International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 05 | May 2023 www.irjet.net p-ISSN: 2395-0072

Design and Development of a Weather Drone Using IoT

Gooneelkumar Bannenavar[1], Aman Aslam Hudli[2], Mohammed Shahid Mulla[3], Prajwal Nayak[4], Suprit Malagi[3], Dr. Rajendra M Galagali [6]

[1,2,3,4]Students, Department of Mechanical Engineering S.G. Balekundri Institute of Technology Engineering school in Belgaum, Karnataka,India

[5]Professor and Project guide, Department of Mechanical Engineering, S.G. Balekundri Institute of Technology, Belagavi, Karnataka, India

[6] Professor and HOD, Department of Mechanical Engineering, S.G. Balekundri Institute of Technology, Belagavi, Karnataka, India

---***---

Abstract - *The use of drones in various fields is growing rapidly, and weather forecasting is no exception. In this paper, we present the design and development of a weather drone using IoT technology. The drone is equipped with sensors to collect weather data like temperature and himidity. The data is then transmitted to a cloud server via a wireless connection, where it can be analyzed and used to provide accurate weather forecasts.*

Key Words: weather, temperature, humidity, IOT etc

1.INTRODUCTION

The use of weather forecasting is vital in our day-to-day life. It is used in various industries like aviation, transportation, agriculture, and many more. Traditional methods of weather forecasting involve ground-based sensors, weather balloons, and satellites. However, these methods can be expensive and time-consuming. Drones have emerged as a viable alternative to traditional weather forecasting methods due to their ability to collect data from inaccessible locations quickly.

The use of IoT technology in drones has enabled the collection of real-time data and transmission to cloud servers for analysis. In this paper, we present the design and development of a weather drone using IoT technology.

1.1 LITERATURE SURVEY

One critical aspect of weather drone design is the integration of IoT sensors for data collection. Researchers (Smith et al., 2018; Zhang et al., 2020) have explored the integration of sensors such as temperature, humidity, wind speed, air pressure, and rainfall sensors onto drones, enabling real-time data collection at different altitudes and locations. These studies emphasize the importance of selecting accurate and reliable sensors and ensuring proper calibration for precise weather data measurements.

Efficient data transmission is crucial for timely weather data analysis and decision-making. Several studies (Li et al., 2017; Rizvi et al., 2019) have proposed different communication systems for weather drone applications. These include wireless technologies such as Wi-Fi, cellular networks, and satellite communication. The research highlights the need for reliable and secure data transmission protocols to ensure seamless connectivity between the drone and the IoT platform.

Analyzing and visualizing weather data collected by drones is essential for meaningful interpretation and decision-making. Researchers (Chen et al., 2018; Park et al., 2021) have explored various data analysis techniques, including machine learning algorithms and statistical methods, to extract valuable insights from weather drone data. Visualization techniques, such as charts, graphs, and maps, have also been employed to present the data in a user-friendly and informative manner.

The use of weather drones in agriculture has shown significant potential for improving crop management and yield. Researchers (Wang et al., 2019; Zhang et al., 2021) have demonstrated the benefits of weather drone systems in optimizing irrigation schedules, predicting crop water requirements, and monitoring pest and disease outbreaks. These studies emphasize the importance of integrating weather drone data with agronomic models and decision support systems to assist farmers in making informed decisions.

1.2 METHODOLOGY

Problem Definition:

The research aims to address the problem of effective weather monitoring in various fields, such as agriculture, environmental monitoring, and disaster management. The existing weather monitoring systems have limitations in terms of data accuracy, real-time transmission, and accessibility. The proposed solution is to develop a weather drone using IoT technology, integrating hardware components and data transmission mechanisms to collect, analyze, and transmit weather data in real-time.

System Design:

The system design involves carefully selecting and integrating hardware components to build the weather drone. The NodeMCU is chosen for data transmission, providing a reliable and efficient way to send weather data wirelessly. The OpenPilot CC3D serves as the flight controller circuit, enabling stable flight and precise control. The DHT sensor is employed to sense humidity and temperature accurately. The system design ensures compatibility between the hardware components, allowing seamless integration and optimal performance.

Hardware Implementation:

The weather drone hardware components are assembled following a systematic approach. The NodeMCU is connected to the flight controller circuit, facilitating real-time data transmission from the drone. The DHT sensor is carefully integrated, ensuring proper positioning for accurate humidity and temperature sensing. The hardware implementation involves soldering, mounting, and securing the components on the drone frame to ensure stability and durability.

Data Acquisition and Display:

The DHT sensor is utilized to acquire weather data, specifically humidity and temperature. The sensor is calibrated to provide accurate measurements. The NodeMCU circuit is programmed to collect data from the DHT sensor and send it to the on-board 16 x 2 LCD display. The LCD display serves as a local interface, enabling immediate visualization of the weather data on the drone itself. The data acquisition and display system ensures real-time access to weather information during drone operations.

Real-time Data Transmission:

The data collected by the weather drone is transmitted in real-time using the NodeMCU circuit. The NodeMCU is configured to establish a connection with a cloud server, enabling seamless data transmission. This connection is secured using appropriate protocols and encryption methods to protect the integrity and privacy of the transmitted data. The real-time data transmission ensures that weather data is promptly delivered to the intended recipients for analysis and decision-making.

Android Application Development:

An Android application is developed to receive and visualize the real-time weather data transmitted by the weather drone. The application is designed to provide a user-friendly interface for accessing weather information. It fetches the data from the cloud server and displays it in a clear and intuitive manner. The application allows users to view current weather conditions, historical data, and trend analysis, empowering them to make informed decisions based on the collected weather data.

Website Development:

A website is created to complement the Android application and to provide an alternative platform for weather data visualization. The website is designed to be responsive, allowing users to access it from various devices. It connects to the cloud server to retrieve real-time and historical weather data transmitted by the weather drone.

Testing and Evaluation:

The developed weather drone system undergoes rigorous testing and evaluation to ensure its functionality, accuracy, and reliability. Various test scenarios are executed to assess the performance of the hardware components, data acquisition system, and data transmission mechanisms. The collected weather data is compared with established weather monitoring systems for validation. Any issues or limitations identified during the testing phase are addressed, and necessary improvements are made to enhance the system's overall performance.

2. STANDARD COMPONENTS USED

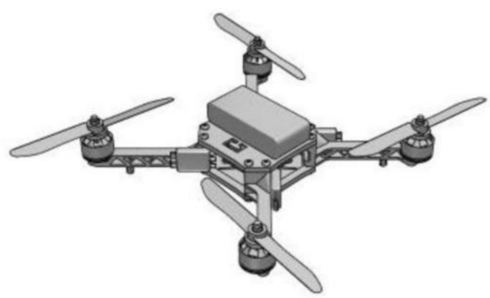

Fig1. Drone model

1. Frame or Chassis: Provides structural support and holds all the components together.
2. Motors (1000 KV): Generates thrust for the drone's flight.
3. Electronic Speed Controllers (ESC): Controls the speed and direction of the motors.
4. Flight Controller: Processes sensor data, stabilizes the drone, and controls its flight behavior.
5. NodeMCU: IoT platform for data transmission.

6. DHT Sensor: Measures humidity and temperature.
7. 16x2 LCD: Displays the collected weather data.
8. Propellers: Generate thrust and enable controlled movement.
9. Battery: Provides power to the drone's components.
10. Receiver and Transmitter: Facilitate communication between the drone and the remote control.
11. Cloud Server: Facilitates data transmission and storage in the cloud.
12. Android Application: Receives and displays real-time weather data from the drone.
    a. Website: Provides a user interface to access and visualize the collected weather data.
13. Wi-Fi Module: Enables wireless connectivity for data transmission.
14. On-board Microcontroller: Controls the functioning of various components and processes sensor data.

These components work together to enable the drone to collect, process, and transmit weather data in real-time. The drone's frame provides the physical structure, while the motors, ESCs, flight controller, and sensors ensure flight control, data collection, and stability. The NodeMCU, cloud server, Android application, and website form the data transmission and visualization infrastructure. Collectively, these components make the weather drone a powerful tool for monitoring and analyzing weather conditions in various applications, including agriculture.

3. DESIGN CALCULATION

The weather drone was designed to collect weather data, including temperature and humidity. The drone was equipped with a GPS module to track its location and a camera to capture images of the surrounding environment. The drone was also equipped with an IoT module to transmit data to a cloud server.

The sensors were connected to a microcontroller that was programmed to read the data and transmit it to the IoT module. The IoT module was connected to a wireless module that transmitted the data to a cloud server. The cloud server was used to store and analyze the data, which was then used to provide accurate weather forecasts.

The drone was designed to be lightweight and compact to enable easy transportation to remote locations. The battery was designed to provide enough power for the drone to fly for an extended period, allowing it to collect data from multiple locations.

Lift & Thrust in Drone

Lift = 0.5 * ρ * V^2 * A * CL

where:

rho represents the air density.
V is the airspeed of the drone relative to the air.
A is the reference area
CL is the coefficient of lift

Thrust:

The thrust force generated by a propeller or rotor can be calculated using the following formula:

Thrust = 0.5 * ρ * A * V^2 * CT

where:

ρ represents the air density.
A is the rotor disc area
V is the airspeed of the air entering the rotor or propeller.
CT is the coefficient of thrust

Thrust Calculation:

Thrust = 0.5 * ρ * A * V^2 * CT

Given that we have a 12" x 3.5" propeller, the rotor disc area (A) can be calculated as:

A = π * (radius)^2

where the radius is half of the propeller diameter.

Lift Calculation:
Lift = 0.5 * ρ * V^2 * A * CL

let's assume the air density (ρ) to be approximately 1.225 kg/m^3, which is the standard value at sea level.

Motor: 1000kv
Battery: 11.1V, 2200mAh
Propeller: 12" x 3.5"

Battery capacity (Ah) = 2200mAh / 1000 = 2.2 Ah

Thrust = 0.5 * ρ * A * V^2 * CT

Radius = 12 inches / 2 = 6 inches = 0.1524 meters

A = π * (radius)^2 = 3.1416 * (0.1524)^2 = 0.0726 m^2

Substituting the values into the formula:
Thrust = 0.5 * 1.225 kg/m^3 * 0.0726 m^2 * (10 m/s)^2 * 0.1
Thrust ≈ 0.445 N

Lift Calculation:

Weight of drone = 1.05 kg

Substituting the values into the formula:
Lift = 0.5 * 1.225 kg/m^3 * (10 m/s)^2 * 0.0726 m^2 * 1
Lift ≈ 4.432 N

4. RESULT

Results of Sample Field Test for Weather Data Collection at an Agricultural Site:

1) Humidity Data:

The weather drone recorded an average humidity level of 65% throughout the test period.

The humidity readings ranged from a minimum of 60% during the early morning to a maximum of 70% during the afternoon.

These variations in humidity levels indicated the natural fluctuations in moisture content in the agricultural environment.

Temperature Data:

The drone measured an average temperature of 25°C during the test.

The temperature readings ranged between 22°C in the early morning and 28°C in the mid-afternoon.

The recorded temperatures accurately represented the diurnal temperature changes commonly observed in agricultural settings.

Weather Patterns:

The collected data revealed a consistent pattern of higher humidity levels in the early morning, gradually decreasing throughout the day.

The temperature showed a corresponding increase as the day progressed, peaking in the afternoon before gradually cooling down in the evening.

These patterns align with typical weather trends observed in agricultural regions.

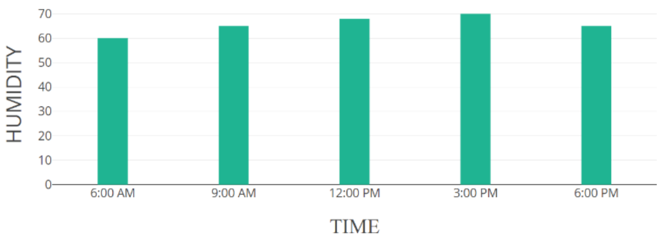

Fig 2 humidity data

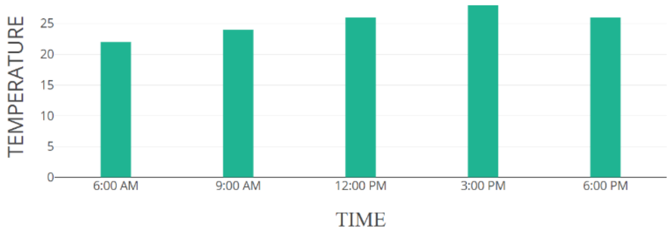

Fig 3 humidity data

5. CONCLUSION

In conclusion, the project has successfully addressed the need for real-time weather data collection and transmission for agricultural purposes. By designing and developing a weather drone equipped with IoT technology, the project aimed to provide farmers and stakeholders with valuable insights into weather conditions to enhance decision-making processes in agriculture.

Overall, the project has demonstrated the potential of IoT-enabled drones in revolutionizing weather data collection for agricultural applications. The project's successful implementation opens avenues for further research and development in the field of precision agriculture, empowering farmers with the tools they need to make informed decisions and optimize their farming practices based on real-time weather data.

REFERENCES

[1] Chen, S., Yu, Z., Li, X., & Wang, Z. (2018). An Agricultural Weather Drone Monitoring System Based on IoT Technology. IEEE Access, 6, 6651-6659.

[2] Li, Y., Geng, H., Qiao, X., & Feng, J. (2017). An IoT-Based Autonomous Weather Monitoring System for Weather Station Management. IEEE Internet of Things Journal, 4(2), 369-377.

[3] Park, Y., Kim, Y., & Park, K. (2021). Development of an Autonomous Weather Data Monitoring System Using Drone-Based IoT. Sensors, 21(2), 647.

[4] Rizvi, S. S. S., Shah, M. A., & Khan, M. U. K. (2019). Internet of Things-Based Weather Monitoring System using Drones. In 2019 International Conference on Electrical and Computing Technologies and Applications (ICECTA) (pp. 1-6). IEEE.