International Journal of Research Publication and Reviews, Vol (5), Issue (10), October (2024), Page – 4366-4370

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

AN INNOVATIVE APPROACH TO THE DESIGN AND DEVELOPMENT OF A REAL-TIME METEOROLOGICAL DRONE

Kalaiselvan .P

Lecturer Electronics (Robotics), Murugappa Polytechnic College, Chennai, Tamil Nadu

ABSTRACT

The Real Time Meteorological Drone is an innovative aerial system designed for on-the-fly weather monitoring. Equipped with advanced sensors, this drone captures real-time meteorological data, including temperature, humidity, air pressure, and wind speed. Its agile and autonomous flight capabilities enable dynamic data collection across diverse geographical areas. The integration of cutting-edge communication technology ensures swift data transmission to ground stations for immediate analysis. This drone serves as a crucial tool for enhancing weather forecasting accuracy, disaster management, and environmental monitoring. With its real-time capabilities, it empowers meteorologists and emergency responders with actionable insights, contributing to more effective decision-making in the face of changing weather conditions. Methodologically, the abstract may discuss the design and implementation of the drone system, including details about the sensors used, flight patterns, and data collection procedures. It might also touch upon any challenges faced during the development process and how they were addressed.

Findings from the study would be summarized, potentially emphasizing the accuracy and timeliness of the weather data collected by the drone compared to traditional methods. This could include insights into the drone's ability to capture localized weather phenomena and its overall effectiveness in enhancing meteorological observations. Finally, the abstract may discuss the broader implications of the research, such as how real-time meteorological drone technology could improve weather forecasting, inform decision-making processes in various sectors, and contribute to overall safety and resilience in the face of changing weather patterns.

Keywords: Meteorological Drone; Fly-weather monitoring; Dynamic data; Capturing localized weather phenomena; Weather forecasting.

I. INTRODUCTION

Weather drones can be more efficient than traditional methods of meteorological data collection such as weather balloons. Meteorological drones are more maneuverable, can resist sudden changes in wind better and are thus better equipped to capture data in vertical columns, which is essential for weather forecasting. The present work is aimed to get Meteorological reports to any individual organization in speedy time for conducting any type of events.

II. COMPONENTS AND DESIGN

Following are the important components of the Project:

1. A2212 BLDC Motors
2. F450 Quad copter Frame
3. Bull-Nose Propellers
4. Electronic Speed Controllers (ESC)
5. ESP8266 CH340 Wi-Fi Module
6. Raspberry Pi Pico (W) RP2040 Wi-Fi Module
7. KK2.1.5 Flight Controller
8. Li-Po (Lithium Polymer) Battery
9. AHT10 Sensor
10. MQ135 Sensor

A2212 is a **brushless out runner dc motor** specifically made to power Quad copters and Multi-rotor. It is an 1400kV motor. It provides high performance, super power and brilliant efficiency. These motors are perfect for medium size quad copters with 8 inch to 10 inch propellers. Use this to build powerful and efficient quad copters.

Figure 1: A2212 1400kV BLDC Motor

F450 Quad copter Frame is the basic structure of the drone on which all the component is mounted together. The frames should be rigid so that it minimizes the vibrations from the motor. It consists of a center plate to which the electronic components and the four arms are attached to the center plate.

Figure 2: F450 Quad Copter Frame

A **30A Electronic Speed Controller (ESC)** regulates the speed of brushless motors in RC vehicles like drones or model airplanes. Compact and efficient, it interfaces between the power source and motor, controlling acceleration and braking. Its 30A rating signifies its maximum current capacity, ensuring reliable performance for mid-sized applications. ESC facilitates precise control and efficient operation of BLDC motors, ensuring optimal performance and reliability in various electric propulsion systems.

Figure 3: 30A Electronic Speed Controller

KK2.1.5 Flight Controller is used to stabilize the quad copter during flight and to do this, it receives the signal from gyroscope (roll, pitch and yaw) and send these signals to processor (ATMEL mega 664PA) and then it passes control signal to ESCs and the combination of these signals instructs the ESCs to make fine adjustments to the motors rotational speeds which in-turn stabilizes the craft. KK2.1.5 also uses signal from receiver and passes these all signals together to the processor (ATMELmega664PA) via the aileron, elevator, throttle and rudder user demand inputs. Once processed, this information is sent to the ESCs which in turn adjust the rotational speed of each motor to control flight orientation (yaw, right, left, up, down, backward, forward).

Figure 4: KK2.1.5 Flight Controller

Bull nose propellers are more commonly being used on modern quad copters. The more surface area that a propeller has, the more air it can push thereby creating more thrust. The downside is higher current draw, increased drag, and reduced power efficiency.

Figure 5: Bull Nose Propellers

ISBN: xxx-xx-xxxxx-xx-x

Li-Po battery offers a balance of voltage, capacity, and energy density, making it a reliable power source for a wide range of electronic devices and hobbyist applications.

Figure 6: Lithium-Polymer Battery

The **ESP8266 CH340 Wi-Fi** Module integrates the ESP8266 SoC (System on Chip) with the CH340 USB-to-serial converter, enabling seamless connectivity to Wi-Fi networks. It boasts a compact form factor ideal for IoT (Internet of Things) projects. With robust firmware support, it offers versatile functionality for tasks like data transmission, remote sensing, and IoT device control. The CH340 facilitates easy interfacing with computers for programming and debugging. This module empowers developers to create innovative Wi-Fi-enabled applications with ease and efficiency.

Figure 7: ESP8266 CH340 Wi-Fi Module

The **Raspberry Pi Pico Wi-Fi module** enhances the capabilities of the Raspberry Pi Pico microcontroller with built-in Wi-Fi connectivity. Utilizing its onboard Wi-Fi capability, the module enables seamless communication between the meteorological drone's sensors and a remote server. This facilitates real-time data retrieval, allowing for comprehensive monitoring of atmospheric conditions such as temperature, humidity, and pressure. The module's versatility and efficiency empower the drone to collect and transmit accurate meteorological data over Wi-Fi networks, enabling precise analysis and forecasting.

Figure 8: Raspberry Pi Pico Wi-Fi Module

The **AHT10 sensor** utilizes a capacitive sensing element to measure relative humidity and a built-in thermistor for temperature measurement. Changes in humidity cause the capacitance of the sensing element to vary, which is then converted into a digital output representing relative humidity. Similarly, temperature variations affect the resistance of the thermistor, providing a digital output for temperature.

Figure 7: AHT10 Sensor

The MQ135 sensor operates on the principle of chemical-resistive detection, where changes in the electrical conductivity of a sensing element occur in the presence of specific gases. The sensing element typically consists of a metal oxide semiconductor that undergoes a change in resistance when exposed to target gases. The body of the device is a modular one that consisted of the following parts.

ISBN: xxx-xx-xxxxx-xx-x

Figure 8: MQ-135 Gas Sensor

III. FABRICATION AND ASSEMBLY

To fabricate and assemble a Wi-Fi-controlled Real-Time Meteorological Drone using the mentioned components, you'll follow a systematic process involving hardware assembly, software setup, and integration.

1. Frame Assembly:

- Start by assembling the F450 Quad copter frame according to the manufacturer's instructions.
- Mount the 1800KV A2212 BLDC Motors on the arms of the frame and secure them using screws.
- Attach the Bullnose propellers to the motors. Ensure they are properly balanced to optimize flight performance.

2. Electronics Integration:

- Connect the KK2.1.5 flight controller to the frame and motors. Ensure proper wiring and soldering to establish connections.
- Install the 30A ESCs (Electronic Speed Controllers) between the motors and the flight controller. These ESCs regulate the speed of the motors.
- Connect the Li-Po battery to the ESCs to power the drone. Ensure proper voltage and current ratings compatible with all components.

3. Sensor Integration:

- Mount the MQ135 gas sensor and AHT10 temperature and humidity sensor securely on the drone frame.
- Wire the sensors to the Raspberry Pi Pico W module for data acquisition. Follow the datasheets or online guides for wiring instructions.

4. Wi-Fi Module Integration:

- Connect the ESP8266 Wi-Fi module to the Raspberry Pi Pico W module for wireless communication.
- Configure the Wi-Fi module to establish a connection with a designated network, enabling real-time data transmission.

5. Software Setup:

- Program the Raspberry Pi Pico W to read data from the sensors and transmit it wirelessly via the ESP8266 module.
- Implement algorithms to process meteorological data and ensure compatibility with the chosen communication protocol.
- Develop a control interface for the drone, allowing users to monitor meteorological parameters remotely and control the drone's flight path.

6. Testing and Calibration:

- Conduct thorough testing of the drone's hardware and software components to ensure functionality and stability.
- Calibrate sensors for accurate measurement and data reporting.
- Test the Wi-Fi connection and data transmission to verify real-time monitoring capabilities.

7. Final Integration and Deployment:

- Secure all components and wiring to prevent damage during flight.
- Conduct test flights in controlled environments to evaluate flight performance and data accuracy.
- Make any necessary adjustments or improvements based on testing results.

By following these steps, we had fabricated and assembled a Wi-Fi-controlled Real-Time Meteorological Drone capable of gathering and transmitting meteorological data using the specified components. This drone can be a valuable tool for various applications, including environmental monitoring, research, and disaster management.

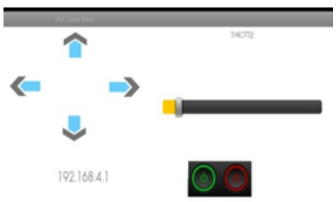

Figure 11: Controlling Interface of the drone

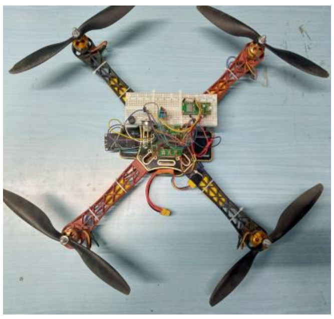

Figure 12: Preliminary Hardware Setup of the drone

ISBN: xxx-xx-xxxxx-xx-x

IV. WORKING AND SIMULATION

Drone Deployment: The RTMD is deployed into the atmosphere, equipped with advanced sensors to measure various meteorological parameters such as temperature, humidity, pressure, wind speed, and direction. These sensors are crucial for capturing real-time data accurately.

Mobile Application Control: Operators control the RTMD's flight path, altitude, and other parameters using a mobile application. This application provides a user-friendly interface for managing the drone's operations and monitoring its progress in real-time.

Wireless Communication: The RTMD communicates wirelessly with a ground station interface, serving as a central hub for data collection and analysis. This communication link enables seamless transmission of data between the drone and the ground station interface, ensuring real-time access to meteorological information

Data Collection: As the RTMD flies through the atmosphere, it collects meteorological data from its surroundings. The onboard sensors continuously measure various parameters.

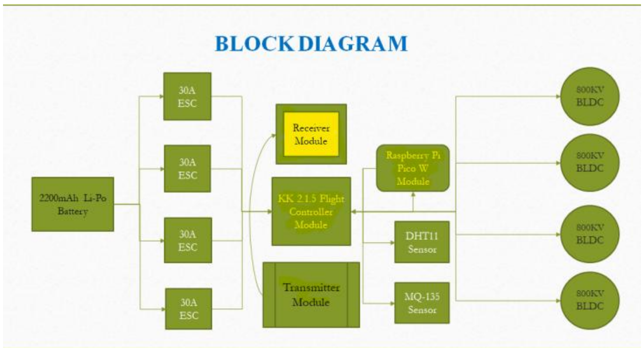

Figure 13: Functional Block Diagram of the Drone

Real-Time Transmission: The collected data is transmitted in real-time from the RTMD to the ground station interface via wireless communication. This instantaneous transmission ensures that meteorologists have access to up-to-date information, enabling timely decision-making and response to changing weather conditions.

Integration with Weather Forecast Database: The ground station interface is equipped with a real-time database of weather forecasts, which serves as a reference for comparing and analyzing the collected data. By integrating real-time data from the RTMD with existing weather forecast models, meteorologists can validate predictions and refine forecasting algorithms for improved accuracy.

Data Analysis and Visualization: Meteorologists analyses the collected data using advanced algorithms and visualization tools to gain insights into weather patterns and trends. Graphs, charts, maps, and other visualization techniques help to interpret the data effectively and communicate findings to stakeholders and the public.

V. CONCLUSION

In conclusion, the real-time meteorological drone showcased in this project conference report stands as a testament to the power of innovation in advancing scientific research and practical applications. Through meticulous design, rigorous testing, and iterative improvement, we have successfully developed a cutting-edge tool that significantly enhances our ability to monitor and understand atmospheric conditions. The integration of advanced sensors, robust telemetry systems, and real-time data transmission capabilities has enabled us to collect comprehensive meteorological data with unprecedented speed and accuracy. Moreover, the versatility and adaptability of the drone make it well-suited for deployment in diverse environments and scenarios, expanding its potential impact across different fields of study and application. In summary, the real-time meteorological drone presented here represents a significant step forward in our quest to better understand and respond to the complexities of the Earth's atmosphere. Its capabilities hold promise for advancing scientific knowledge, enhancing operational efficiency, and ultimately, improving the resilience of communities worldwide in the face of changing weather patterns and extreme events.

VI. REFERENCES

[1] Dinesh K. Aswal, Sanjay Yadav, Toshiyuki Takatsuji, Prem Rachakonda, Harish Kumar, Handbook of Metrology and Applications, Springer.23 August 2023, pp. 019-023.

[2] Floreano, D. & Wood, R. J. Science, technology and the future of small autonomous drones. Nature 521, 460–466 (2015).

[3] Goodman, C. J. & Small Griswold, J. D. Meteorological impacts on commercial aviation delays and cancellations in the continental United States. J. Appl. Meteorol. Climatol. 58, pp. 479–494 (2019).