ART & TECHNOLOGY PUBLISHING PTE. LTD.

2024 Volume 2, Issue 1

Education Innovation Research

ISSN (Online): 3029-1852 ISSN(Print): 3029-1844

Ecological Environment Monitoring System Based on AIoT Technology

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Abstract:

This project aims to establish a Zhanjiang mangrove ecological environment monitoring cluster system based on artificial intelligence IoT technology through the ESP32-E master control and all-in-one air quality sensor, all-in-one soil sensor, composite water quality temperature and PH sensor, water quality TDS sensor for data collection and analysis, using NB-IoT wireless communication module for multi-point data transmission, Ali Cloud IoT platform for data summarization and real-time visualization display, to build a complete Zhanjiang mangrove ecological environment monitoring system, to provide quantitative data basis for Zhanjiang mangrove ecological environment protection, to provide scientific references for the relevant departments, which is conducive to the improvement of Zhanjiang mangrove ecological environment management level.

Keywords:

AIoT

Mangrove ecological environment monitoring

IoT cloud platform

Online publication: September 12, 2024

1. Introduction

With the acceleration of urbanization, the ecological environment is under increasing threat. As a precious natural resource, the protection of the mangrove ecological environment is particularly important. Implementing the Zhanjiang mangrove ecological environment monitoring cluster system based on AIoT aims to keep abreast of the changes in the ecological environment by real-time monitoring of the data of the mangrove ecological environment and take corresponding measures to protect and repair [1]. It utilizes cutting-edge technologies such as NB-IoT remote communication and IoT platforms to build the cluster system, which integrates multiple technologies such as sensors, communication, data aggregation and analysis to improve the efficiency of data analysis and processing and provide more accurate data support for environmental management. At the same time, automated data management technology is introduced to optimize the system management and operation efficiency effectively, provide more scientific

and sustainable solutions for environmental protection, and strengthen the protection of the mangrove ecological environment [2].

1.1. Design significance

Based on AIoT, the Zhanjiang mangrove ecological environment monitoring cluster system realizes the collection, processing and analysis of water quality, air quality and other data of mangrove forests through ESP32-E master control, composite water quality PH and multiple sensor technologies. Meanwhile, it combines the NB-IoT module and the AliCloud IoT platform to realize the remote transmission of data in a WIFI-free environment, realize the aggregate and visualization of data, and be able to obtain the data of mangrove forests in real-time to grasp the changes in the ecological environment of mangrove forests in time to take corresponding measures for protection and restoration [3]. Therefore, the implementation of the Zhanjiang mangrove ecological environment monitoring cluster system based on AIoT is of great significance for the protection of mangrove forests and the promotion of ecological civilization [4].

1.2. Project objectives

Aiming at the traditional monitoring technology of mangrove forests with a single means, the lack of long-term and systematic monitoring in a wide range, and the fact that an integrated monitoring system and monitoring network have not yet been constructed, it is proposed to establish a Zhanjiang mangrove forest ecological environment monitoring cluster system based on Artificial Intelligence Internet of Things (AIoT) technology, aiming at applying informatization technology, helping the construction of ecological civilization, and providing comprehensive support for the construction of Zhanjiang as the "City of Mangrove Forests," "Mangrove City" [5].

2. Survey status and analysis

The team went to the nature reserve to conduct a multi-faceted field research. The study clearly understood the Guangdong Zhanjiang Mangrove National Nature Reserve's existing mangrove restoration measures and related protection work carried out [6]. Using the data method and field visits and inspections, it is fully understood that the current development status of the implementation of mangrove ecological protection work in Zhanjiang City, as well as the ecological restoration of the problems faced by the problem, a realistic response to the urgent need for mangrove protection, the use of professional knowledge to analyze, and preliminary pre-testing of our research and development of Zhanjiang Mangrove Ecological Monitoring Cluster System based on Artificial Intelligence Internet of Things (AIoT) technology, for the Protected Area to provide technical support, and strive for ten years to build Zhanjiang Mangrove Nature Reserve into a multi-functional, multi-benefit, internationally recognized national nature reserve [7].

Meanwhile, the study team take advantage of the winter vacation to conduct field trips, participate in discussions of mangrove management methods and restoration techniques many times, examine various indicators of mangrove forests, and carry out comprehensive exchanges on discipline construction [8].

Figure 1. Limitations of domestic mangrove monitoring technology.

3. Project realization

3.1. System program design ideas

(1) Realize the collection, processing and analysis of water quality, air quality and soil quality data of mangrove forests through ESP32-E master control, composite water quality PH and water temperature detection sensor, water quality TDS module, RS485 type all-in-one soil sensor and RS485 type all-in-one air quality sensor [9].

(2) Use the NB-IoT module to realize the remote data transmission without a WIFI environment.

(3) Use the AliCloud IoT platform to realize data aggregation and visualization.

3.2. Design process

(1) Requirements analysis: Understand the needs and requirements of mangrove ecological environment monitoring in Zhanjiang and clarify parameters such as monitoring indicators and collection frequency.

(2) System architecture design: Design system hardware architecture, software architecture, communication mode, etc.

(3) Sensor selection: Select suitable sensors according to the requirements, including water temperature, air humidity, water PH value, water TDS value and so on.

(4) Data acquisition and transmission design: Design the data acquisition and transmission process and select the appropriate transmission protocols and methods, such as the pivotal device to report messages to the AliCloud IoT Wi-Fi, multi-device communication methods NB-IoT, etc.

(5) Platform construction: Choose a suitable platform for data processing, storage and analysis, such as a cloud platform or IoT platform.

(6) AliCloud web-side interface design: Design the web-side interface to provide users with the ability to view environmental data and alarm information.

(7) System Integration Test: Conduct an integration test to determine the system's stability, reliability and practicability.

3.3. Production process

The sensor module mainly measures the temperature, pH, turbidity, dissolved oxygen and other water quality parameters of the mangrove water body to determine whether the water quality around the mangrove forest or the aquaculture pool is up to standard [10]. When the parameters exceed the normal range of the set threshold, the upper computer will issue a warning and send commands to the lower computer to perform the corresponding operation. Comparison of a variety of models of similar sensors, and ultimately chose the DS18B20 temperature sensor, SEN0114 soil moisture sensor, E-201 pH sensor, TWS-30 water turbidity sensor, but subsequently expected to add other measurement values of the sensor, so that data acquisition multi-faceted [11].

3.3.1. Hardware deployment

According to the system architecture design, select suitable hardware devices and arrange sensor nodes. The following is the selection of some relevant hardware:

(1) Gravity: E-201 analog PH meter (Arduino compatible)

(2) Gravity: DS18B20 waterproof temperature sensor kit

(3) Gravity: TWS-30 Water Turbidity Sensor

(4) Gravity: SEN0114 Soil Temperature and Humidity Sensor

(5) Gravity: Analog Conductivity Meter (K = 10)

The above equipment has been tested to meet the needs of the project.

3.3.2. Software programming

Write sensor node data acquisition program, communication protocol program, platform data processing program, user interface program, etc.

3.3.3. Data transmission test

Test the stability, speed and reliability of data transmission protocols and methods [12].

3.3.4. Platform integration test

Conduct integration tests on the platform to test the accuracy and stability of data processing, storage and analysis.

3.3.5. User interface test

Test the friendliness and practicability of the user interface.

3.3.6. Joint debugging

Conduct joint debugging on the whole system to ensure the stability and reliability of the system [13].

4. Testing process

(1) Test the connection of collection equipment and sensors and the accuracy of collected data.

(2) Test the feasibility and effectiveness of data transmission and storage.

(3) Test the function of multiple display data of terminal equipment to guarantee its reliability. According to the field parameter values, use the Ali cloud background for parameter adjustments [14].

(4) According to the relevant literature on China Knowledge Network, the study has developed a suitable standard for mangrove ecological environment level division, according to which the data analysis is carried out.

Through ESP32-E master control, composite water quality PH and water temperature detection sensor, water quality TDS module, RS485 type all-in-one soil sensor, RS485 type all-in-one air quality sensor, real-time detection of mangrove wetland vegetation (growth, temperature, humidity, etc.) and water quality elements (temperature, salinity, pH, dissolved oxygen, water level, etc.) to realize the mangrove's water quality, air quality, Soil quality data collection and analysis, NB-IoT for remote communication, using the AliCloud IoT platform for data aggregation, visualization and analysis, using processing and analysis [15].

5. Summary

Aiming at the mangrove environmental monitoring means and policy call, the Zhanjiang mangrove ecological environment monitoring cluster system designed and realized based on AIoT technology realizes multi-dimensional data collection and monitoring, real-time monitoring of environmental data of Zhanjiang mangrove forests, including multi-dimensional data collection such as water quality, air quality, soil quality, etc., with high data accuracy and timeliness. Adopting distributed data collection and analysis and processing, constructing a distributed cluster-type data processing and management system, and building a cluster-type system to ensure the high efficiency and safety of the data. The environmental data of Zhanjiang mangrove forests are analyzed through the AliCloud IoT platform to derive an environmental model suitable for mangrove growth, and automated data summarization and analysis are carried out. At the same time, data sharing is carried out through the AliCloud IoT cloud platform to realize data sharing and interoperability among Zhanjiang City's relevant government departments, the public, and other parties and to realize real-time communication among multiple parties.

Funding

2024 Guangdong College Students' Innovation and Entrepreneurship Training Program (Project No.: X202410579009)

Disclosure statement

The authors declare no conflict of interest.

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