Air-Mouse
-Based on ESP-32 and MPU-6050

Project Report

EKLAVYA MENTORSHIP PROGRAMME

AT

**SOCIETY OF ROBOTICS AND AUTOMATION,
VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
MUMBAI**

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ACKNOWLEDGEMENT

Working in the Eklavya Mentorship Programme was interesting. We learnt a lot about ESP-32 and MPU6050 especially the Capacitive Touch pin feature of the ESP-32.

We have to thank My Seniors for helping me with the project.
We owe special thanks to Vedant Paranjapee for taking out his precious time to solve our doubts.

Therefore, We are grateful to the people in Society for Robotics and Automation for the Chance to make this Project.

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1)INTRODUCTION

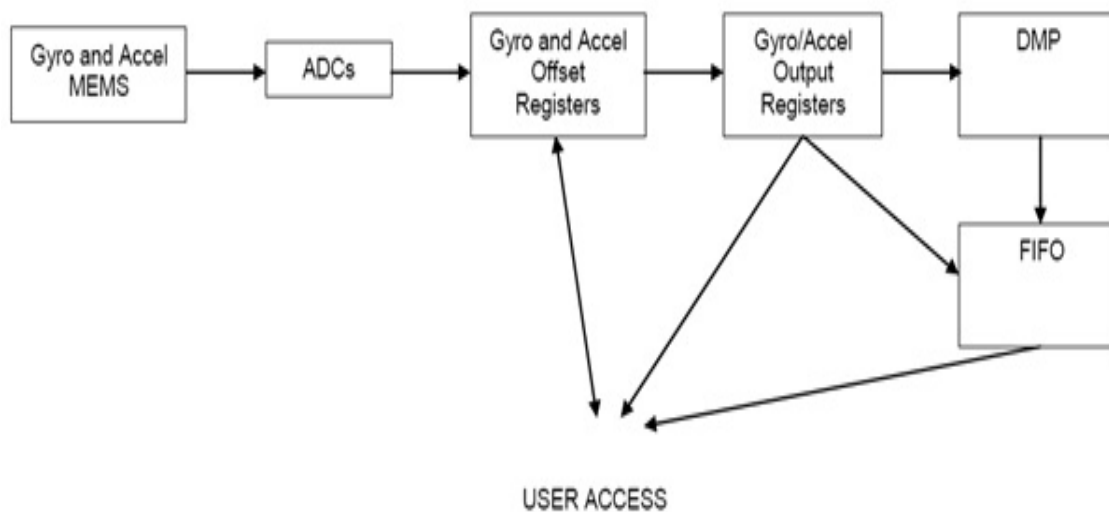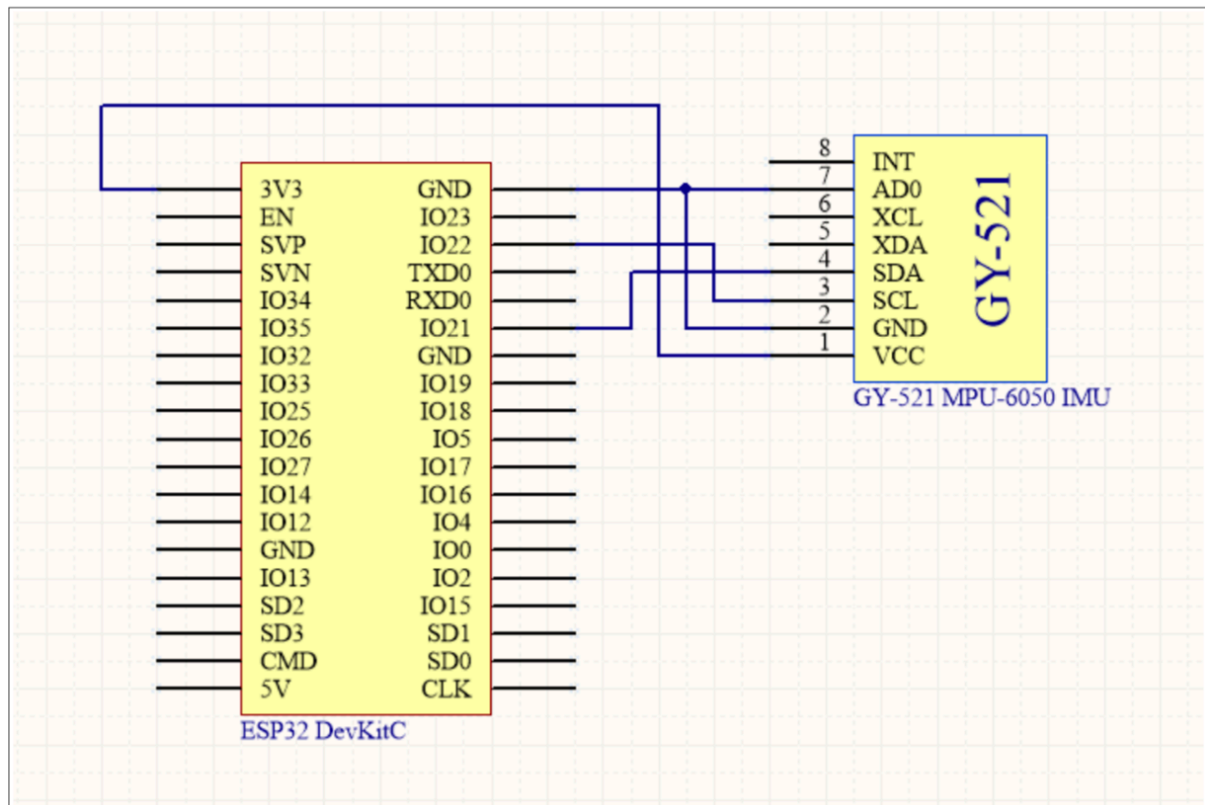With the Improvement in technology and efficiency of human lives, There is an increasing demand among the Gamers to Improve the mouse functionality. So here We brings to you Air-Mouse with Bluetooth compatibility. You can the wave the mouse in air and the pointer on screen move according to the motion. This feature is been offered in new Smart TV remotes. The prototype is made using ESP-32 and MPU6050. ESP-32 is the Microcontroller/Microprocessor with Bluetooth and Wi-Fi support. The Capacitive Touch Pins has been used for Right and Left clicks. Furthermore more functionality can be added using other touch pins if required. The Data received from MPU6050 in the form of Yaw, Pitch and Roll is used to move the pointer on the screen. The Yaw, Pitch and Roll values are obtained using DMP(Digital Motion Processor), which is contained in MPU6050.
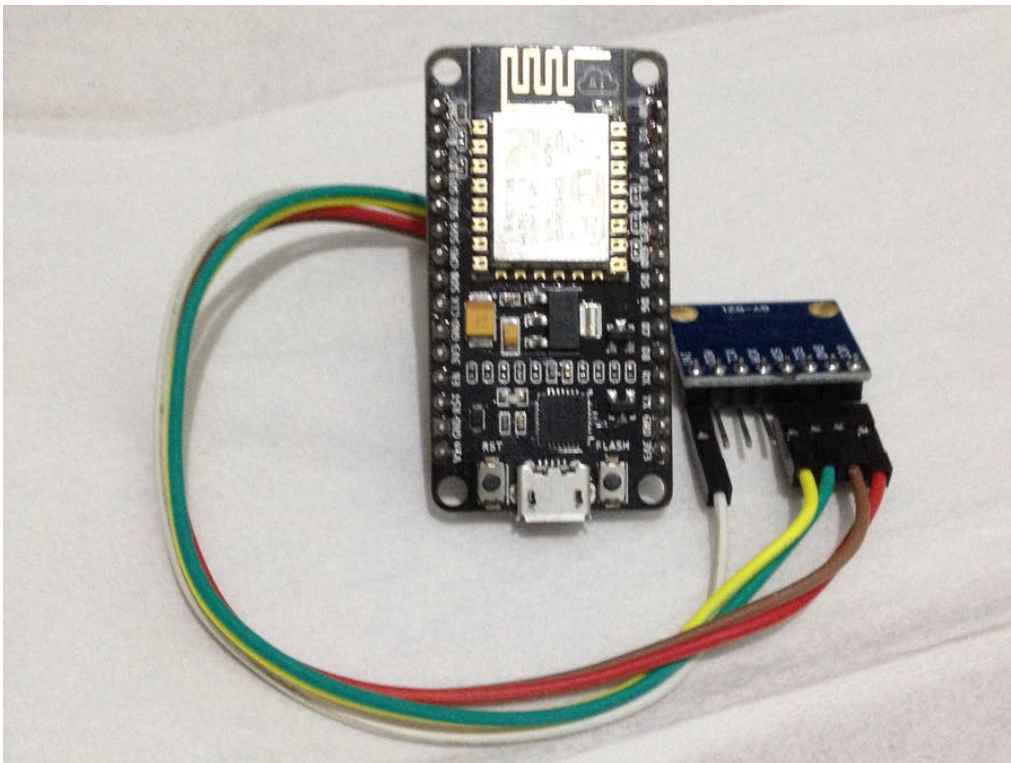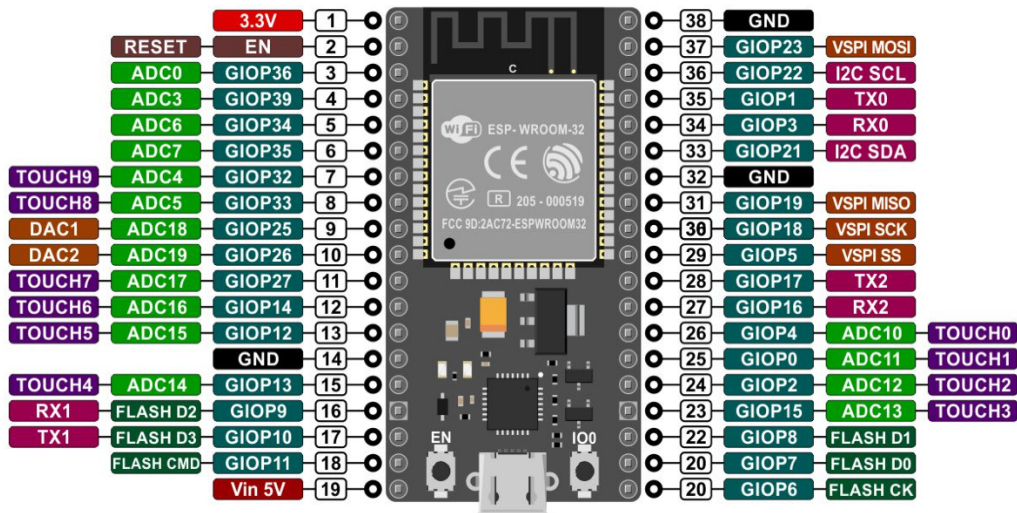
2)PROPOSED METHOD

This section describes the process behind the working of Air-Mouse. The motion in MPU6050 sensor is sensed and reported to the ESP32 in the form of FIFO buffer. The DMP is integrated in MPU6050, and thus provide accurate Yaw, Pitch ,Roll using both accelerometer and gyroscope values. The MPU6050 is connected with ESP-32. ESP-32 comes with integrated Bluetooth chip, which makes it possible to transfer the packets received from MPU6050 over Bluetooth to the connected Device and hence the cursor or pointer is moved. The touch pins. The further Description of the process and components individually is provided in the hardware section.

	ESP32 DevKitC			GY-521	
	3V3	GND		8	INT
	EN	IO23		7	AD0
	SVP	IO22		6	XCL
	SVN	TXD0		5	XDA
	IO34	RXD0		4	SDA
	IO35	IO21		3	SCL
	IO32	GND		2	GND
	IO33	IO19		1	VCC
	IO25	IO18			
	IO26	IO5			
	IO27	IO17			
	IO14	IO16			
	IO12	IO4			
	GND	IO0			
	IO13	IO2			
	SD2	IO15			
	SD3	SD1			
	CMD	SD0			
	5V	CLK			

ESP32 DevKitC

GY-521 MPU-6050 IMU

3)Hardware

ESP-32

ESP32 is a system on a chip that integrates the following features:

- Wi-Fi (2.4 GHz band)
- Bluetooth
- Ultra-Low Power co-processor
- Multiple peripherals

Powered by 40 nm technology, ESP32 provides a robust, highly integrated platform, which helps meet the continuous demands for efficient power usage, compact design, security, high performance, and reliability.

Espressif provides basic hardware and software resources to help application developers realize their ideas using the ESP32 series hardware. The software development framework by Espressif is intended for development of Internet-of-Things (IoT) applications with Wi-Fi, Bluetooth, power management and several other system features.

ESP32 not just supports the latest BLE Bluetooth 4.2, it also supports classic Bluetooth. It basically means it can speak to old and new Bluetooth phones/tables.

This could one of the best features especially, if you're designing a device that needs to work with existing as well as new phones/tablets in the market.

MPU6050
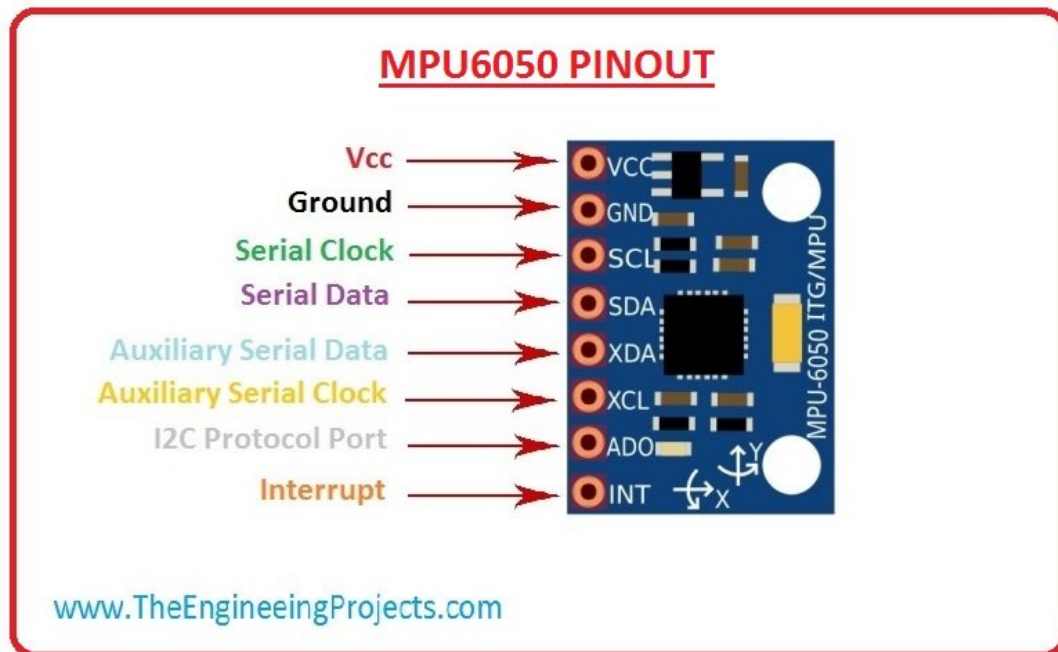
The MPU6050 is a Micro Electro-Mechanical Systems (**MEMS**) which consists of a 3-axis Accelerometer and 3-axis Gyroscope inside it. This helps us to measure acceleration, velocity, orientation, displacement and many other motion related parameter of a system or object. This module also has a (DMP) Digital Motion Processor inside it which is powerful enough to perform complex calculation and thus free up the work for Microcontroller.

The module also have two auxiliary pins which can be used to interface external IIC modules like an magnetometer, however it is optional. Since the IIC address of the module is configurable more than one **MPU6050 sensor** can be interfaced to a Microcontroller.

MPU6050 Pin Configuration

| Pin Number	Pin Name	Description
1	Vcc	Provides power for the module, can be +3V to +5V. Typically +5V is used
2	Ground	Connected to Ground of system
3	Serial Clock (SCL)	Used for providing clock pulse for I2C Communication
4	Serial Data (SDA)	Used for transferring Data through I2C communication
5	Auxiliary Serial Data (XDA)	Can be used to interface other I2C modules with MPU6050. It is optional
6	Auxiliary Serial Clock (XCL)	Can be used to interface other I2C modules with MPU6050. It is optional
7	AD0	If more than one MPU6050 is used a single MCU, then this pin can be used address
8	Interrupt (INT)	Interrupt pin to indicate that data is available for MCU to read.

MPU6050 Features

- MEMS 3-aixs accelerometer and 3-axis gyroscope values combined
- Power Supply: 3-5V
- Communication : I2C protocol
- Built-in 16-bit ADC provides high accuracy
- Built-in DMP provides high computational power
- Can be used to interface with other IIC devices like magnetometer
- Configurable IIC Address
- In-built Temperature sensor

4)Quaternion

A quaternion is a four-element vector that can be used to encode any rotation in a 3D coordinate system. Technically, a quaternion is composed of one real element and three complex elements, and it can be used for much more than rotations. In this application note we'll be ignoring the theoretical details about quaternions and providing only the information that is needed to use them for representing the attitude of an orientation sensor.

The attitude quaternion estimated by CH Robotics orientation sensors encodes rotation from the "inertial frame" to the sensor "body frame." The inertial frame is an Earth-fixed coordinate frame defined so that the x-axis points north, the y-axis points east, and the z-axis points down as shown in Figure 1. The sensor body-frame is a coordinate frame that remains aligned with the sensor at all times. Unlike Euler Angle estimation, only the body frame and the inertial frame are needed when quaternions are used for estimation (Understanding Euler Angles provides more details about using Euler Angles for attitude estimation).
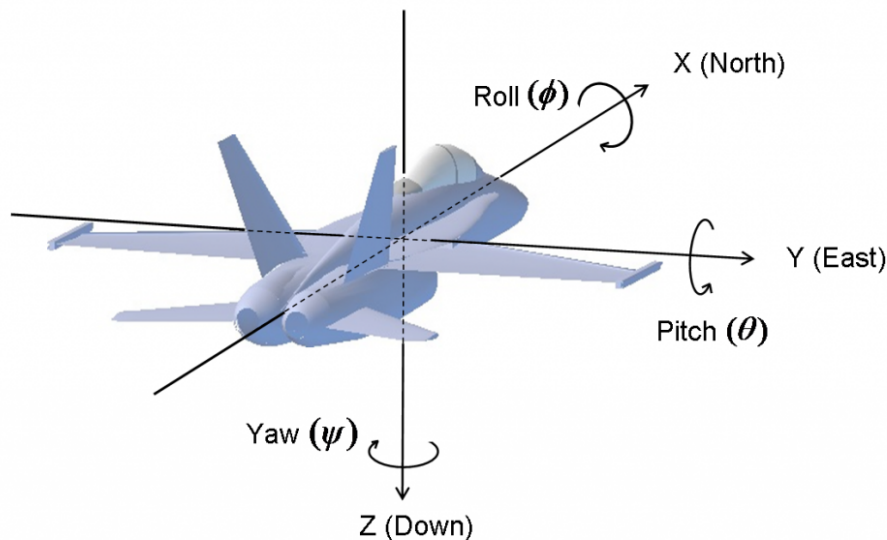
5)EXPERIMENTAL RESULTS AND ANALYSIS

Using the above hardware and methods ,a user satisfied accuracy was achieved. Of all the filter we tried, DMP data fusion gave the best results. DMP data fusion data was found to be more accurate than the data obtained from the complimentary filter. The Project Uses the Jeff Rowberg for the MPU6050 library for ESP-IDF :https://github.com/jrowberg/i2cdevlib/tree/master/ESP32_ESP-IDF.
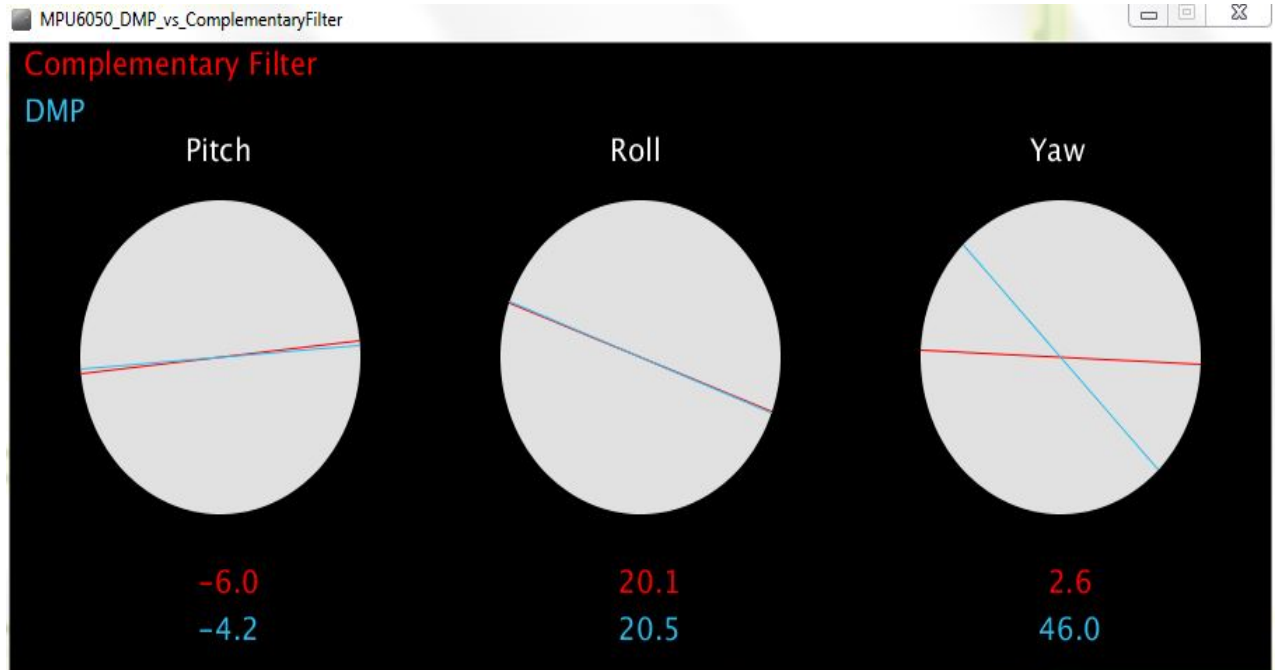
The Air-Mouse is yet not feasible for the general users, While It may works wonder for gamers who wants simple and particular functionality in the mouse.

6) CONCLUSION AND FUTURE WORK

Currently Our Project Uses MPU6050 which has only 6 axis ,While more advanced version of it MPU9250 has 9 axis to work with, hence more accuracy. So our Future aim would be to work with MPU9250. Using touch pins more functionality can be added to the Air-mouse like scrolling up and down, dragging etc.