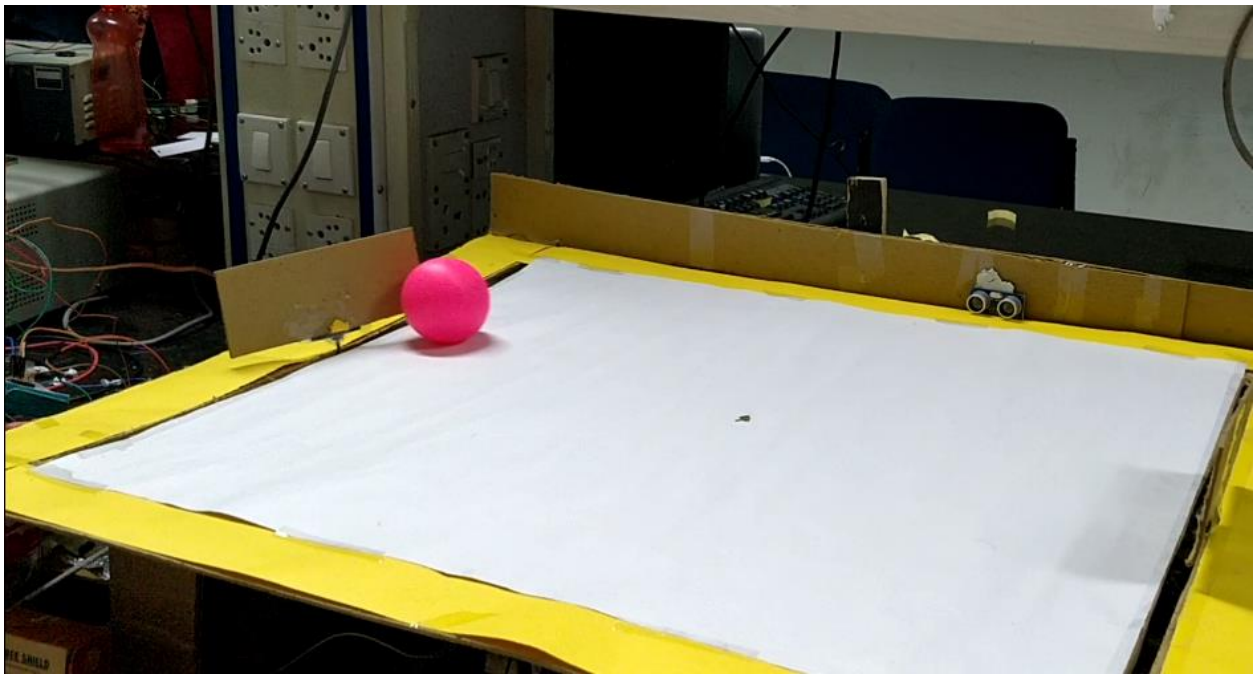
CS-321 HARDWARE LAB



Pin Ball Game

Guided By:

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Date :- 18th Nov, 2017

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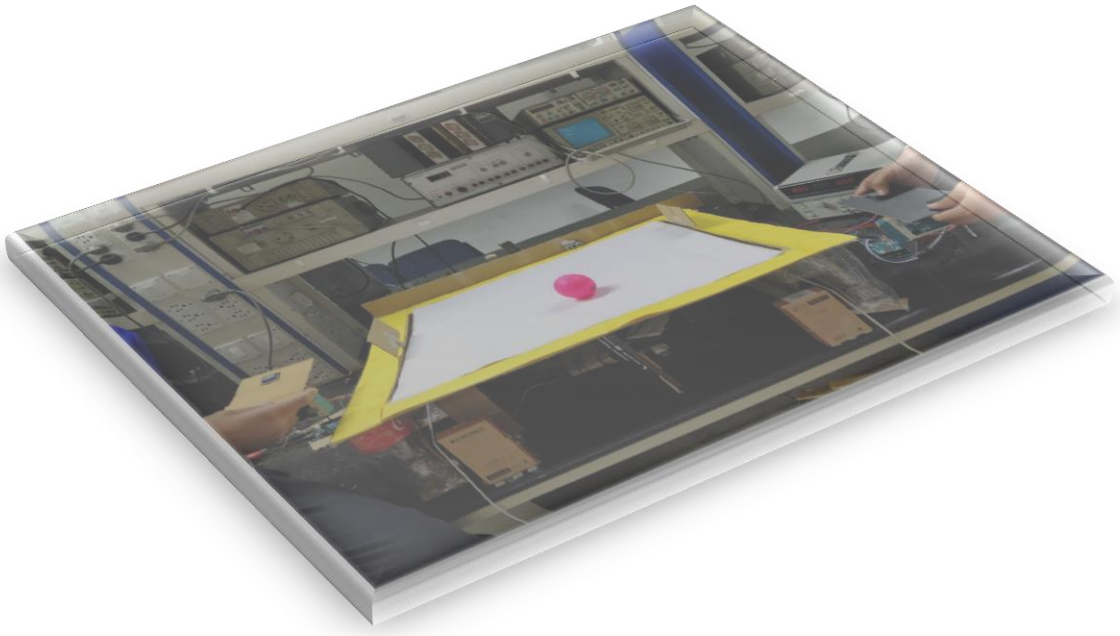
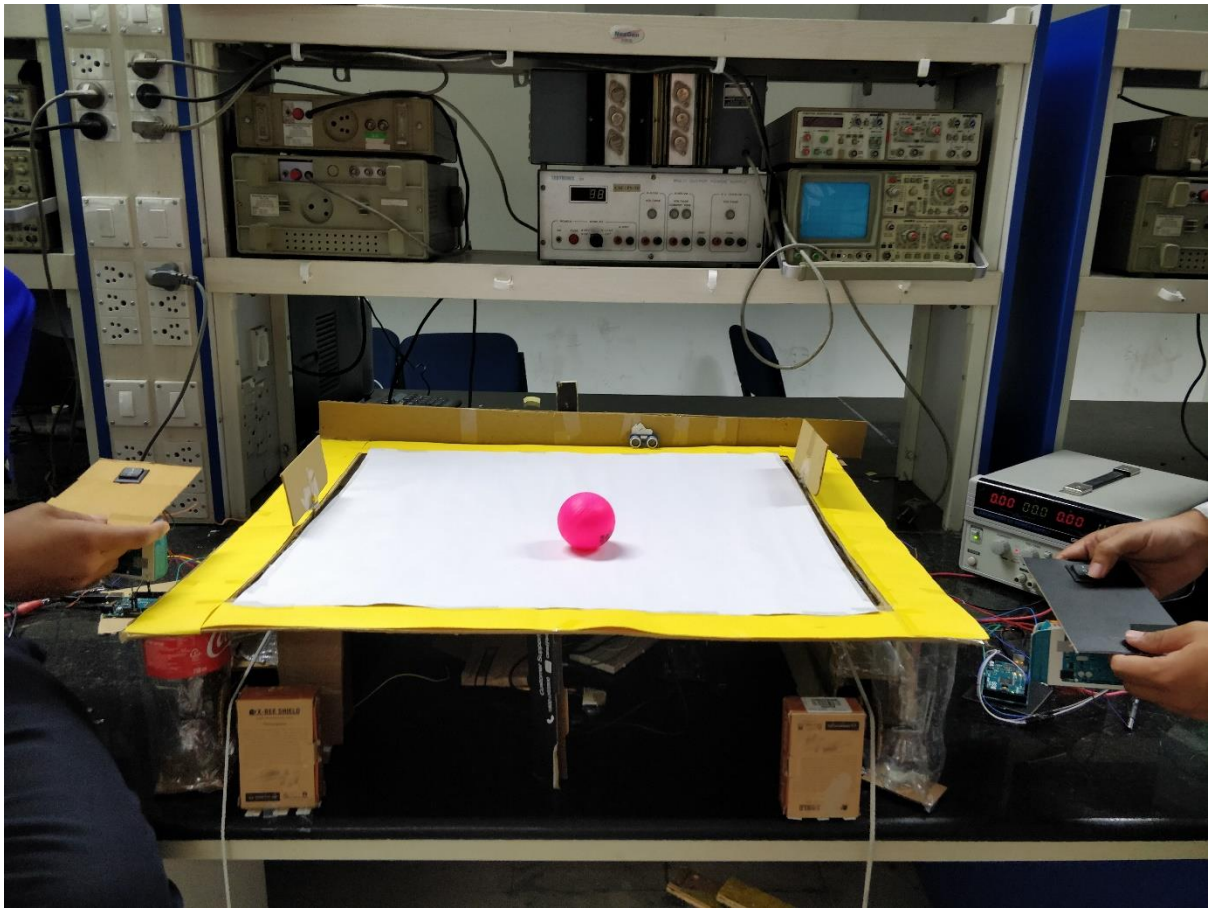


Introduction



Having played the **Pinball** game in our childhood days and later the **Air hockey**, we got inspired by the concept, to build on it and contribute to it. This project is our attempt to make one of a kind.

In this **two-player** game, each player has to hit a ball using a striker and making the ball pass through a certain region (in the middle of the board) to gain a point and at the same time ensuring that the ball doesn't cross the boundaries else he loses 5 points and the game ends. The player with the maximum no of points is declared as the **WINNER** of the game.

Videos Link:- https://goo.gl/8pqxSg

Hardware modules

Sensors

a) 2x MPU 6050 Gyro + Accelerometer

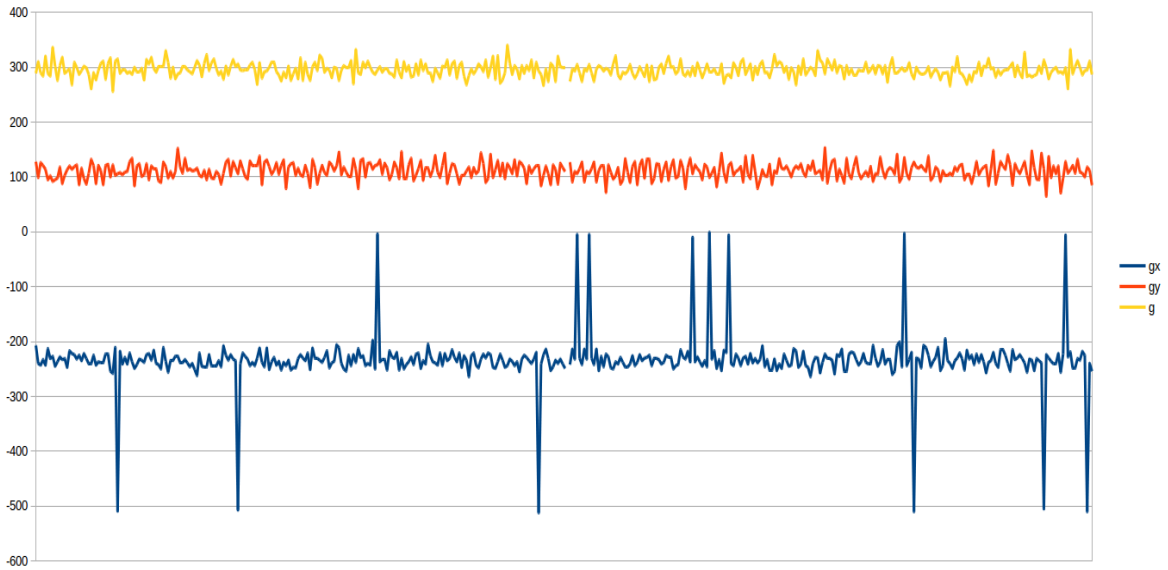
- **Why used?**

We have used this sensor to measure the orientation of the hand and then accordingly align the servomotor to hit the ball.

- **What it is?**

MPU 6050 contains 3axis MEMS Accelerometer and a 3-axis gyroscope. This makes it to have 6 degrees of freedom (6 DOF). MPU-6050 is very accurate, low power and high performance Sensor for motion tracking.

- **Characteristic Graph?**



b) 2x Ultrasonic Proximity Sensor

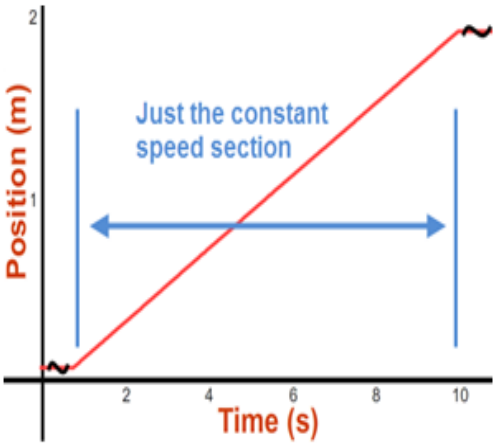
- **Why used?**

In our game to find out which players' ball crossed the scoring terrain, we have used Ultrasonic Sensors. If the value of the sensor decreased prior to the decrease in intensity of light over the LDR sensor, then either one of them scores a point. To increase the accuracy of our game we have used two sensors running sequentially with a delay of 10ms in between.

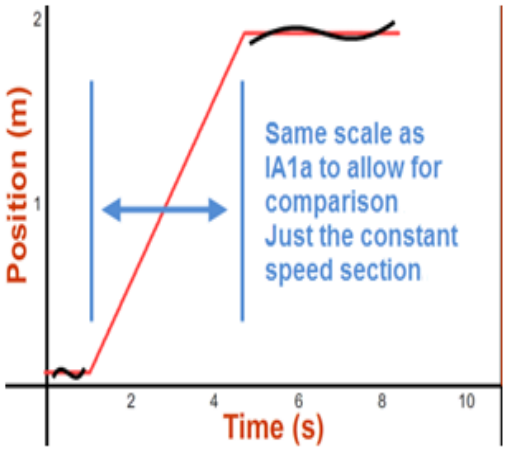
- **What it is?**

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back.

- **Characteristic Graph?**



IA1a. Cart moves slowly away from the motion sensor



IA1b. Cart moves quickly away from the motion sensor

c) 1x Digital Light Sensor

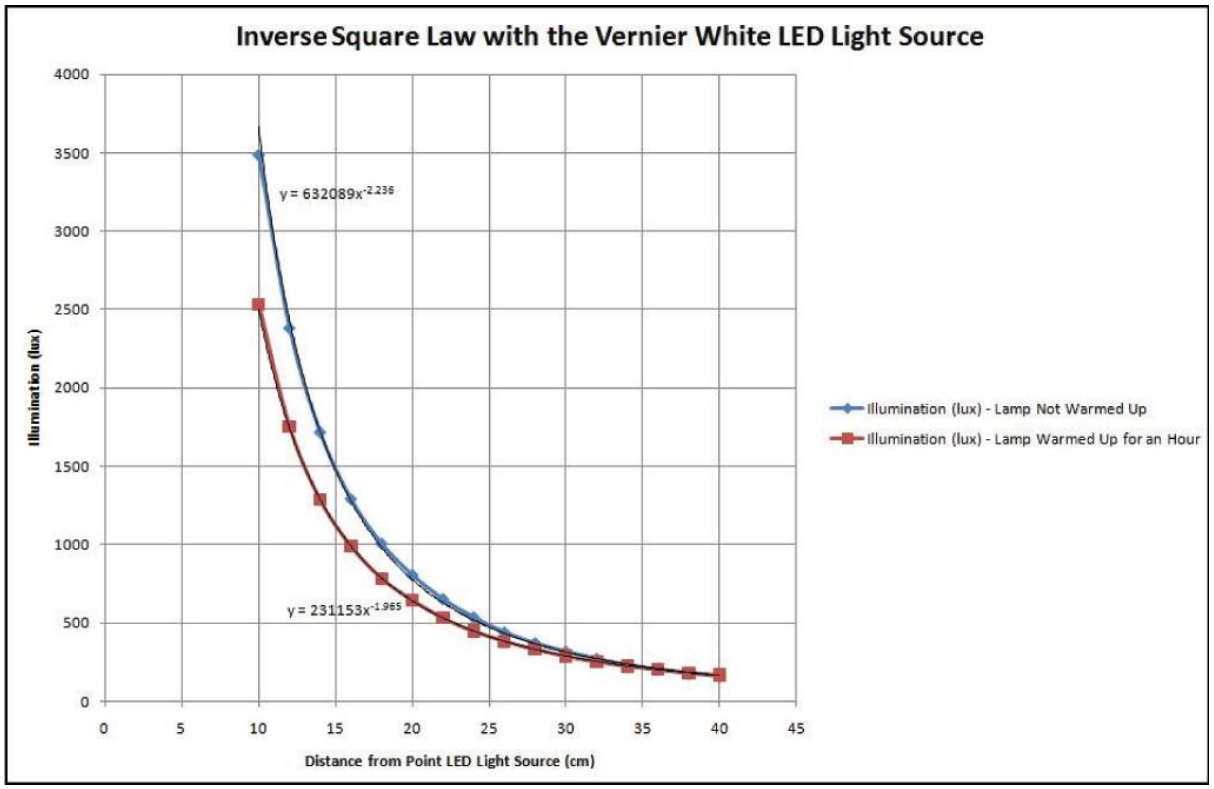
- **Why used?**

To win a game, a player has to cross the ball through certain region so to identify the crossing we have used the LDR sensor. Whenever a ball crosses the region, the intensity of light decreases and the value changes. Using the change in value we identified the crossing of the region.

- **What it is?**

  This module is based on the I2C light-to-digital converter TSL2561 to transform light intensity to a digital signal.

- **Characteristic Graph?**



Motors

a)2x Servomotor

- **Why used?**

To hit the ball we needed to orient the striker at a certain angle, so to align the striker we used servomotor.

- **What it is?**

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.

b)2x DC motor

- **Why used?**

To move the striker left/right we have used the DC motor. It was placed at one end to pull the striker whenever required and release it accordingly.

- **What it is?**

A DC motor is a rotary electrical machine the converts direct current electrical into mechanical energy.

Switches

2x DPDT Switch

- **Why used?**

We have used a on-off-on switch to move the striker left/right using constant 12V DC power supply.

Microcontroller

d)2x Arduino Board (Arduino Mega 2560)

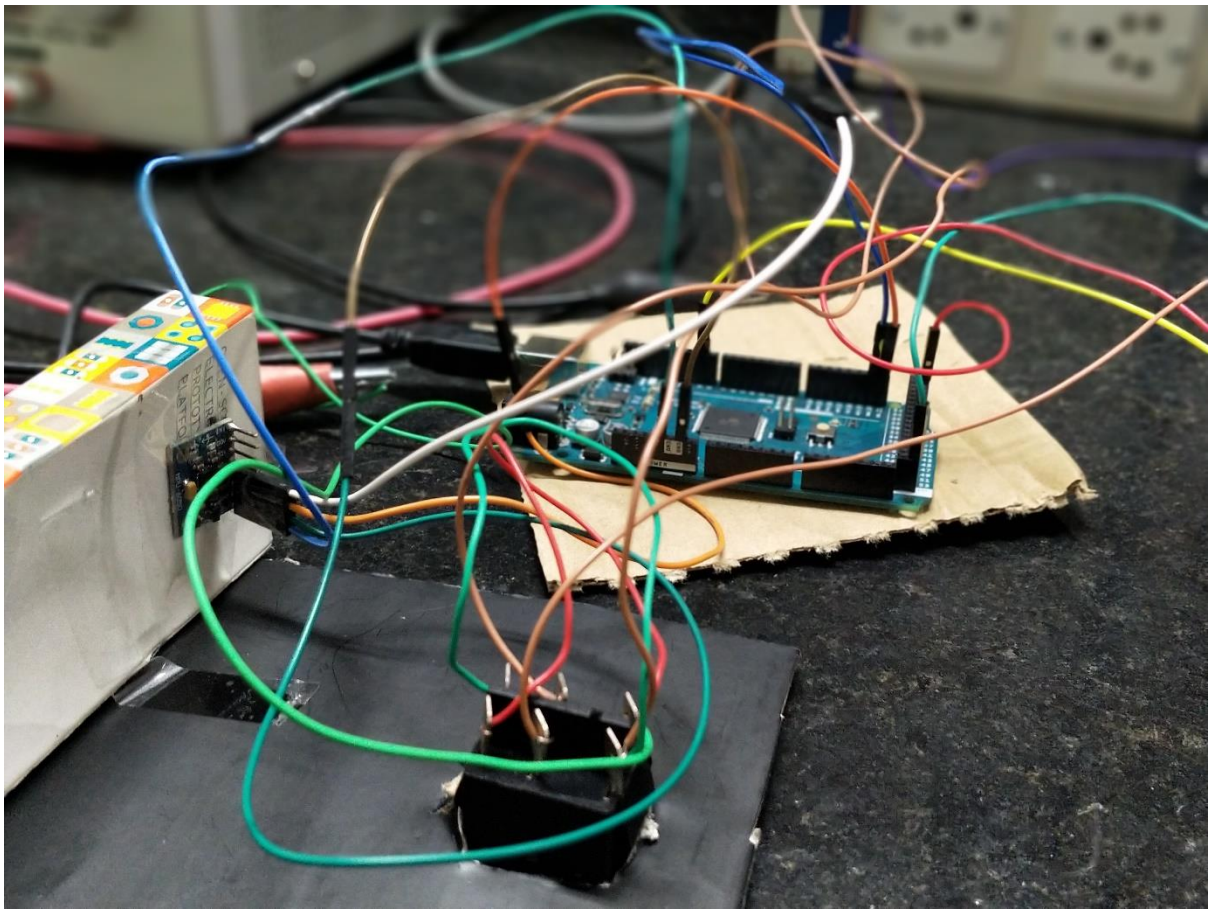
- **Why used?**

To control the sensors and the motors we have used Arduino mega 2560. One Arduino gets the values from both the Gyro sensors and accordingly align the servomotors.
Other Arduino controls the Ultrasonic Sensor and LDR and also keeps a record of the score by each player and declares a winner when the game ends.

- **What it is?**

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Setup

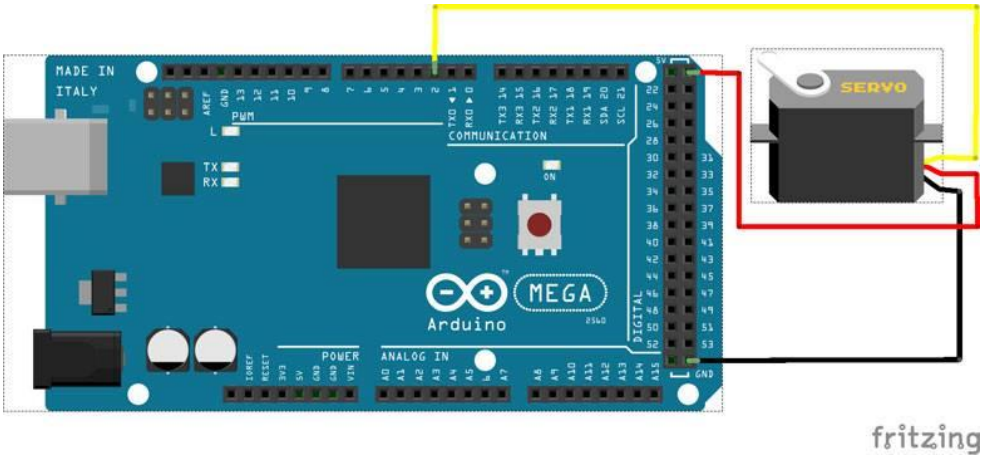


A thick cardboard acts as the surface for the game on which all the components are attached. It is supported by 4 pillars. The players play on either side of the board. The other two sides have a cardboard wall. Each player has a console to which a gyroscope and a DPDT switch is attached. Also each player has his striker which hits the ball. The striker is mounted on a servo motor which rotates it depending on the input from the gyroscope controlled by the player's hand. The servo motor can slide from left to right and vice-versa with the help of the DPDT switch on the console and a DC motor which operates on 12V from a constant DC power supply. The entire mechanism uses a string, aluminium foil to reduce friction, pulley and weights attached on one side.

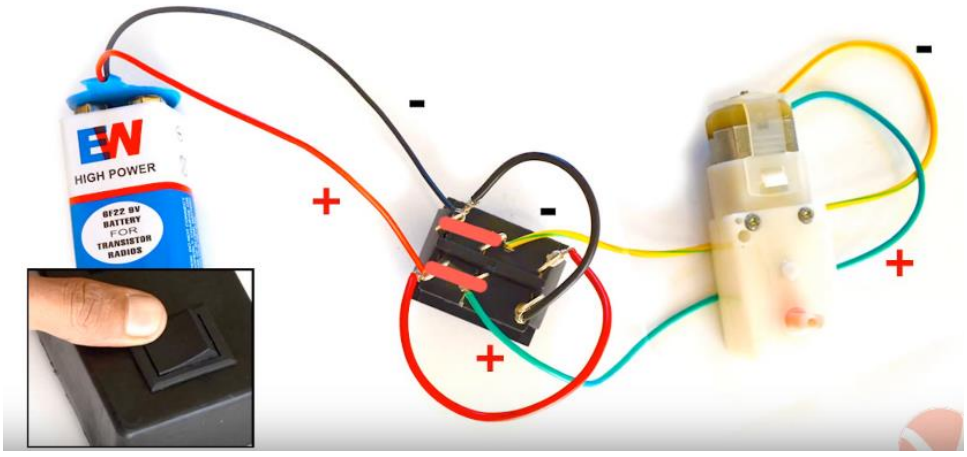
The middle of the board also has a LDR attached and two ultrasonic sensors are attached on opposite walls which operate sequentially.

Circuit Diagram

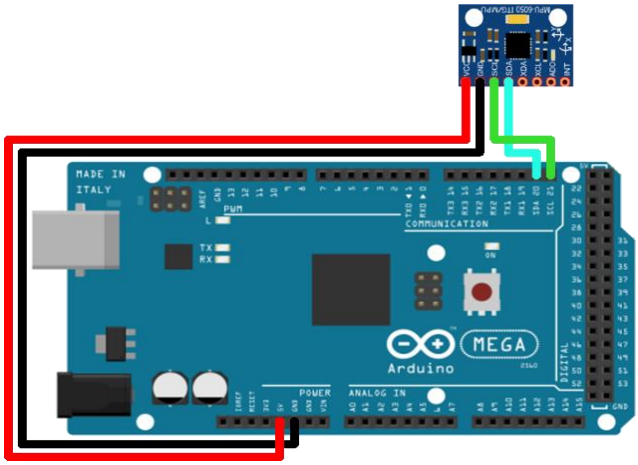
Servo Motor and Arduino connection



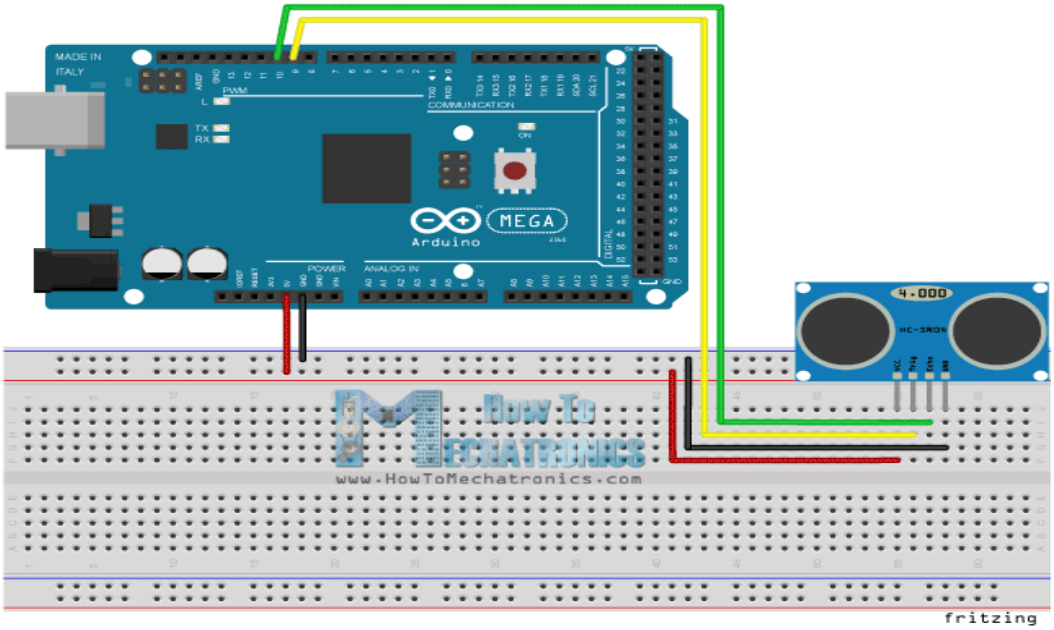
DC Motor and 3-way DPDT switch connection



Gyroscope and Arduino connection



Ultrasonic sensor and Arduino connection



Salient Features

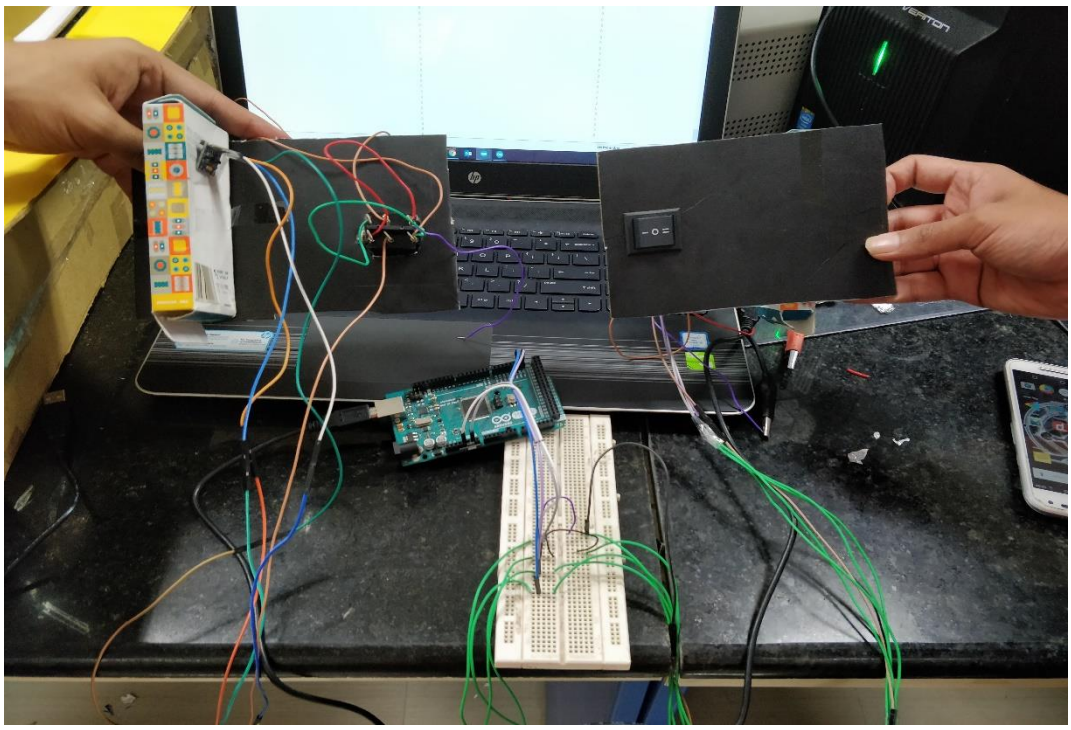
I2C Protocol

We have implemented **Inter-Integrated Circuit (I2C) Protocol** which provides two-wire interface to connect low-speed devices which are: -

i. **SDA** (Serial Data) – The line for the master and slave to send and receive data.

ii. **SCL** (Serial Clock) – The line that carries the clock signal.

I2C is a **serial** communication protocol, so data is transferred bit by bit along a single wire (the SDA line). Simple master/slave relationships exist between all components. Each device connected to the bus is software-addressable by a unique address.



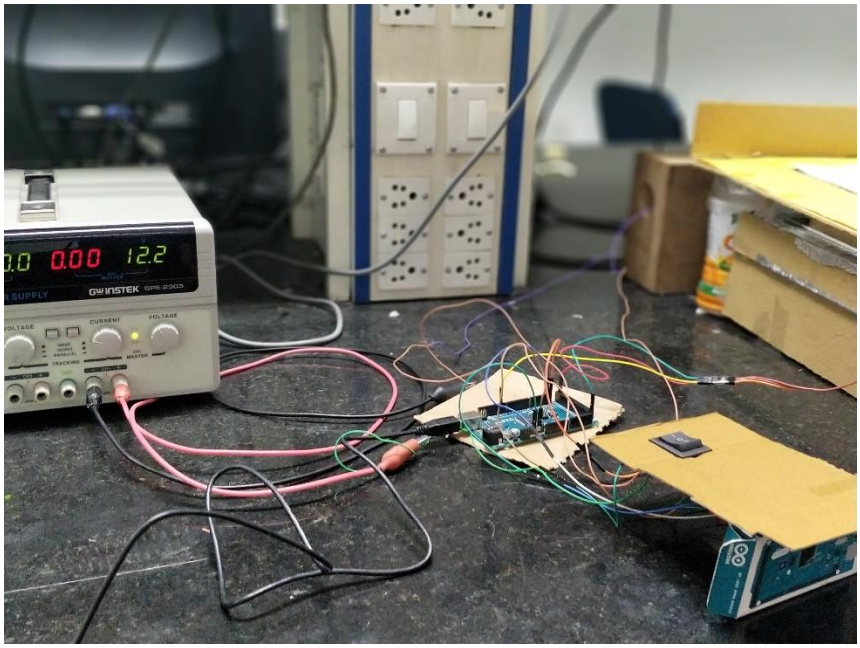
In **our project** Arduino Mega 2560 acts as the master which communicates with two slave devices i.e. the MPU-6050 sensor for both the players using the I2C bus. In order to make the address unique for both the sensors the **ADO** pin is made high for one sensor.

The tuning of MPU-6050

The value of the z-axis given by the gyroscope is divided in three ranges where these ranges represent three values (-1/0/1). These values map to 40, 90 and 140 degrees on the servomotor respectively. Hence, fine tuning was required as per the motive of the game for the correct shot.

Sliding

The sliding forms an integral part of the game. The sliding helps move the servo motor to the right place so that it can hit the ball at the right time. The



perfect sliding required us to set the right values for voltage and current in the DC power supply, and choose the right string. This sliding was then made better by reducing friction between the cardboard that held servo motor and the cardboard base on which it slid. This was done by covering both bases in aluminum foil thus considerably reducing friction.

Precautions

(i) Do not press the DPDT switch for a longer period of time during unwind otherwise the thread rolls on itself and thus the settings for wind and unwind are reversed. If we press it for long time during winding, it might cause the servo motor cardboard to derail from the sliding track.

(ii) All voltage supplies should not be more than 5V (except DC motor) to ensure safe functioning.

(iii) The setup needs to be handled with care as it is fragile.

Limitations

(i) In case the ball stops in between, the game restarts.

(ii) The striker does not provide sufficient force to hit the ball as the rotational speed of the servomotor cannot be increased.

(iii) Needs sufficient light as the light sensors are not that good, so as to sense light the setup needs to place under sufficient amount of light.

(iv) Size of the ball needs to be sufficient large such that ultrasonic sensor perfectly knows the distance. If the ball is too small ultrasonic sensors will not be able to sense the ball.

Further scope

(i) Rotational speed of servos are fixed and is not enough to provide sufficient amount of speed to the striker (can be seen in the video), as a result ball is not getting sufficient speed sometimes. Thus we can use steeper motor instead of servos whose speed can be controlled and is greater than servos. steeper motors can also rotate 360 degrees.

(ii) We can use ply board instead of cardboard as cardboards are very fragile and difficult to handle, also they provide more friction. we can also bring more stable setup using ply board.

(iii) MQTT could have been implemented.

(iv) For the ball going outside the board, we can make a setup outside the board on both the sides such that the ball directly goes into the hole through the setup. we can fit a light sensor such that as the ball comes the light sensor senses zero value and thus we will know which side the ball went.