# MOTION SENSOR ENHANCED VIRTUAL REALITY GEAR FOR PILOTING THE UAV's

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**Abstract -** *This Document introduces a technology to control 3 Axis of motions of Unmanned Aerial Vehicles with motion sensor enhanced virtual reality gear. Where the VR gear is enhanced with 6-axis gyroscope embedded with ESP32 microcontroller, to capture the head motion in 3-axis namely roll, pitch, yaw. The values which later will be range mapped and transmitted to UAV over conventional RC trans-receiver of bandwidth 2.4 GHz and based on Pulse Width Modulation (PWM). With this enhancement of virtual reality gear, one can take an aerial view virtually and also control the UAV using just motions of head.*

***Key Words*: UAV, Roll, Pitch, Yaw, VR controlled, ESP32.**

## 1. INTRODUCTION

Many researches and technology advances are been made in the field of UAVs and Virtual Reality. This Documents introduce about one such technological advances where both virtual reality is combined into world of UAVs. Virtual reality is technology, which brings virtual into real time experience, with one of such tech is being combined with embedded system to use the same existing VR gear to control the three axes of motion namely Roll, Pitch, Yaw of UAVs with the motion of the human head. A person cannot experience a true virtual reality even if a small segment of a system is left without virtualization. Hence, we have come with virtualization of UAVs controller. Which makes the UAV piloting more easier and adventurous.

## 2. PROBLEM STATEMENT

The piloting an UAVs using conventional joystick remote control makes difficulties in controlling the motions of drone during flight and also according to civil aviation norms UAVs can be on flight until the UAV is in line of sight. Hence using the motion sensor enhanced VR gear for piloting UAVs can eliminate these problems, depending on range of UAVs control and can also make piloting user friendly and adventurous.

## 3. EXISTING SYSTEM

The UAV is controlled by conventional RC joystick controller which has 5-6 channel where each channel is dedicated for throttle, roll, pitch, and yaw. Where the values are mapped within the range of 1000 to 2000. These values are pulse width modulated of total time period(T) of 2000 micro seconds, where $T_{on}$ is equal to values of each input and $T_{off}$ is equal to $T - T_{on}$.

To Discuss the topic we consider UAV to be Quad-copter with 4X configuration.


**Fig 2.1: Pulse Width Modulated signal.**

## 3. Quad-copter 4X mechanism

The drone is implemented by using quad copter of 4x configuration which has four arms containing four motors at each end. The quad copter stands to be the most symmetrical, simple in design, and elegant configuration of all times. The principle of controlling the roll, pitch, yaw is elegantly simple. The pattern of rotation of the propellers is shown in the figure 3.1.

Motor 1 and 3 rotate clockwise and motor 2 and 4 rotate counter clockwise in order to make it fly. The total thrust produced by all the motors should be at least twice the drone weight. The UAV has three types of motions namely roll, pitch, and yaw.

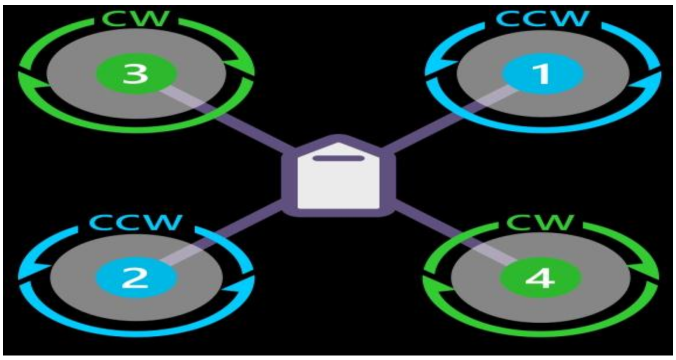


Fig 3.1: Quad 4X configuration schematic.

Pitch - It is the up and down movement of the drone along vertical axis.

Roll - It is forward, backward, right and left movement of the drone along horizontal axis.

Yaw - It is the clockwise or anticlockwise movement of the drone.

All these movements are shown in fig 3.2

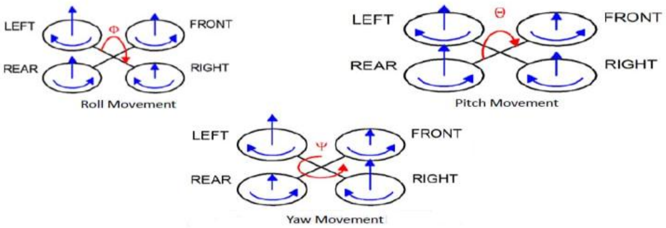


Fig 3.2: 3 axis of motions.

## 4. METHODOLOGY OF PROPOSED SYSTEM

The methodology of the proposed system can be shown in the Fig-4.1 in which we use the microcontroller ESP32

For reading the data and calculate motions from the motion sensor used that is MPU6050. The embedded system is housed within the VR gear. Here we use ESP32 as micro-controller as the microcontroller has inbuilt Wi-Fi support, which makes the VR gear to operate wireless.

The Roll, Pitch, Yaw is transmitted wirelessly to transmitter block, using Wi-Fi medium. The data calculated is further mapped to the range from 1000 to 2000 making the values suitable for pulse width modulation (PWM) and transmitted through radio frequency of 2.4 GHz over different channels for different axis of motions using nrf24 IC. The signals are received by receiver in drone and its further manipulated by flight controller and controls the drone.

The flow chart of system is described in Fig 4.1

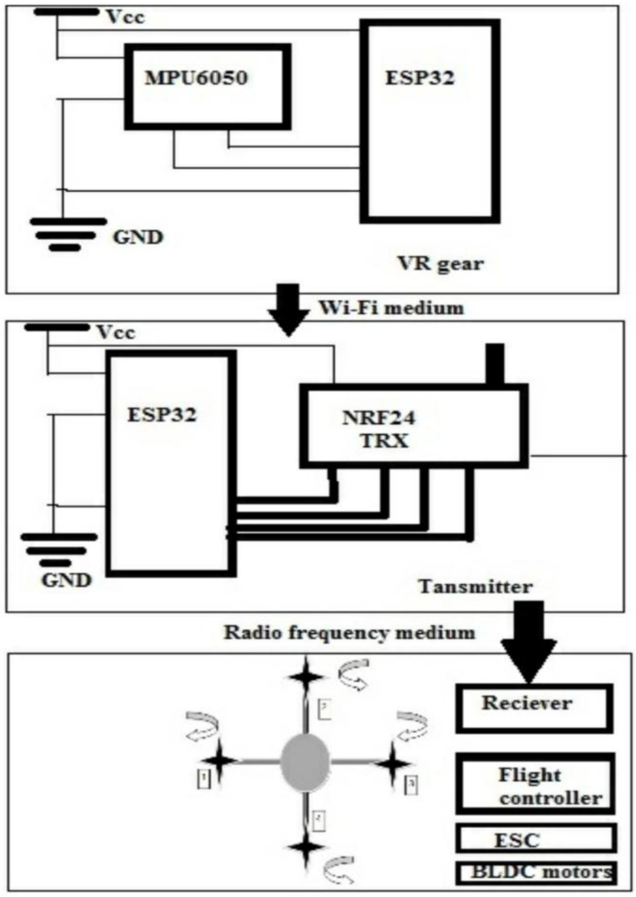


Fig 4.1: System flowchart.

## 5. Tracking Motions using MPU6050

The operation of the drone is purely based on the sensor in the VR box which is MPU6050. It is a 6 Axis gyroscope with 3 axis accelerometer and 3 axis gyroscope values combined. It communicates through I2C protocol it has 12 registers as shown in the table 5.1

| |
|---|
| ACCEL_XOUT_H |
| ACCEL_XOUT_L |
| ACCEL_YOUT_H |
| ACCEL_YOUT_L |
| ACCEL_ZOUT_H |
| ACCEL_ZOUT_L |
| GYRO_XOUT_H |
| GYRO_XOUT_L |
| GYRO_YOUT_H |
| GYRO_YOUT_L |
| GYRO_YOUT_H |
| GYRO_YOUT_L |

Table 5.1: Register map of MPU6050

The exact values of each axis of accelerometer and gyroscope are found by combining high and low registers of each axis. Then, the output values of accelerometer and gyroscope are passed as the argument to low pass filter and high pass filter respectively. For filtering the data of the sensors as the data is highly noisy. Then, slow moving signal from accelerometer and fast moving signal from gyroscope are combined in complementary filter.

**Calculation of pitch**

The changes in the values of accelerometer reading of y axis and z axis and gyroscope reading of x axis should be used.

**Calculation of roll**

the changes in the values of accelerometer readings of x axis and z axis and gyroscope reading of y-axis are to be used.

**Equation for low-pass filter:**

y[n] = (1-alpha).x[n] + alpha.y[n-1]

use this for values obtained from accelerometers x[n] is the pitch/roll/yaw that you get from the accelerometer y[n] is the filtered final pitch/roll/yaw.

**Equation for high-pass filter:**

y[n] = (1-alpha).y[n-1] + (1-alpha)(x[n]-x[n-1])

use this for values obtained from gyroscopes x[n] is the pitch/roll/yaw that you get from the gyroscope y[n] is the filtered final pitch/roll/yaw, n is the current sample indicator.

**Implementing a complementary filter:**

angle = (1- alpha)(angle + gyro * dt) + (alpha)(acc)

First reading is the angle as obtained from gyroscope integration. Second reading is the one from accelerometer.

Where, alpha = (tau)/(tau + dt)

Where tau is the time constant and dt = 1/fs where fs is your sampling frequency

## 6. VALUE MAPPING

As specified in text 3 (Quad-copter 4X mechanism), The 3 axis of motion of UAV is Roll, Pitch, and Yaw. The values for these axis is set at $0^o$ and has range from negative to positive angle. Hence for all three axis $0^o$ is considered to be stable. The value of Pulse width modulation is between range 1000 to 2000. Therefore for all axis $0^o$ angle is mapped to 1500 and all negative angle is mapped below 1500 and positive angle is mapped above 1500. The mapped values are considered as control signals for the UAVs.

## 7. HARDWARE COMPONENTS

### 7.1 MICROCONTROLLER :

The micro-controller device used to process the data received from the health support devices is ESP32.

ESP32 is a low-cost micro-controller which has integrated Wi-Fi and dual-mode Bluetooth(BLE).

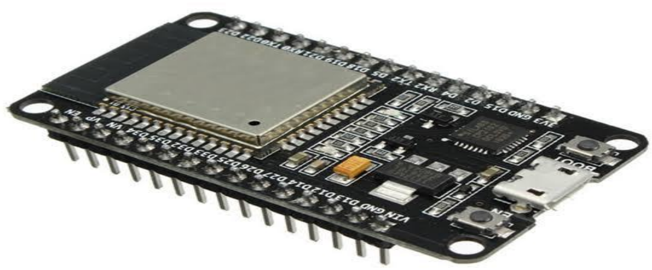

Fig 7.1: ESP32 micro-controller

ESP32 also has a variety of modules and development boards for building IoT applications effectively.

Wi-Fi and BLE (Bluetooth low energy) are common network stacks in the Internet of Things applications that provide cost-effective solutions.

Due to integrated Wi-Fi, ESP32 can easily transmit the received data from

### 7.2 MPU6050 Motion sensor

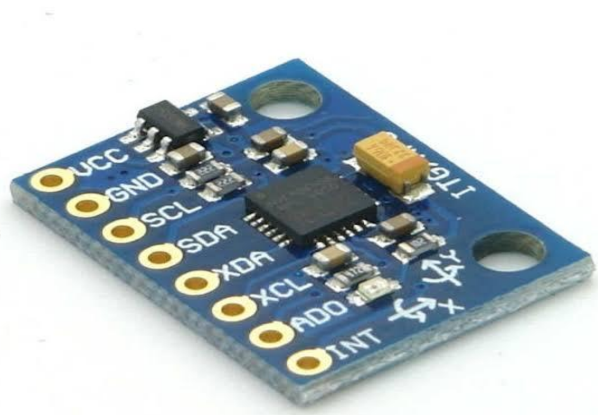


Fig 4.2.1 mpu6050

MPU6050 is 3 Axis motion sensor, with ability to track motions exactly every 10 micro seconds. MPU-6050 IC is communicated with ESP32 using I2C communication protocol which uses two wires for clock synchronization and data transfer. The SDA pin of IC is connected D1 pin of ESP32, and SCL is connected to D4 pin of ESP32.

### 7.3 NRF24 Transmitter

Fig 7.3 : NRF24 TRX

The mapped values are pulse width modulated over different channels for specific axis with time period of 2000 microseconds where $T_{on}$ is equal to values of each input and $T_{off}$ is equal to $T - T_{on}$..

The modulated signals are transmitted using a nrf24 radio transmitter of 2.4 GHz bandwidth with 6 channels.

Fig 7.3: NRF24 radio transmitter.

### 6. CONCLUSIONS

The benefit of using the motion sensor enhanced VR gear to pilot UAVs is it makes easy to pilot the UAV. With respect to Civil Aviation Norms on UAVs and Drone where the drone should be piloted only in line of sight limitation can be overcome.

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### REFERENCES

**[1] Types, payloads, applications, frequency spectrum issues and future developments**

B Vergouw, H Nagel, G Bondt, B Custers - The Future of Drone Use, 2016 - Springer

**[2] Ethical implications of drone technology in journalism**

KB Culver - Journal of mass media ethics, 2014 - Taylor & Francis

**[3] The co-evolution of technological and entrepreneurial developments in the drone industry**

F Giones, A Brem - Business Horizons, 2017 - Elsevier

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