Real-Time Flight Data Monitoring Mobile Application using ESP-32

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ABSTRACT:

This project focuses on tracking and displaying a compact flight computer system using ESP32 microcontroller with the help of a mobile app. It integrates the BMP280, MPU6050 and HMC5883L sensors to monitor altitude, motion, and direction (yaw ,pitch, roll). Sensor data is collected via I2C protocol and transmitted wirelessly using WebSocket. For displaying real time flight data, a flutter based mobile app is used. The system is modular and USB powered. It is ideal for experimental payloads, and educational applications.

INTRODUCTION:

A flight computer system is developed using ESP32 microcontroller which has built-in WiFi capabilities, processing power, and supports communication protocols. The system utilizes three sensors which are :

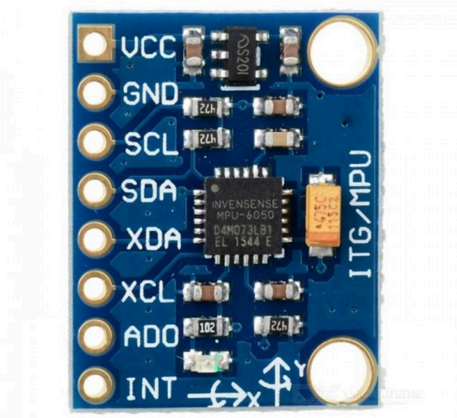
- BMP280 (Barometric pressure sensor) for measuring pressure & temperature
- MPU6050 (Inertial Measurement Unit) for tracking acceleration & gyroscopic measurements
- HMC5883L (magnetometer) which is for magnetic heading.

This system solves the problem of monitoring key flight parameters such as altitude, orientation, and heading in real time without the need of bulky ground stations, and complex telemetry systems. It serves as a efficient and portable solution for drones and Unmanned Ariel Vehicles (UAV). The mobile application serves as an ease of access and helps users to view flight data on-the-go through the responsive interface.

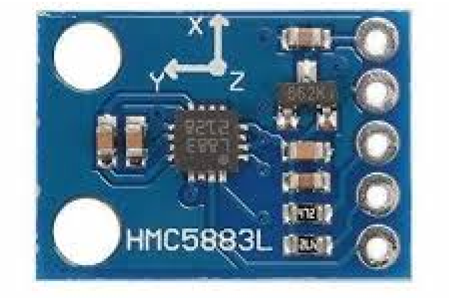
COMPONENTS USED:

- HARDWARE:

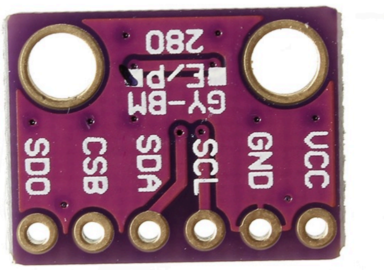
1. MPU6050



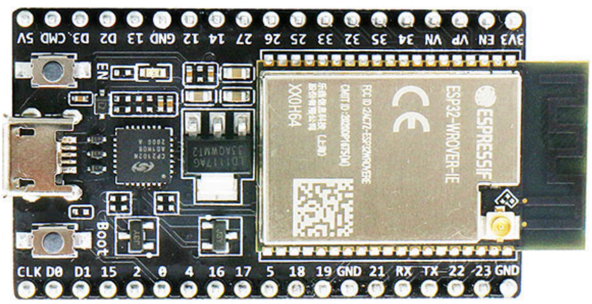
2. HMC5883l



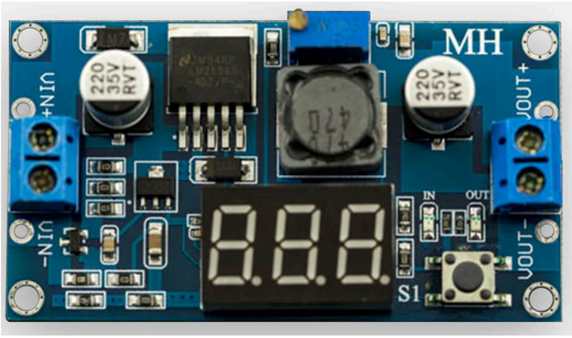
3. BMP280



4. ESP32



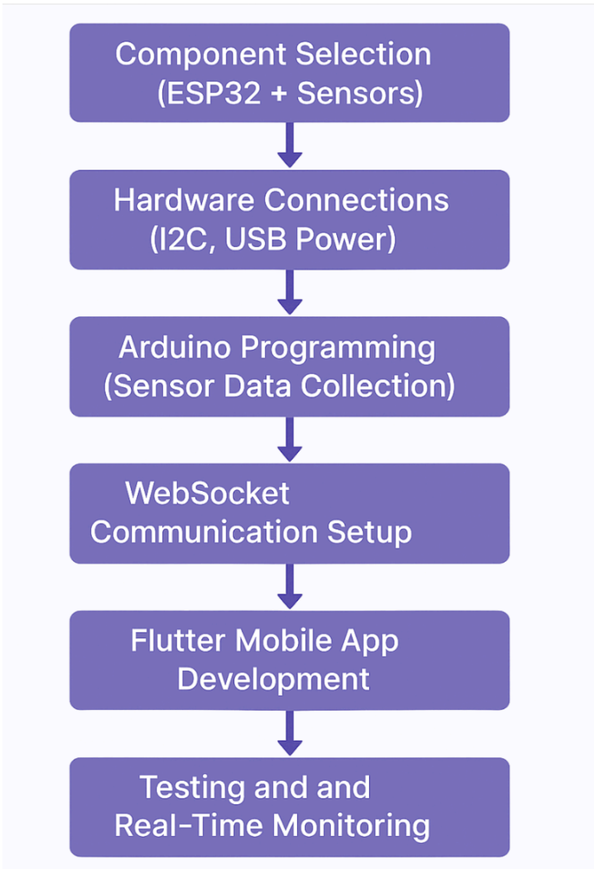
5. Connecting wires
6. Power supply (9v battery and a buck convertor)



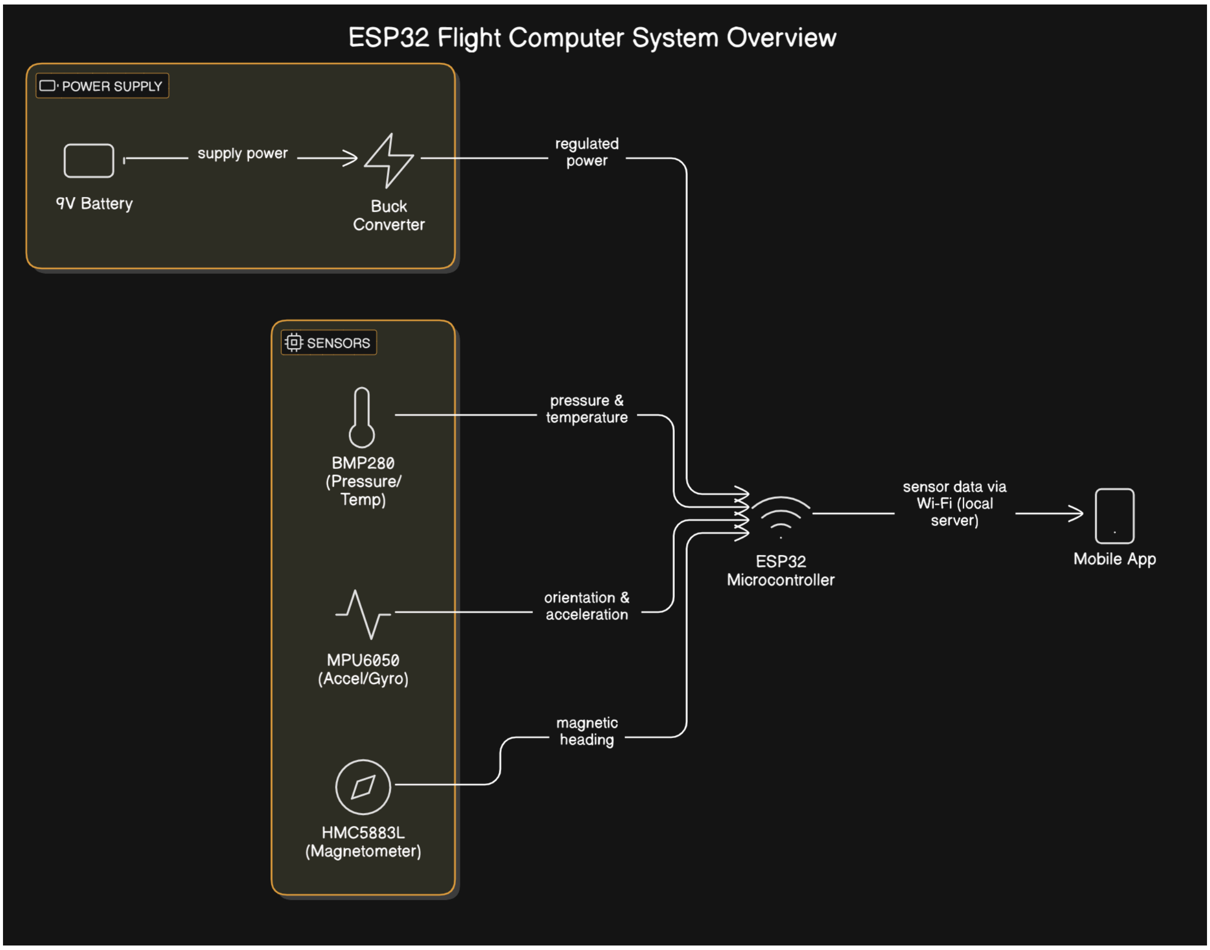
- SOFTWARE:

1. Arduino IDE
2. Flutter
3. Websockets
4. Serial Display

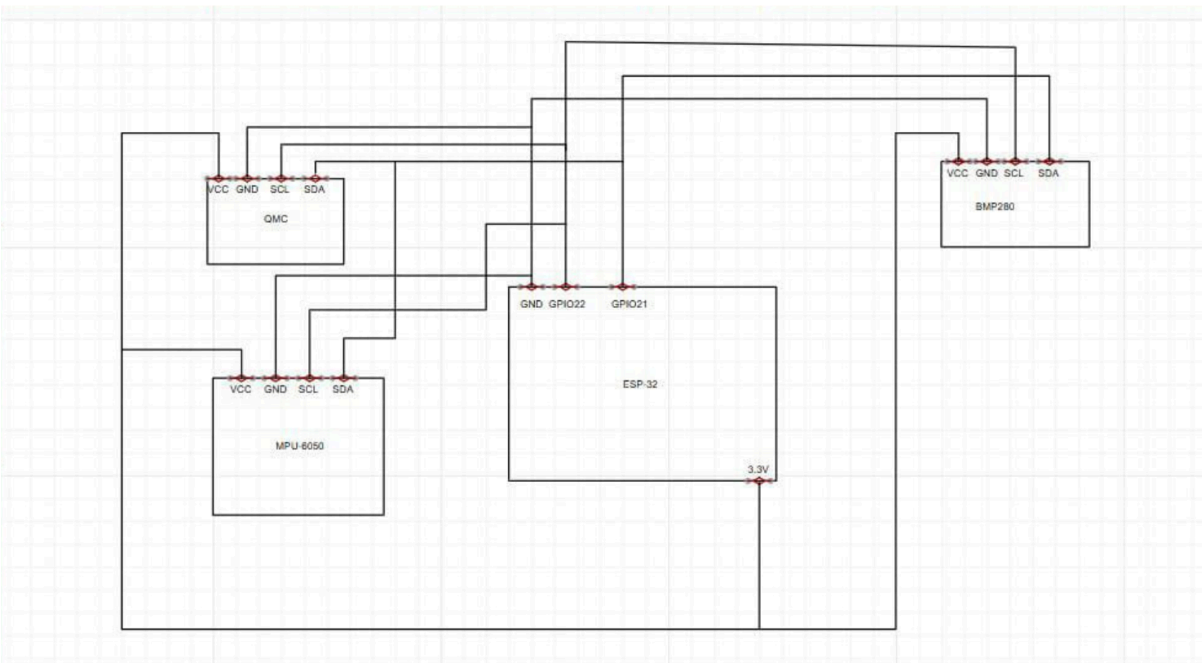
METHODOLOGY:



BLOCK DIAGRAM:



CIRCUIT DIAGRAM:



WORKING:

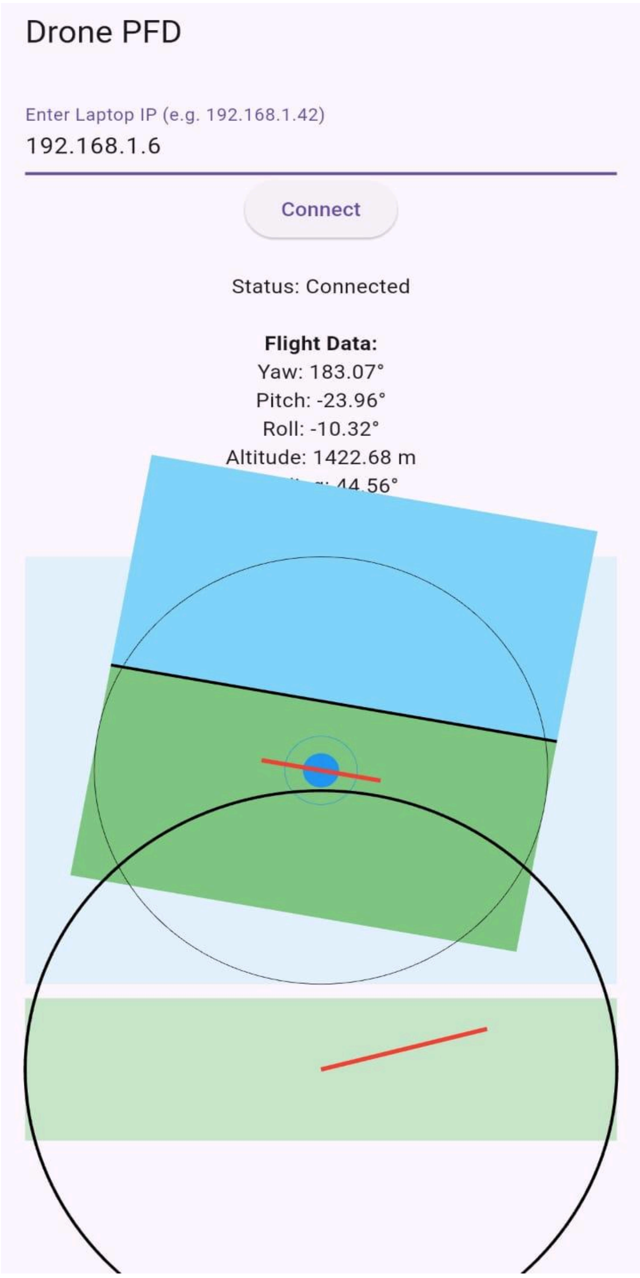
The flight computer system is built using the ESP32 microcontroller. This serves as the central processing unit (CPU) for processing, and transmitting sensor data. The ESP32 is powered using a USB connection that is powered by a 9V power supply. We have utilized a buck converter to step down the voltage to accommodate the input voltage of ESP32 and sensors. The three key sensors forming the core sensor suite are BMP280, MPU6050, and HMC5883L.

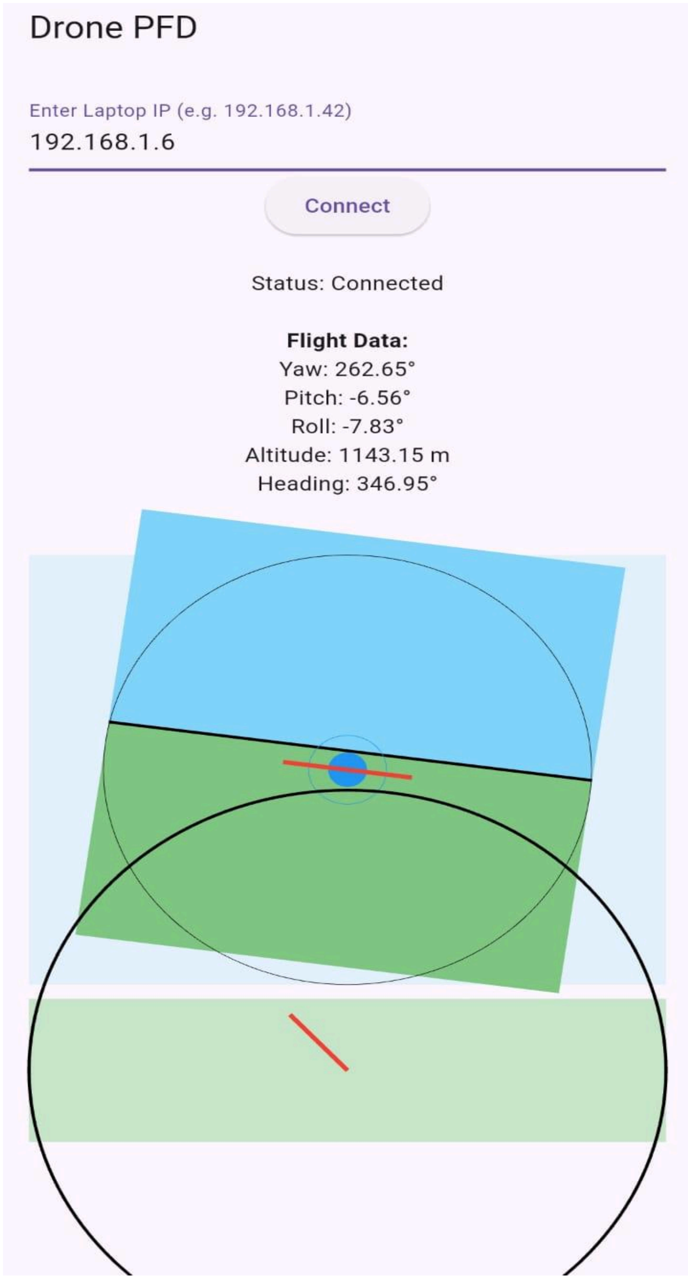
- The BMP280 is a barometric pressure sensor that gives us both pressure and temperature readings. With changes in atmospheric pressure, the system estimates the altitude. The readings are an integral part of a flight computer system.
- The MPU605 is a 6-axis inertial measurement unit that combines a 3-axis accelerometer and a 3-axis gyroscope. It is used for measuring acceleration and angular velocity. It also enables the detection of motion dynamics such as tilts, turns, and orientation changes during flight.
- The HMC5883L is a 3-axis magnetometer that basically serves as a digital compass. It measures the strength and direction of the Earth's magnetic field that gives us the heading information.

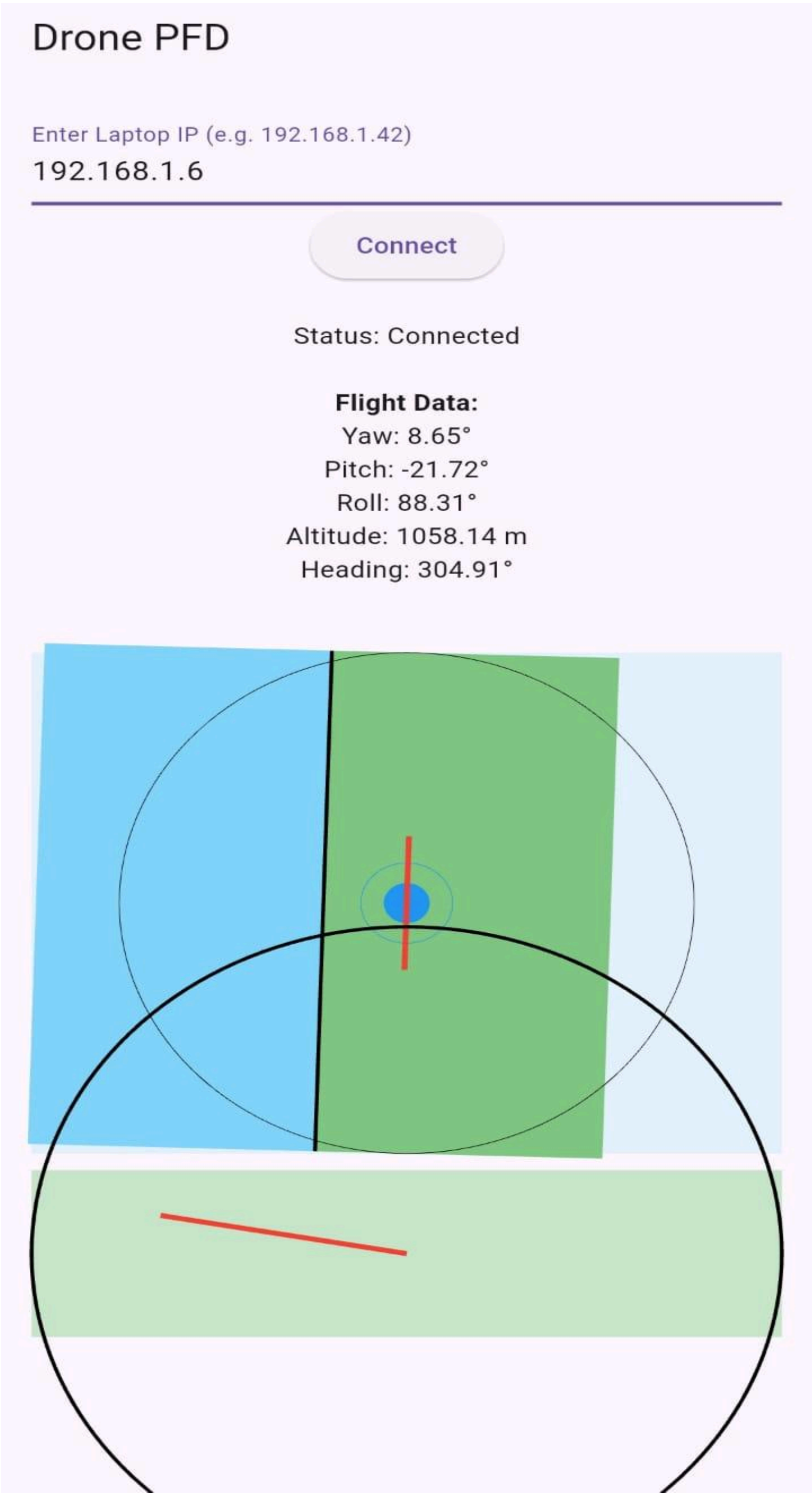
All three sensors communicate with the ESP32 using the I2C protocol. Their outputs are collected at regular intervals via the serial monitor. Using WebsSocket communication, the ESP32 wirelessly transmits this data over WiFi. The setup is structured for low-latency and bidirectional data flow between the flight computer and the mobile application. A custom mobile application is developed using Flutter (an open source software development kit that is widely used for building applications), which is connected to ESP32 through the local Wi-Fi network. This app is designed to receive real-time sensor data and visualize it using orientation indicators. The lightweight and responsive system can monitor environmental and motion changes in real time.

RESULT:

The Real-Time output of the system can be viewed in the mobile application. Here are a few test case scenarios:


Drone PFD
Enter Laptop IP (e.g. 192.168.1.42)
192.168.1.6
Connect
Status: Connected
Flight Data:
Yaw: 183.07°
Pitch: -23.96°
Roll: -10.32°
Altitude: 1422.68 m


Drone PFD
Enter Laptop IP (e.g. 192.168.1.42)
192.168.1.6
Connect
Status: Connected
Flight Data:
Yaw: 262.65°
Pitch: -6.56°
Roll: -7.83°
Altitude: 1143.15 m
Heading: 346.95°


Drone PFD
Enter Laptop IP (e.g. 192.168.1.42)
192.168.1.6
Connect
Status: Connected
Flight Data:
Yaw: 8.65°
Pitch: -21.72°
Roll: 88.31°
Altitude: 1058.14 m
Heading: 304.91°

INTERMEDIATE RESULTS:

The data displayed is acquired from all the sensors shown in the serial monitor that is useful for debugging and testing.