



# Research and Design of UAV Environmental Monitoring System

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**Abstract.** With the rapid development of China's economy and the increasing level of urbanization, more and more attention has been paid to urban air pollution. Accurate monitoring of air quality at high altitude is always a problem. It is difficult to collect air quality data at high altitude, and the high cost leads to the lack of data collection of air quality at vertical height. It is imperative to combine UAV and traditional environmental monitoring devices to learn from each other when it is necessary to periodically test and compare air quality data at different altitudes. Environment monitoring system based on UAV, environment monitoring device and Internet. The system includes four rotor UAV, environmental monitoring terminal and computer environmental monitoring platform. This paper mainly studies and designs from these three parts.

**Keywords:** UAV · Environmental monitoring · 4G module · Monitoring management system

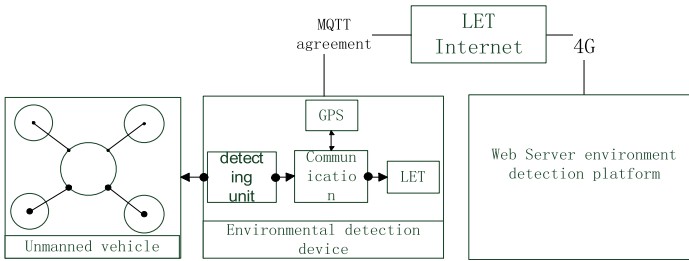
## 1 Introduction

At present, many cities in China are conducting environmental air quality assessment and prediction. The basic monitoring sample data for the assessment and prediction of ambient air quality come from one automatic monitoring system of ambient air quality. In China, multi-rotor UAV has become a new favorite of all walks of life in recent years. With the opening of China's multi-space and the rapid development of consumer drones, multi-rotor UAV has come into our life. At present, air quality monitoring stations still mainly detect air quality in horizontal direction, and there are few data related to vertical height. Therefore, in the process of investigating airborne particulate matter, in order to better detect the numerical difference of suspended particulate matter at different altitudes and stratify the data vertically, it is imperative to apply uav technology to detect air quality.

## 2 Correlation Technique

### 2.1 The Overall Structure of the UAV Environmental Monitoring System

We will STM32F103C8T6 as control core, MPU6050 VR technology, cooperate with the external circuit controller, realize the operator to air of beauty appreciation, camera on the unmanned aerial vehicle (UAV) figure back to the images obtained with VR technology, make the line of sight of the operator feel on the unmanned aerial vehicle (UAV), through MPU6050 module, track fast and slow or quick, indeed make The cradle head of the drone follow the operator on the line of sight change and change, make the operator feel “immersive” lifelike [1] (Fig. 1).



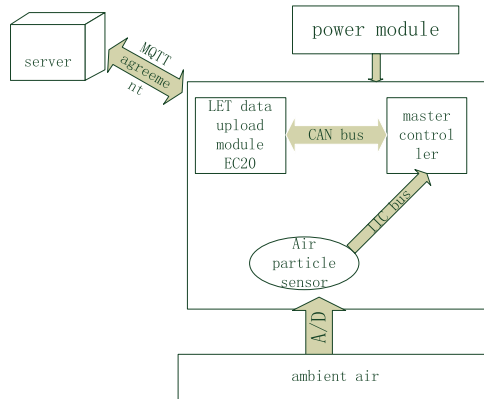
**Fig. 1.** General structure diagram of UAV environmental monitoring system

UAV environmental monitoring device is a set of independent equipment that needs the assistance of UAV. It is independently powered and can be connected to temperature and humidity sensors, particulate matter sensors and other sensors to accurately detect air quality. The device has its own barometer, GPS, 4G module, and memory for accurately recording air quality on the route. When flying at low altitude, the data can be transmitted to the environment monitoring and management platform in real time through 4G module, and the data can be viewed and managed online through Web client on the mobile terminal and computer terminal. At high altitude, due to the limited coverage of 4G signal, the data will be stored in the device’s memory, and the Excel file can be exported after the flight. The data includes altitude, latitude and longitude, air quality index, number of particulate matter, temperature and humidity, etc., and sensors can be added if necessary. The environmental monitoring management platform can aggregate, process and display the data, conveniently, effectively and intuitively provide the air particulate data at different altitudes, and solve the problem of high difficulty and high cost for the monitoring of high-altitude particulate matter caused by the traditional environmental monitoring system.

### 2.2 Overall Structure of Environmental Monitoring Unit

This paper studies the design scheme and hardware structure design of the environmental monitoring device. The overall structure of the UAV environmental monitoring device is shown in Fig. 2. The environmental monitoring device can connect to the

Web server in real time and upload data through 4G signal and MQTT protocol. The primary task of the environmental monitoring device is to obtain the monitoring data of air particulate matter sensor and barometer, as well as the geographical coordinates and position data obtained by GPS, and then the master MCU Uploads the data to the Web server through THE STANDARD of MQTT protocol of LTE module, and provides the staff for management and view through the interface design [2, 3].



**Fig. 2.** The overall structure of the UAV environmental monitoring device

The internet-based UAV environmental monitoring device is mainly divided into parts, which are described as follows:

- (1) Master MCU: STM32F103ZET6 chip is used for master control. STM32 series is based on armCortex-M3 kernel specially designed for embedded applications requiring high performance, low cost and low power consumption. Low power mode: STM32F103RCT6 supports three low power modes to achieve the best balance between low power, short startup time and available wake-up sources. Mainly responsible for reading data from air monitoring sensor, barometer and GPS module through IIC serial port bus, processing and processing the respective data, filtering noise data caused by sensor or circuit problems. The data is uploaded to the Web server in MQTT protocol via LTE module [4–6].

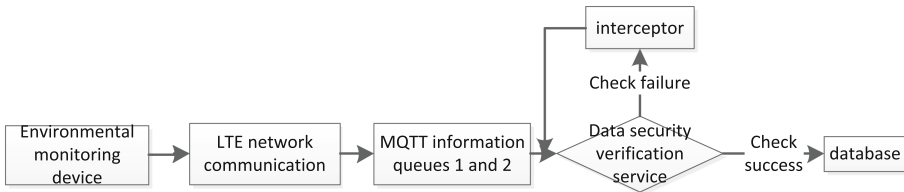
- (2) Power supply module: Provide stable power supply for each functional module.

LET module/GPS module: LET and GPS module adopt EC20 chip, which encapsulates 4G communication LET chip and GPS chip. It is mainly used to provide geographic coordinate location and upload data to the Web server.

- (3) Air particulate acquisition module: The acquisition module adopts sensors to obtain accurate original particulate data.

### 2.3 Communication Scheme Design of UAV Environmental Monitoring Device

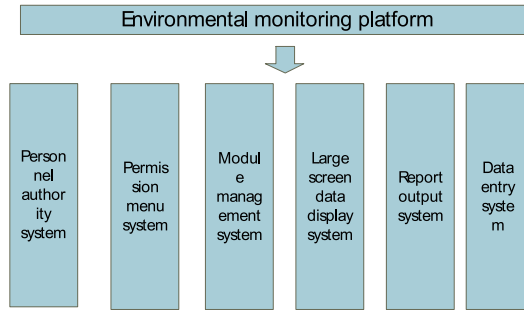
Data transmission scheme between environment monitoring device and Web server: Internet connection is required to establish connection with the IP specified port of the server public network [7–9]. Therefore, LTE module is used to connect 4G network and upload to the server through MQTT protocol. The server establishes MQTT service, and the data is encrypted with the private key. The server USES the public key to decrypt and verify to ensure the accuracy of the data source, and then puts the data into storage, which ensures the authenticity and security of the data. Use MQTT messaging middleware to ensure data integrity. The communication scheme design of UAV environmental monitoring device is shown in Fig. 3.



**Fig. 3.** Communication scheme design of UAV environmental monitoring device

### 2.4 Monitor Platform Development Process Design

The environmental monitoring platform is used for the staff to check and manage the data of atmospheric particulate monitoring of the UAV, and the data stored in the SD card can be uploaded to the server with one click through the system program (Explanation: When the UAV is in the upper air without 4G signal or the airspace with poor signal, the data will be stored in the SD card. When the 4G signal is good, the data will be directly uploaded to the server.) To save labor, and the server will analyze and store the data. Staff are also supported to export UAV monitoring reports through the system. More convenient and fast report generation, easy to work. It also supports real-time viewing of air quality data at different elevations of streets in different cities and regions. Based on the above requirements, the environment monitoring platform will include the following six systems: authority menu configuration system, personnel authority configuration system, module management system, large-screen data display system, report output system, and data upload and input system. The architecture of environment monitoring platform requirements is shown in Fig. 4.



**Fig. 4.** Environment monitoring platform requirements architecture diagram

This paper will analyze and study the specific requirements of these six systems:

(1) Personnel authority system:

The basic functions of the management system can be added, deleted, frozen, unfrozen personnel account in the system. Can be configured to modify edit account permissions. When logging into the system, the staff shall verify through the staff permission system to determine whether the user is a white list user, the account permission level, what function points the current level contains, and the dynamic rendering function menu.

(2) Configure the system with the permission menu:

The basic functions of the management system, can be configured in the system function items and menu directory corresponding relationship, can be configured in the system of different authority accounts contained function points.

(3) Module management system:

The module (environmental monitoring device) in the imported system can then be connected to the system and upload data. Each module system will automatically generate a unique module code, which is the certificate for the module to upload data. Administrator can add, edit and delete modules through the module management system.

(4) Large-screen data display system:

The visual display module of EChat diagram is used to collect data, and the collected data of the module is presented on the page in real time for the convenience of staff. Historical data can also be displayed to show the dynamic changes of air quality particles in the same area at different times.

## (5) Report output system:

The staff can export the historical acquisition data of some modules through the report output system, and the system will automatically generate the report according to the template for the convenience of the staff.

## (6) Data upload and entry system:

When 4G signal is weak, the module can't upload data automatically, such as unmanned aerial vehicle (UAV) flight monitoring environmental monitoring device is complete, you can remove the SD card of equipment, through the card reader computer, copy of monitoring data file, upload data input function in the recycling system, will copy the monitoring data file upload data collection [10–12].

### 3 Conclusion

This paper focuses on the design of UAV environmental monitoring device and environmental monitoring platform. The data collection of users and staff on environmental status and air particles at different altitudes was realized, and the data was uploaded to the server in real time through LTE module. The server verified, stored and displayed the data.

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