain the balance of automatic self-balancing two wheeled robot. It is documented as a three termed control unit. The error signal from the system is an input to the controller. There are three constants Kp (proportional constant), Ki(integral constant) and Kd(derivative constant) by which the three terms are get multiplied. The closed-loop system is additionally mentioned as a feedback system. To measure the output y from the sensor is the is the basic idea of a feedback system. There is a subtraction of process output and a reference set point value to supply a mistake. Then the PID controller gets the error where it is arranged in 3 techniques. The execution of proportional and integral term is done by using the error on the PID controller for reducing the steady state errors. And so that the derivative term is used to handle the outreaches. After processing the error by the PID algorithm, an impact signal u is produced by the controller. The PID control signal is supplied into the methods in check.

2. **Arduino UNO:** The purpose of a micro-controller is to end computations and method information by capital punishment directions. It includes all the desired parts of an ADP unit throughout one Integrated Chip (IC)which are mentioned as follows-

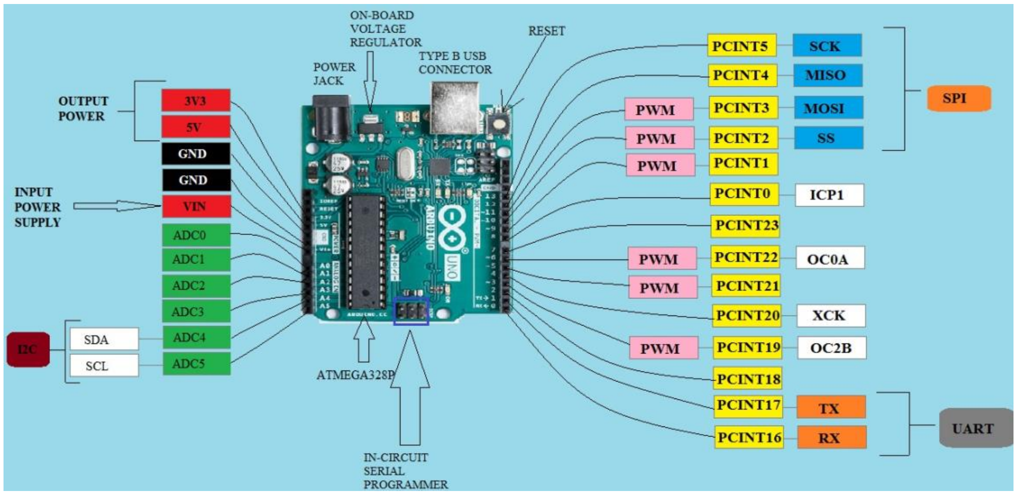

Figure no 2: Arduino UNO

1. Sensing Element - measuring instrument, gyroscopes are the foremost usual styles of sensors utilized in robots and machines that require stability management. It provides how to measurement acceleration, speed and direction. If we measure multiple axes with sure quite sensing element then a sensing element would be needed for every explicit axis This sensors can facilitate to require care of feedback system and provide output to controller so as that error are getting to be detected and paid. This sensor is as shown in below figure –

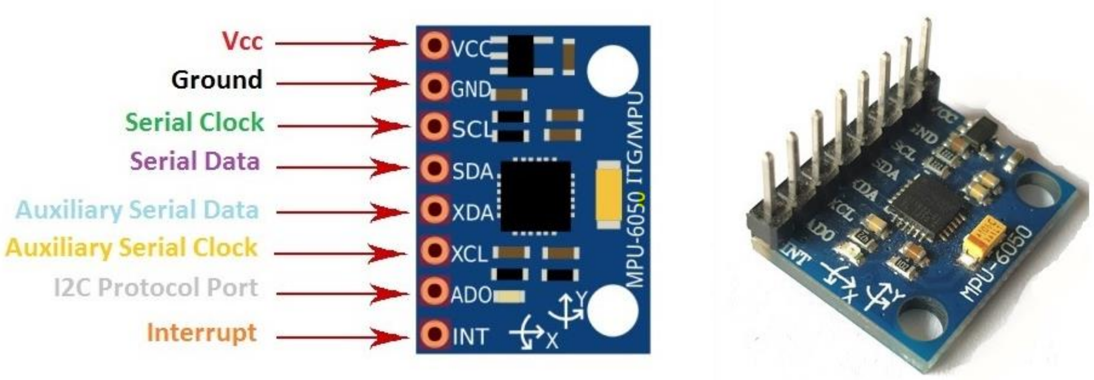

Figure no 3: Sensor (MPU 6050) Gyro

2. **Motors**
3. **Motor Control**
4. **Power Source Batteries**
5. **Node MCU/ Bluetooth module** - these devices are usually used for maintaining communication or for giving command to system through Bluetooth association or wireless fidelity. this could be useful for manual system

3. **Support** - support like shaft, knees, auxiliary knees are mechanical part that are style in cad software system and manufacture through appropriate producing method. It acts like skeleton throughout that different system homes. It ought to be rigid enough to sustain shocks and vibrations. RAM, computer storage and input/outputs. The IC ought to contain all the devices necessary for operational needs.

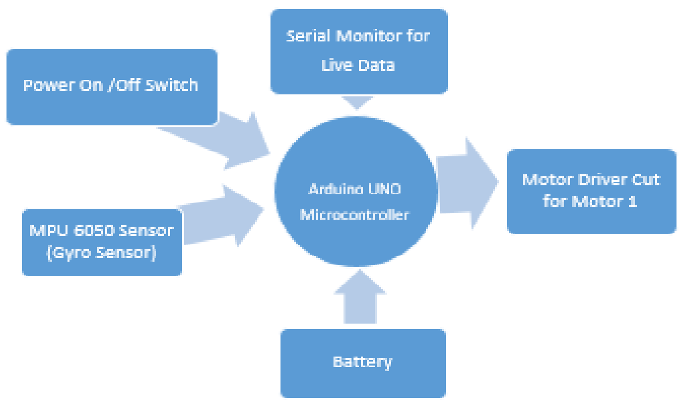

Figure no 4: Block Diagram

IV. Interfacing Diagram of Every Component

1. MPU Sensor with Arduino Microcontroller

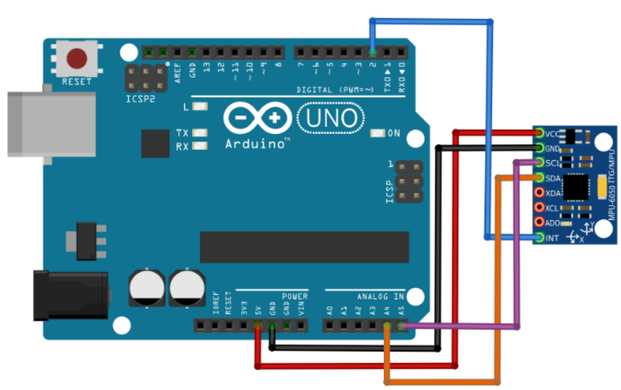

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Figure no 4: MPU sensor connected to Arduino

2. Arduino with MotorDriver & Motor-

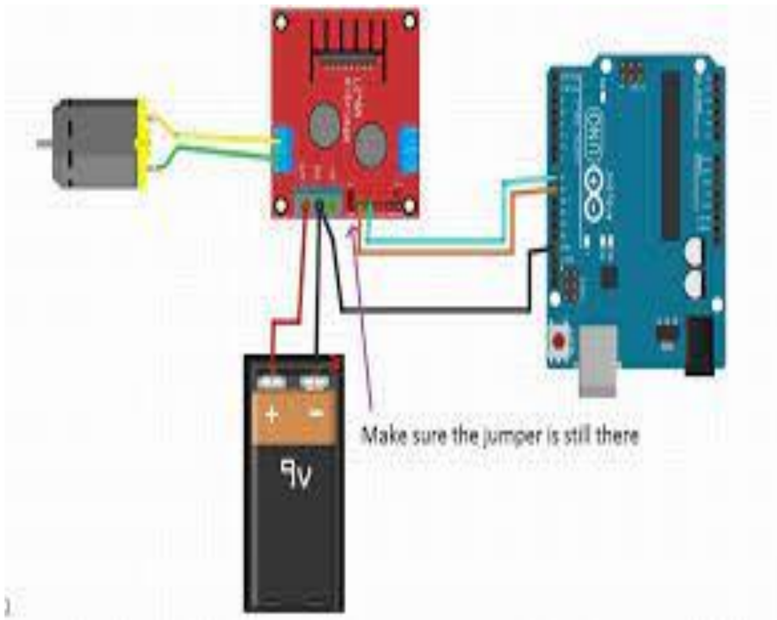

Figure no 5: Arduino with motor driver

V. Calculations

A. How we selected the Motor

- We selected the 12V DC Motor because of the following reasons-
- Low Cost
- Sufficient Torque (Torque = Payload = Weight carrying Capacity)
- Can be controlled using a Motor Driver Circuitry (Electronically)
- The Bot Can be Wireless because of DC Motors
- Lowest power Consumption hence high Battery Life
- Arrangement of direct coupling of Wheels to the Shaft

B. Why Not-

- Stepper Motor- Controlling Steps is not required for the BOT to control & High Price
- Servo Motor- Controlling Torque, Speed, Position not required in the Bot & High price
- AC Motor- Bot would not be Wireless with AC Supply

- **Analysis & Calculation for Motor Selection**

(Only Motor Payload Calculation is a point of Calculation in the Project as rest of the components are electronics)

Table no 1: Specifications

1	Motor Type	DC with Gear Box, Metal Gears
2	Base Motor	DC 3000 RPM
3	Shaft Type	Circular 6mm Diameter with Internal Hole for coupling, 23 mm shaft Length
4	Maximum Torque	3 Kg-cm at 12V
5	RPM	100 RPM at 12V
6	Weight	130 Gms
7	Max Load Current	330mA at 12

A. Calculation of Torque of Our Motor

Torque (lb.in) = 63,025 x Power (KW) / Speed (RPM)

Calculation factor= 63025

Current Rating- 330mA= 0.00396 KW

Speed of Motor= 100 RPM

63,025 * 0.00396 / 100 = 2.5 lb.in

5.25 lb-in * 1.115 = 2.7 KG-CM

Working Status on PID: Not Working as PID Control needs multiple Realtime values from Sensor performance to take actions of Proportional, Derivative & Integration. Due to Lockdown we cant work on Sensor based readings.

Structure & Dimension: Still working on Lower Part of the BOT (Self Balancing of the BOT)

Considerations: Max. Load- Upto 5KG can be sustained as 2 Motors of 2.7 KG Cm deployed on the Robot Vibration- No calculations done yet

Working of Algorithm: Sensor senses the Values of X, Y, Z Axis change and notifies on Serial Monitor of the Arduino IDE These value are to be recorded (Atleast 1000 values) in different angles and conditions Once we get the manual understanding of deviation of Values according to the Angles, We select the Range of Values

Range i.e. For X axis- if X_Axis =< 30 && X_Axis => 100;

digitalWrite(Motor_Fwd , HIGH);

delay(100)

The algorithm above means that if the Position of Bot in X Axis is between 30 to 100 then we have to rotate the Motor Forward for 100 milliseconds .Similarly for Y & Z Axis, first we take values of sensors according to the position of the BOT and then put them in program

Final calculation: **Dimensions of total Robot** **Height- 200mm**

Width- 150mm **Weight- 1.5 KG**

VI. Experimental Results

The performance of balancing control with corresponding plots is demonstrated in the experimental studies. The balance is well maintained by a gyro cycle with the time. It does not fail yet there is a power on. Still, the gyro cycle's heading angle is leaned slightly as equated with first figure. This happens since; the flywheels involved in the balance control performance cause the dynamical movement to try to stay in upright position. The gyro cycle attempts to take balance by proceeding the entire system in rolling direction through the leaning of the flywheels. This makes the system vibratory. As we see, the lean angle is maintained well with the error of 0.01 radians, also the flywheel angles have been plotted. There is the convergence of both the angles in the same direction which indicates the synchronization of both the flywheels. 2 degrees of difference is calculated between the left and right flywheel angles, which is fine as we have set the 8 degrees of critical angle. Experimentally, the 8 degree of threshold is found. The gyro cycle fails after balancing without a synchronization control for a while. This happens since both flywheels revolves in same direction at the starting and then in opposite direction in such a way that the effects of gyroscope are neutralized with each other giving the null effect. This problem is solved by simple synchronization method.

VII. Expected Result

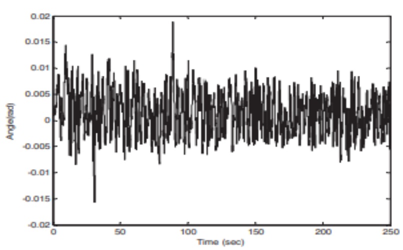

Figure no 6: Lean angle of Gyro cycle

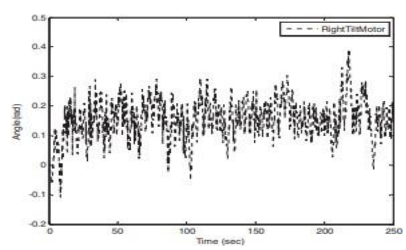

Figure no 7: Angle of the right flywheel

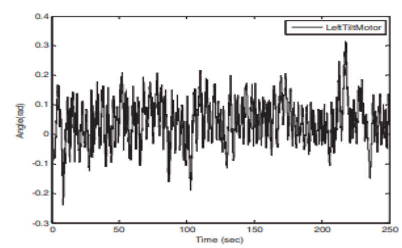

Figure no 8: Angle of the left flywheel

- The One Wheeled Self-Balancing Robot Project should be able to do the following tasks-
- The Robot should be able of maintain its balance in any condition for which we have used a MPU Sensor.
- e. if it is losing the Balance, the wheels should automatically rotate opposite to the direction of falling.
- While maintaining the Balance of itself, Robot should have spring so that it can bounce on the surface in case ofsudden jerk in vertical motion.
- The Data of this Robot should be sent to Serial Monitor of the PC using Arduino Data Cable
- Battery should power the Robot un-interruptly
- For which we are using an algorithm of giving advance signal in serial monitor of Battery warning.
- Additional Future Scope can be added to the Robot whenever necessary.

VIII. Conclusion

In the development of this Project, we have achieved the following points and followed the procedures.

1. Learnt and understand Mechatronics & Robotics system
2. Learnt Mechatronics, Robotics & Embedded Components
3. Learnt about design and Calculations
4. Design and assembly of chassis of the robot
5. Introduction to varies Sensors and actuators of a mechatronics system
6. Implemented the Sensor based, Microcontroller based Robot with all the parameters in Embedded & Electronics domain
7. We learnt all the concepts of Fabrication, Design, Electronics, Embedded Systems, IOT, Mechatronics in this Project Journey
8. We are also focusing on implementing the Future scope features in upcoming years to come

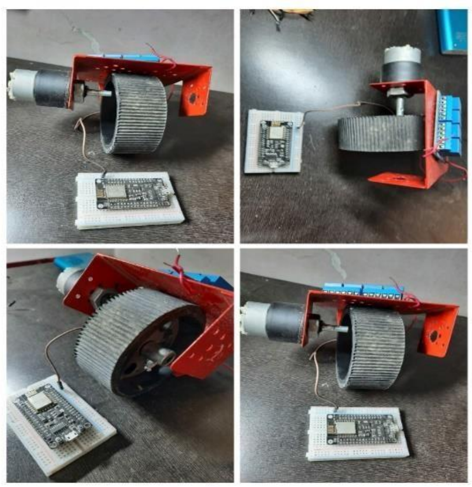

Figure no 9: Actual Figure of Bike

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