IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Volume 1, PP 66-70

Self Balancing Unicycle

Aditya Devaskar[1], Arunkumar Dubey[2], Gautam Prince[3], Tejas Abhange[4], Meenakshi Saraon[5] (Prof.)
Electronics And Telcommunication Engineering
Atharva College Of Engineering
Malad (W), INDIA.

Abstract : *Self-Balancing Unicycle is based on the principle of inverted pendulum. It consists of both hardware and software implementation. Mechanical model is based on the state space design of the cart pendulum system. To find its stable space inverted position, a generic feedback controller i.e. a PID controller is used. According to the situation, we have to control both angle of pendulum and position of cart. Mechanical design consists of brushless DC motor Hub Motor, Arduino controller unit, IMU sensor Inertial Measurement Unit and motor driver as a basic need. The acceleration and angle with respect to vertical ground is provided by the IMU sensor. The motor controller which is attached with the motor controls the speed of the motor. These system parameters determine the force needed to balance the unicycle. The unicycle is prevented from falling by giving acceleration to the wheel according to its inclination from the vertical. If the cycle is tilted by an angle, along the frame of the wheels, the centre of mass of the body will experience a pseudo force which will apply a torque opposite to the direction of tilt. The effectiveness, reliability, and feasibility of the proposal will be confirmed through simulation studies and experimenting on a physical one wheeled vehicle*

Keywords - *ATMEGA328 microcontroller Arduino Board, Battery pack, IMU MPU6050 (Inertial Measurement Unit), Hub Motor, Hub Motor Controller.*

I. INTRODUCTION

A self-balancing unicycle is compact personal transporter. The rider controls the speed by leaning forwards or backwards. The self-balancing mechanism uses gyroscopes, accelerometers to maintain the position of the unicycle. A self-balancing unicycle is commercial unit in the direction of travel only with lateral stability provided by the rider.

Fig 01: SELF BALANCING UNICYCLE

II. THE HARDWARE SYSTEM

2.1 ATMEGA328 Arduino Board

The position values from the IMU sensor are given to the arduino board through the analog pins on the board. The analog values from the gyroscope are converted to digital values using processor. The PWM signal is provided by the arduino on the digital pins which is then given to motor controller. The motor controller processes the position values and in-turn controls the speed of the motor. Here Atmega328 along with peripherals acts as the processing device of the unicycle. 9V supply is given to the Arduino Board.

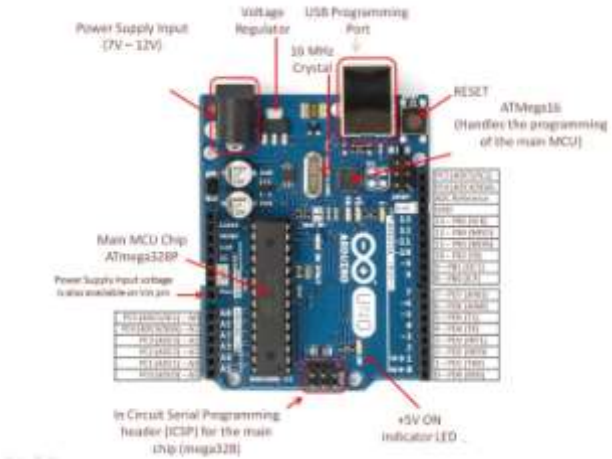

Fig 02: ATMEGA328 ARDUINO PINOUT

2.2 MPU6050

IMU sensors usually consist of two or more parts. They are: accelerometer, gyroscope, magnetometer and altimeter. The MPU6050 gas 6 DOF (Degree of Freedom) or it is a six axis IMU sensor, which means it gives six values as output, three values from the accelerometer and three values from the gyroscope. The MPU6050 is a sensor based on MEMS (Micro Electro Mechanical Systems) technology. Both the accelerometer and the gyroscope is embedded inside a single chip. This chip uses I2C (Integrated Circuit) protocol for communication.

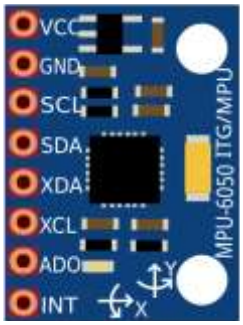

Fig 03: SCHEMATIC OF MPU6050

IMU6050 Pins	Arduino Pins
VDD	5V
GND	GND
SCL	A5
SDA	A4
INT	D2

Table 01: Interfacing table for MPU6050 and Arduino

2.3 Hub Motor Controller

It is a 350W 36V 15A motor controller with a power lock feature. It has a wide range of input/ output pins. The battery pack delivers 36V 18A which is fed to the motor controller. The controller provides output to the motor controller with 3 phase wire and 5 control pins. It has 3 pin input connection for throttle and 2 pin for reversing the direction of motor. The hub motor controller controls the speed of the controller using the position values from the controller.

Fig. 4: MOTOR CONTROLLER

2.4 BMS

A Battery management system (BMS) is any electronics system that manages a rechargeable battery (cell or battery pack), such as by protecting the battery from operating outside its safe operation Area, monitoring its state, Calculating secondary data, reporting that data, controlling its environment, authenticating it and/or balancing it. A battery pack build together with an external communication data bus is a smart pack must be charged by a smart battery charger.

Specification:

- 10string 36V, 37V, 42V lithium battery power protection board.
- Overcharge, over discharge, over current and short circuit protection.
- Same port 16A discharge current.
- With heat sink and 300mm cable.
- Size: approx. 36 x 32 x 10 mm

Fig. 5: Battery Management System

2.5 Hub Motor

A brushless DC motor (known as BLDC) is a permanent magnet synchronous electric motor which is driven by direct current (DC) electricity and it accomplishes electronically controlled commutation system (commutation is the process of producing rotational torque in the motor by changing phase currents through it at appropriate times) instead of a mechanically commutation system. BLDC motors are also referred as trapezoidal permanent magnet motors. Hall sensors or rotary encoders are most commonly used to sense the position of the rotor and are positioned around the stator. Hall sensor provides the information to synchronize stator armature excitation with rotor position. The rotor position feedback from the sensor helps to determine when to switch the armature current.

Fig. 6: Hub Motor

2.6 Lithium Polymer Battery Pack (LiPo)

It is a smart battery pack which consist of ten 3.7V 5200mAh cells with a battery management system connected across it. The battery pack gives a output of 36V and a current sourcing capacity of 20A.

Fig. 7: LiPo Battery Pack

III. BLOCK DIAGRAM

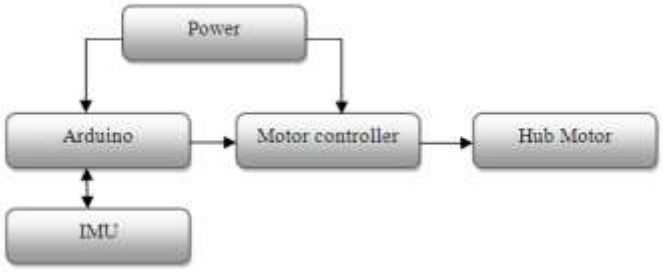

FIG 08: BLOCK DIAGRAM OF UNICYCLE

The block diagram of self balancing unicycle consists of a controller Arduino board with a ATMEGA328 microcontroller on it. MPU6050 module which is basically a Inertial Measurement Unit (IMU) with gyroscope, magnetometer, accelerometer and altimeter on the module itself control the position of the unicycle. 350W hub motor which is the heart of the unicycle which drives the unicycle is basically a motor as a wheel hence the name hub motor. Hub motor is a brushless DC motor with a integrated controller embedded inside it, consisting of hall sensors which keep the track of input/output current through the coils. A motor controller drives the hub motor through relays.

36V 10Ah LiPo Battery Pack used to drive the hub motor. Here, the Arduino board is the brain of the unicycle in which program is uploaded through Arduino IDE. It controls the functioning of the unicycle. The IMU sensor which is interfaced with the arduino helps give the position values to Arduino and in turn drives the Hub motor through the relay.

IV. SOFTWARE USED

We are using an Arduino IDE compiler for programming of Arduino board. The link for the compiler is https://downloads.arduino.cc/arduino-1.8.5-windows.exe .Arduino IDE is open source software. The Arduino IDE consists of useful APIs for programming.

V. ALGORITHM

a) Start
b) Get the values of x, y-axes from the IMU.
c) Scale the values according to requirements using arduino.
d) Send the values to the motor controller for balancing and speed control.
e) Go to step 2.

VI. WORKING

The IMU6050 sensor which is placed on the unicycle helps to calculate the position of unicycle. The values from the sensors are fed to the arduino board through analog control pins. The board processes the analog values and provides the digital values in the form of PWM signal. The PWM signal is fed to the motor controller. The motor controller is given a 36V 10A input via battery pack. The controller processes the PWM signals according to the signal, the speed of the motor is controlled.

VII. CONCLUSION

The unicycle has Maximum Payload capacity is 110 kg. The maximum Speed that can be achieved is around 20-22 kmph with Uphill Capability of 25-30 degrees. It has a Balanced battery charging circuitry with Longer Battery life. The Battery Run time 30 min to 40 mins. The Compact Design is used for quick ride

REFERENCES

[1]. https://www.youtube.com/watch?v=bfwbdHbL688
[2]. https://www.youtube.com/watchv=qYG8Ll7J15g
[3]. https://www.stephanboyer.com/post/17/my-electric-unicycle
[4]. https://www.youtube.com/watch?time_continue=25&v=fADhfmcQ2KA
[5]. https://www.electricbike.com/250-watt-hub-motor
[6]. https://diyhacking.com/arduino-mpu-6050-imu-sensor-tutorial/
[7]. http://selfbalancingelectricunicycles.com
[8]. https://playground.arduino.cc/Main/MPU-6050
[9]. https://www.electricaltechnology.org/2016/05/bldc-brushless-dc-motorconstruction-working-principle.html
[10]. https://en.wikipedia.org/wiki/Battery_management_system