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CONVERTIBLE SELF BALANCING ROBOT

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ABSTRACT-

The field of Robotics plays an important role in the development of modern world with the help of efficient microcontroller such as Arduino and sensor has helped a lot in achieving this milestone. Robots are being used in our daily life .Robotics is an interdisciplinary sector of Science and Engineering .Robotics are generally used in factories appeared as intelligent machine to do a specific task. This paper reports the design ,construction and control of a convertible self balancing robot .It is capable of balancing upright on its two wheel and can be converted into four wheel robot when needed .The system architecture of this robot comprises a pair of stepper motor controller to move the wheel ,two Servo motor to move the middle link and the top part and two Arduino board ,one for the robot and another for remote control and ultrasonic sensor which maintain the movement of robot etc .When four wheel robot converted into two wheel robot ,the MPU-6050 sensor and center of mass are employed for altitude determination. When robot is in self balancing mode,it works on the principal of inverted pendulum. Self balancing robot is essentially solve the Classic inverted pendulum problem .When robot stand on two wheel, the platform will not remain stable itself .Our task will be to balance the platform by using distance sensor and to maintain horizontally .In this robot before going in standby mode additional two wheels also comes out ,we can also off the main motor and due to this more power is consumed by motor and motor driver approximately 60 to 70% .So that convertible self balancing robot become more stable ,efficient and reliable by using four wheel. Battery life also increases and the task of that project is to control the robot on two wheel and can be converted into four wheel robot when needed .This robot provide exceptional robustness and capability due to their smaller size and power requirement. This type of platform finds application in several purposes such as surveillance and transportation. We also perform another task by this robot which is done only on four wheel.

Keywords*:* Arduino, Inverted pendulum, MPU-6050 sensor, Servo motor, Stepper motor, Ultrasonic sensor.

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I. INTRODUCTION-

As technology progresses the area of robotics has ruled the mind of people around the world. In that time robots are used in our everyday life .Robots are used at many places like Industries, malls, Hospital ,restaurants etc. Presently, robots are used in hospital especially in covid-19 situation because it reduces the risk of infectious diseases transmission to frontline healthcare workers .

This paper reports the design ,construction and control of convertible self balancing robot .This is capable of balancing upright on its two wheel and converted into four wheel robot when needed[7] .Self balancing robot provide exceptional robustness, capability and effectiveness due to their smaller size and power requirement[1]. Convertible self balancing robot are used in many application in several purposes such as surveillance and transportation. According to their need robot can be converted into four will to two wheel and vice-versa .This make robot distinct from other self balancing robot. In two wheel self balancing robot, when it is in standby mode as controller is on ,more power is consumed by motor and motor driver approximately 60 to 70%. In convertible self balancing robot when robot is in standby mode then by suitable coding in Microcontroller. It can be automatically converted into four wheel and due to this less load on controller. So that robot become more stable ,reliable and effective. Battery life also increases .We can also perform another task from this robot which is done only on four wheel. When wheel robot converted into two wheel .the sensor and center of mass are employed for altitude determination. The system architecture of this robot comprises a pair of stepper motor to control the movement of wheel because it is very precise than DC motor, ultrasonic sensor will maintain the movement of the robot, MPU-6050 sensor, two Servo Motor connected with two additional wheels ,two Arduino ,one for robot and another for remote control based on Bluetooth hc-05 module[3] etc. Convertible self balancing robot it is two in one project itself as it perform both tasks that is done on two wheeler as well as on four wheel .

II. LITERATURE REVIEW -

The robot that is capable of balancing upright on two wheel is known to be self balancing robot. This section reports the review on some of the research paper based on self balancing robot.

In[1] the basic aim of this paper is to overcome the challenge of balancing initially unstable system by providing control mechanism to robot so that it can be balance itself. The robot uses sensor values provided by accelerometer and gyroscope to find the exact position velocity and angular velocity of the wheel and send the value to the microcontroller.

In[2] Self balancing robot is able to balance smoothly with maximum tilt error of 5 degree. It is capable of taking payloads around 0.3 kg. Components used in it are microcontroller, gyroscope and accelerometer and DC motor .The height of the robot in this project is limited by the top of the DC motor .This robot is suitable only for flat ground.

In[3]This robot is remote controlled,. Stepper motor were used to maneuver the robot .The purpose of this paper is to evaluate the possibility of using two wheeled self balancing robot for package deliver, by testing their ability to maintain the balance.

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In[4] This present a low cost two wheel self balancing robot for control education powered by stepper motor. This type of design improved previous model based on DC motor.

In[5]The design includes arduino mega 2560 , accelerometer, gyroscope sensors ,as well as proportional indicator derivative (PID) control as controlling method. Robot ability improve by adding ultrasonic sensor as an object detector around it, including obstacles or wall around the robot.

In[6] the focus of this paper was to be built a demonstrator and implement of code that enables the demonstrator to balance and to be controlled over a wireless connection.

In[7]In this paper a transformable self balancing robot is design in such a way that it transform from four wheel to two wheel robot, when their centre of mass and IMU sensor are employed for altitude determination.

III. METHODOLOGY-

The block diagram of convertible self balancing robot shown below consists of all the important block that are needed for the working of this platform. Rechargeable battery is used as power source .The functionality of robot start with the serial data transmissions initialization between Arduino and MPU-6050 sensor.When power is switched ON and robot is stand on two wheel then MPU-6050 sensor start reading data that contain inbuilt digital the digital motion processor (DMP) that fuses accelerometer and gyroscope. By reading the given data if the control unit feels that the Robot is falling out of balance then it is instructs the motor driver so that it can direct the motion [5]. The motor in turn control the Wheels of the device. To run the device all components are interfaced i.e., MPU-6050 sensor, Motor driver, Bluetooth HC-05 module, arduino mega,arduino Uno etc .To control the direction and movement of the robot a remote control is used based on bluetooth module. For remote control we can use joystick to give instruction to move the robot .Ultrasonic sensor is used which is an obstacle avoiding control system .The construction of convertible self balancing robot included four wheel and can be converted into two wheel robot when needed by writing suitable code in the Arduino .

WORKING PRINCIPLE -

Convertible self balancing robot is basically a self balancing robot with two additional dummy wheels which can be folded when the robot in normal Self balancing mode the robot uses only two wheels connected with the left and right motor ,when it is in normal self balancing mode .When the robot goes in sleep or in standby mode the other two wheels connected with Servo Motor get unfolded and the robot will be converted into four wheel.When robot is operating in self balancing mode at that time the MPU-6050 (3-Axis accelerometer and gyroscope) comes in action and start measuring robot's speed and vertical position.This measured data further feed to Arduino Mega board .Using this measured data arduino mega board calculate the robot's current vertical position and speed and generate required signal for both stepper motor to control them such that the robot can maintain a vertical position or current speed and also stay in balance mode.They will try to go in standby or sleep mode ,the left and right arm's Servo Motor get activated and additional two wheels comes out and robot get converted into four wheel robot . The robot has also Bluetooth module connected with audio Mega board so that they can be controlled with a smartphone or its remote.

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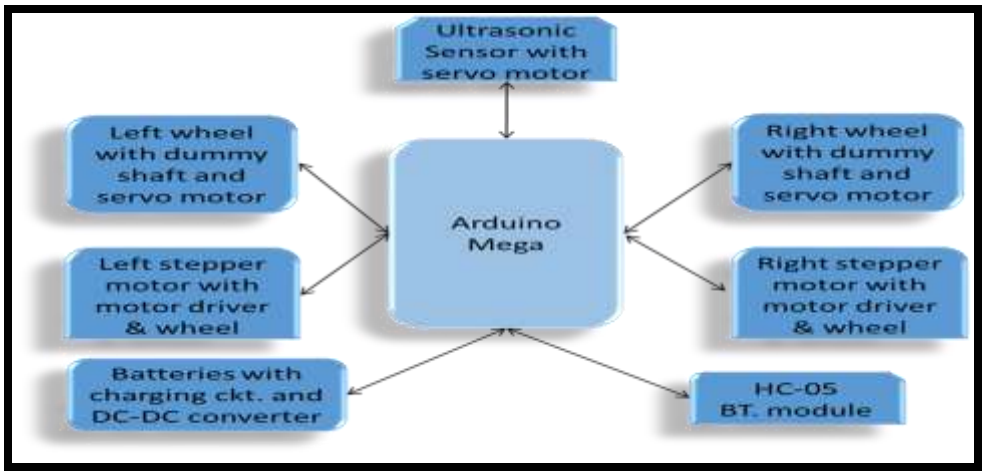


Fig . 1. Block Diagram of Convertible Self Blancing Robot

BLOCK DIAGRAM OF REMOTE CONTROL-

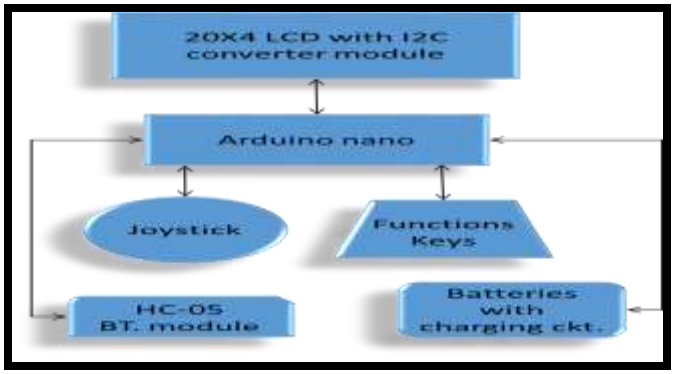


Fig.2.Block Diagram Of Remote Control

IV. COMPONENTS-

1. Android Mega 2560board-

Audino Mega is used for robotic body .It is an open source microcontroller board which is based on Atmega 2560 microcontroller .It includes digital input output pin-54 ,where 16pins are analog Inputs and 14 are like PWM output hardware serial ports (UARTs)-4,a crystal oscillator 15MHZ and ICSP header, power Jack, a USB connection as well as an RST button. The operating voltage of this microcontroller is 5 volt .The length of this board is 101.52 mm and width of this board is 53.3 mm the weight of this board is 36g.



Fig.2. Android Mega 2560board

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2. Arduino nano board-

Audi Nano is one of microcontroller board. It is designed by arduino .cc.It can be built with a microcontroller like atmega328 .This microcontroller is also used in Arduino UNO and it is a small size board and also flexible with a wide variety of application. Its operating voltage is 5 volt .It has 14 Digital Pins. Supports three serial communication like SPI ,IIC and USART.



Fig.3. Arduino nano board

3. MPU-6050 sensor-

The MPU-6050 ,sensor is an electronic device used to calculate and report an exact force of body, angular weight as well as the direction of the body .It consist 3-axis gyroscope and 3-axis accelerometer. It measure acceleration, velocity, orientation, displacement and many other motion related parameter of a system .



Fig.4. MPU-6050 sensor

4. L298N motor driver-

L298N module is a high voltage ,high current dual full Bridge motor driver module for controlling DC motor and stepper motor. This motor driver module consists of two main key component with our l298n and motor driver IC and a 78M05 5 volt regulator. It acts as an interface between motor and the control circuit motor require high amount of current whereas the controller circuit such as arduino work on low current signal. So the function of motor driver is to take a low current control signal and then turn it into the higher current signal that can drive a motor.

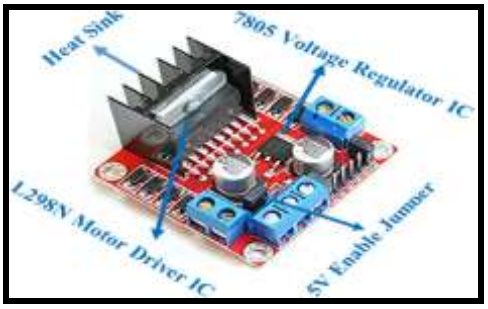


Fig.5.L298N motor driver

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5. **Bluetooth module (HC-05)**-

HC-05 Bluetooth module which is designed and used for wireless communication. This module can be used in a master or slave configuration with user serial communication to communicate with the device. It communicate with microcontroller using serial port (USART).

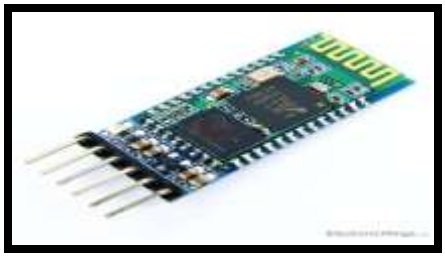


Fig.6. Bluetooth module (HC-05)

6. **Stepper motor-**

Stepper motor is an electromechanical device it converts electrical power into mechanical power .It is a brushless synchronous electric motor that can divide a full rotation into an expensive number of steps . Stepper motor operates differently from DC brushless motor which rotate when voltage is applied to their terminals. It has precise positioning and repeatedly movements since good stepper motor have an accuracy of 3-5% of a step and this error is noncumulative from one step to the next.



Fig.7.Stepper motor

V. RESULT-



Fig.8 Convertible Self Balancing Robot

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VI. CONCLUSION AND FUTURE SCOPE

This paper discusses and analyzes the ability of convertible self balancing robot. It is four wheel robot and capable of converting into two wheel robot such as self balancing robot which balancing itself upright on its two wheel .The placement of MPU-6050 sensor must be in the middle position of the robotic body and positioned at the highest in the robotic body for precise sensor accuracy it has improved performance by enhancing the precision of motor speed reading thereby improving the stability by using stepper motor. Here Bluetooth module are used to create remote control prototype and increasing its accuracy of application. Convertible self balancing robot has many application it can be used for smart gardening purpose, autonomous trolley in in mall ,hospital and airports.

FUTURE SCOPE

In this robot arms can be attached with it for pick and place purposes .

Future work can be done on this robot to make it move and balance itself in different surfaces .

The width of the wheel can be increase its moment of inertia and grip on the surface.

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