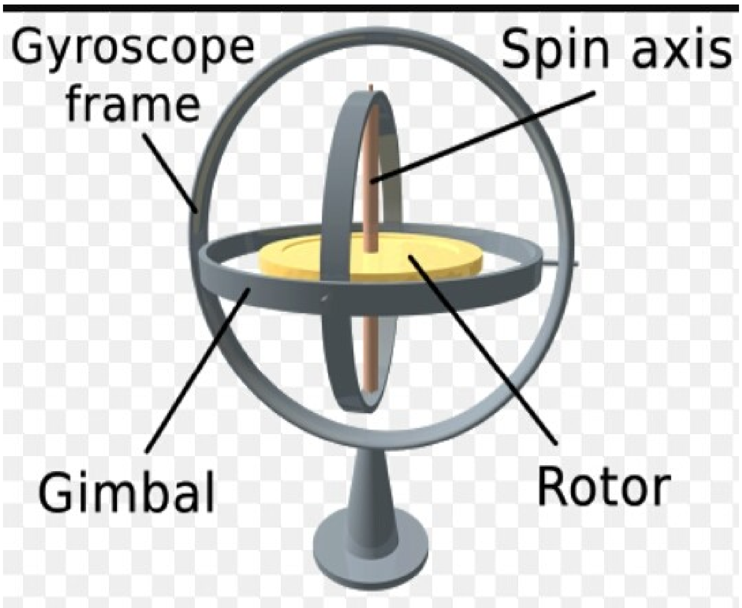
INTERFACE GYROSCOPE TO MEASURE ANGLES



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Gyroscope is a device used for measuring or maintaining orientation and rotational motion .

The main aim of this project is to find the angle between two planes of choice considering the horizontal plane as our reference plane.Using the angular velocity we obtain from the sensor,the angles are calculated.

Hexadecimal register addresses 43 and 44 give the component of angular velocity in x-direction.

Hexadecimal register addresses 45 and 46 give the component of angular velocity in y-direction.

Hexadecimal register addresses 3B and 3C give the component of acceleration in x-direction.

Hexadecimal register addresses 3D and 3E give the component of acceleration in y-direction.

Hexadecimal register addresses 3F and 40 give the component of acceleration in Z-direction.

To read the data from these registers ,import the SMBUS module.

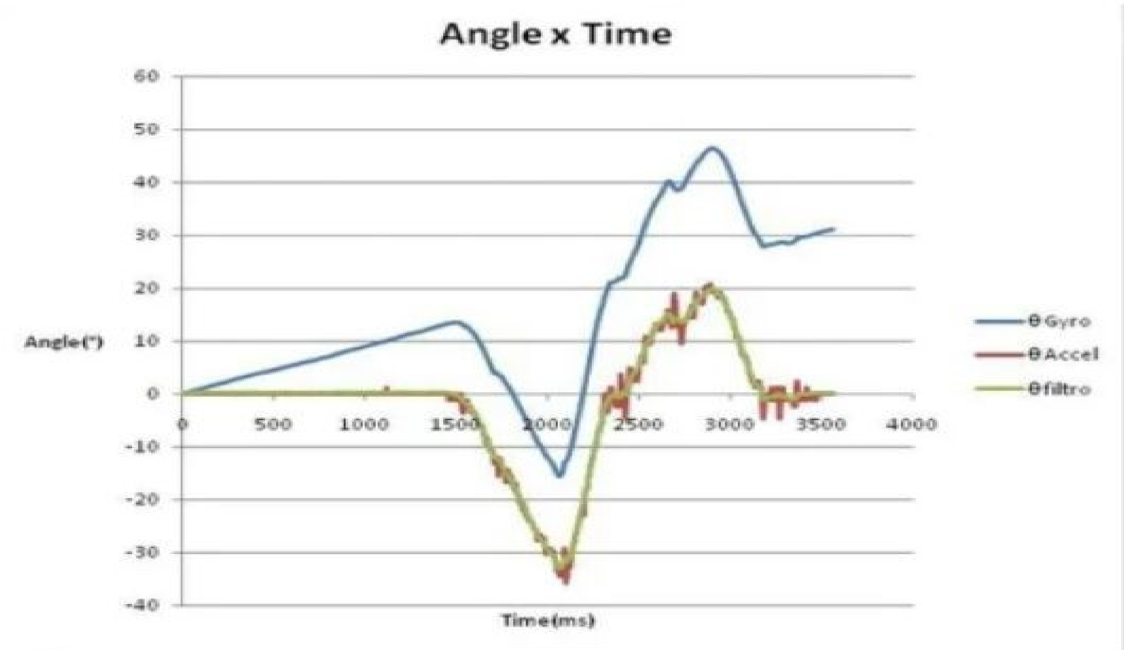
To halt the execution of the program for certain time import time module .

As angle is the integral of angular velocity wrt time . Since we can't find the integral of angular velocity we assume angular velocity to be constant but as it is not, to compensate this error we use drift .

Drift = atan(ay/sqrt(ax^2+az^2))

atan=tan inverse

ax=component of acceleration wrt x-direction , ay=component of acceleration wrt y-direction az=component of acceleration wrt z-direction



Blue :- Gyro

Red :-Acceleration

Green :-Result

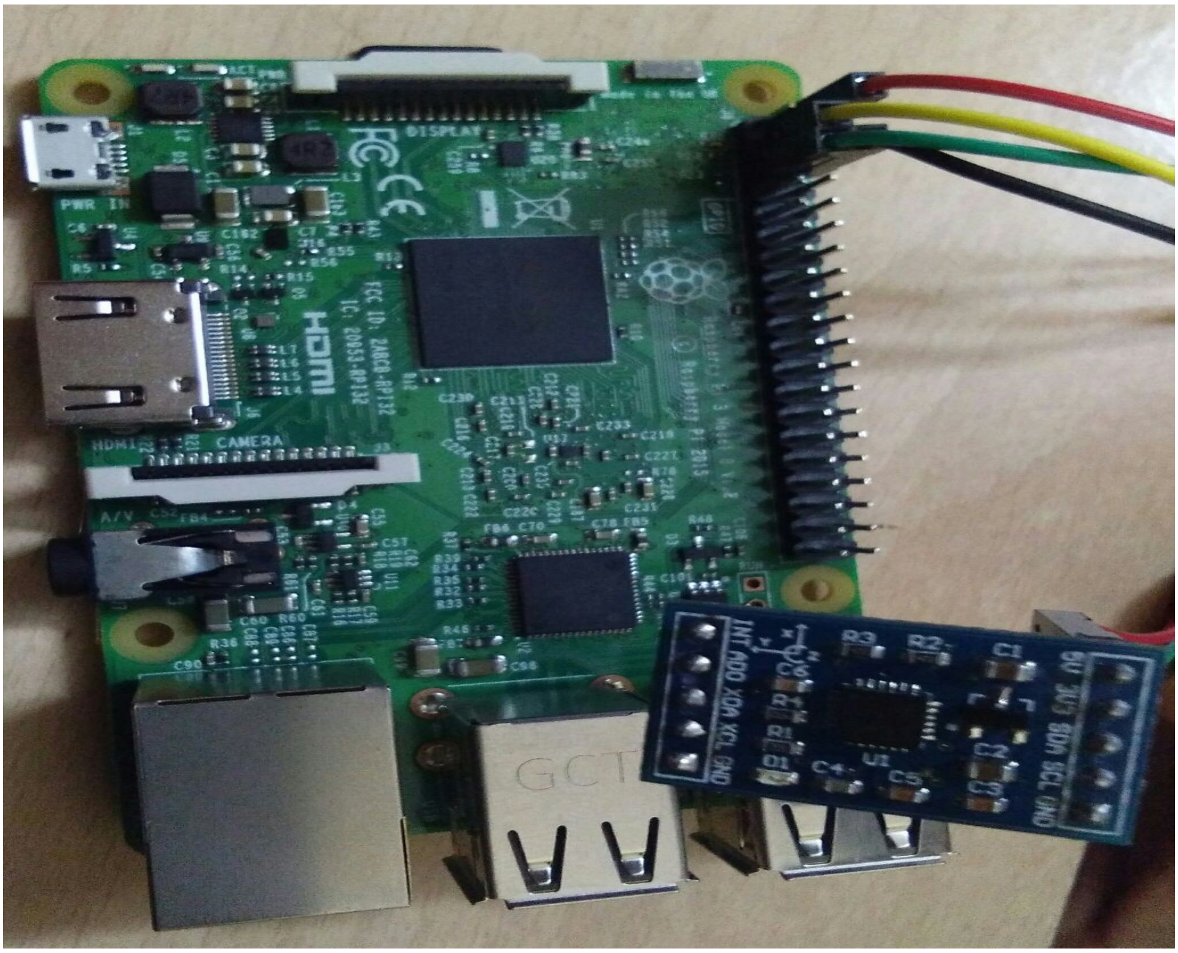
According to the experimental values the contribution of drift is 2% and angular velocity term is 98% to the total angle. This way of combining the 2 contributors to angle is called Composite Filter.

Angle = (0.98)*(prev_angle+w*t) +(0.02)*(drift) (since difference in angles is approximately equals to w*t and here t=sleep time)

Using sleep function from time module we halt the execution for every 0.01 seconds. Thus for every 0.01 seconds the angles in x and y directions wrt initial plane are displayed.

CONNECTIONS :

- 5V in MPU6050 to 5V in Raspberry-pi(Pin no – 2)
- GND(ground) in MPU6050 to GND(ground) in Raspberry-pi(Pin no – 6)
- SCL(colck) in MPU6050 to SCL in Raspberry-pi(Pin no – 5)
- SDA(data) in MPU6050 to SDA in Raspberry-pi(Pin no – 3)

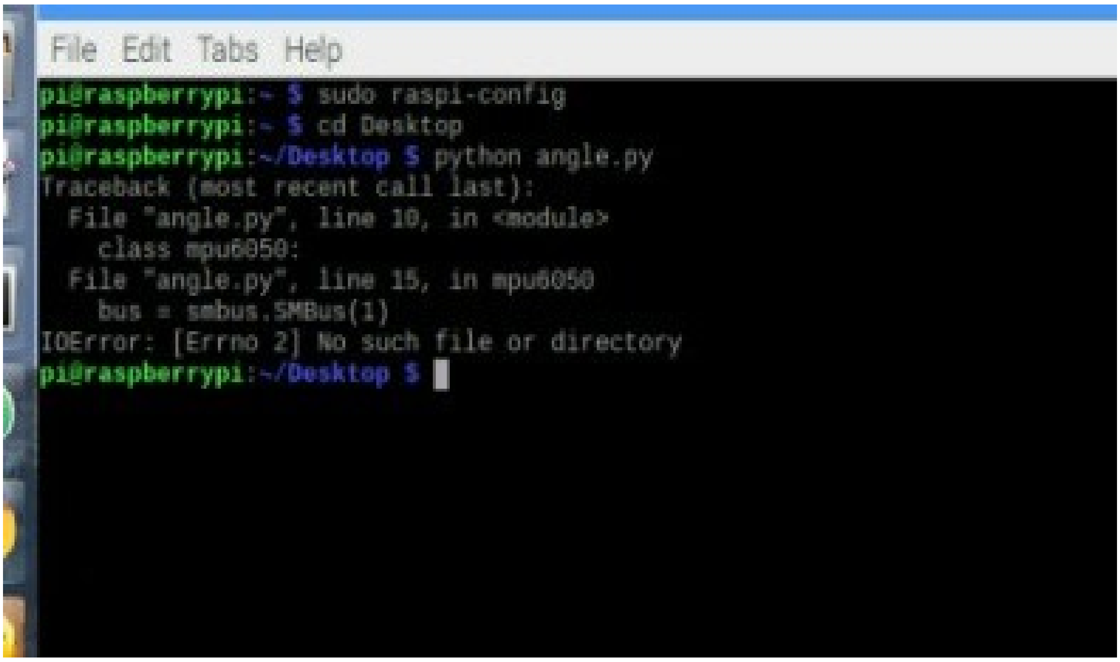


PROBLEMS THAT WE FACED :

1. ENABLING I2C BUS :

Initially we didnt know that we were suppose to enable I2C bus (which is required to read the data from the registers).

The error message was: IOError :[Errno 2]



Thus we overcame this problem by configuring pi,then choosing interface operations and enabling P5 I2C.

2. DRIFT:

The angles which we got weren't that accurate , so we used drift as explained before.

COMPONENTS USED :

1. SENSOR (MPU6050) :

We used MPU-6050 for getting values of angular velocity and acceleration . MPU-6050(Motion Processing Unit) :

The MPU devices provide the world’s first integrated 6-axis motion processor. The devices combine a 3-axis gyroscope and a 3-axis accelerometer on the same silicon die. The MPU-6000 and MPU-6050’s integrated 9-axis MotionFusion algorithms access external magnetometers or other sensors through an auxiliary master I2C bus, allowing the devices to gather a full set of sensor data without intervention from the system processor. Using this sensor we can also calculate temperature in addtion to acclereation and angular veclocity.

The MPU-6050 supports I2C communications at up to 400kHz and has a VLOGIC pin that defines its interface voltage levels.

SMPRT_DIV(Sample Rate Divider) : This register specifies the divider from the gyroscope output rate used to generate the Sample Rate for the MPU-60X0.

Sample Rate = Gyroscope Output Rate / (1 + SMPLRT_DIV)

RANGE AND ACCURACY : For precision tracking of both fast and slow motions, GYROSCOPE has a full-scale range of ±250, ±500, ±1000, and ±2000°/sec . ACCELEROMETER has a full-scale range of ±2g, ±4g, ±8g, and ±16g.

2.RASPBERRY-PI:

- Broad 64bit Quad Core Processor powered Single Board Computer running at 1.2GHz
- 1GB RAM
- WiFi on board
- Bluetooth Low Energy (BLE)
- 40pin extended GPIO (General purpose input/output)
- 4 x USB 2 ports
- 4 pole Stereo output and Composite video port
- Full size HDMI (High-Definition Multimedia Interface)
- Camera port for connecting the Raspberry Pi camera
- Display port for connecting the Raspberry Pi
- Micro SD port for loading your operating system and storing data
- Micro USB power source (now supports up to 2.4 Amps)

Pins :

- Two 3.3Volt and two 5Volt for high
- Eight ground for low
- GPIO 2 to GPIO 27
- ID-SD (I2C ID EEPROM)
- ID-SC(I2C ID EEPROM)

3.JUMPER-WIRES:

We used 4 female – female pins .

4.ETHERNET-CABLE:

We connect raspberry-pi to or laptop where our system acts as server and Raspberry-pi as host.

5.USB-CABLE :

This is connected between raspberry pi and our system.This is used for continuous power supply for raspberry-pi.

CONTRIBUTION OF THE INDIVIDUAL TO THE PROJECT :

- RaspberryPi data-sheet and pin diagram :

  IMT2016078(Kalva Vaishnavi)

- MPU-6050 data-sheet (Registers which we used) :

  IMT2016053(Soumya Kariveda)

  IMT2016066(Chinmayeesai Vajrala)

- Coding (MPU6050 interface and finding angles) :

  IMT2016022(Neeruganti Sai Akshara) and
  IMT2016057(Lakshmi Manonmaie Pasumarthy)

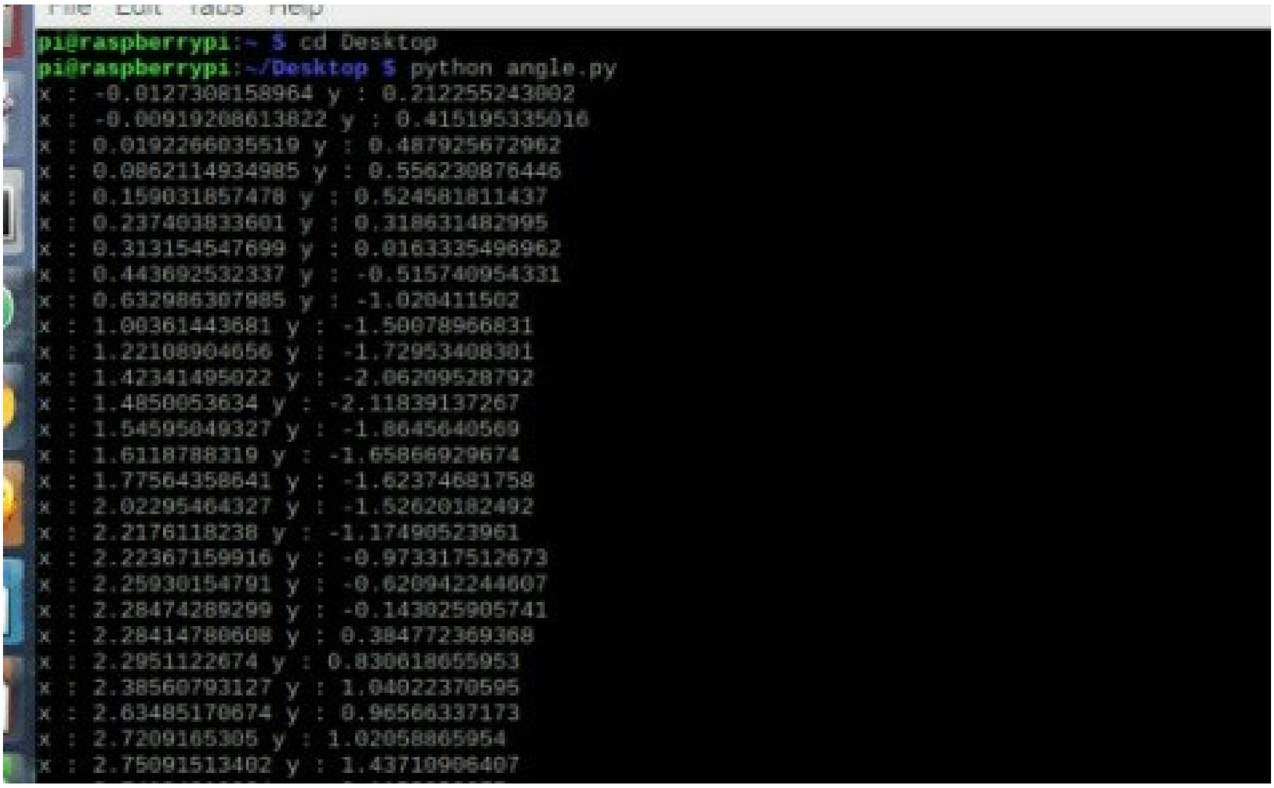
- Connections :

  Everyone

- Though we divided it like this ,eventually everyone gave contribution to everything. All members of our group have a basic idea about everything.

RESULTS :

We are displaying the angle turned in X and Y direction with the referance .



x : Angle with x axis at that time

y : Angle with y axis at that time

If we keep the sensor stable the values will remain almost constant .

FUTURE SCOPE FOR IMPROVEMENTS :

- We thought of giving angle with respect to z-axis i.e., when it is turned in the plane of the sensor.
- We would also have tried to do GUI(Graphic user Interface) which will diplay the movement of sensor on the screen i.e., by what angle we turned the sensor the rectangular box on the screen would also turn by the same.
- We used Composite Filter for angle estimation.We could also use Kalman Filter which servers the same purpose but a bit complex and also gives more presice values.

SOURCES:

- http://www.instructables.com/id/Angle-measurement-using-gyro-accelerometer-and-Ar/
- https://learn.sparkfun.com/tutorials/gyroscope
- http://www.pieter-jan.com/node/7
- DataSheets of RaspberryPi and MPU6050