Environmental monitoring system based on IOT android platform

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Abstract. In order to realize remote monitoring of the environment, this paper uses the Android mobile platform to design an APP based on the Internet of Things environment monitoring system, which can display the environmental data (temperature, humidity and light intensity) of three different places. The system is a complete IoT application system consisting of ZigBee sensor network, gateway protocol converter, cloud server and mobile intelligent terminal. Users can use the mobile phone to display the current environment data by viewing the app.

1. Introduction
In order to improve the user's remote perception of the environment, this paper proposes a more complete IoT environment monitoring system designed by adding the Android mobile platform client to the environment monitoring system based on the IoT sensing technology and the DIGI Device Cloud platform. The sensors have been deployed in three places (Guangzhou University Town, Guangzhou Wushan, Huizhou GDUT Research Institute). The gateway collects the data of the sensing layer through ZigBee wireless transmission technology, and then collects the data into the DIGI cloud through Ethernet. The DIGI Cloud provides many API interfaces for external devices. Users only need to access the mobile to complete the interaction between the device cloud and users. In the development of Android mobile APP, this paper outlines the design and development of an architecture focussing on the Internet-of-Things and it is developed based on the cross-platform Qt. Users can update and view real-time updated temperature, humidity and light intensity data of a distant environment at any time through the connected mobile phone client.

2. Research background
The environmental monitoring system is an important part of the smart home system. Traditional monitoring requires people to directly observe the monitoring instruments to record and analyze the data to determine the current environmental conditions. This method is labor intensive and time consuming. With the maturity of IoT technology, the application of the Internet of Things has become much more common. Therefore, this paper proposes this environmental monitoring system to monitor the temperature, humidity, and light intensity data in the home environment. Compared with traditional monitoring, it is more simple and intelligent. The environmental monitoring system pays...
more attention to the maintenance of the indoor environment. By deploying sensors, people will know about the relevant state data of the current living environment and form an overall judgment of the spatial state, which provides a basis for further control. For example, temperature, humidity and light intensity are significant parameters for measuring the comfort of people in their home life. The environmental monitoring system needs to realize the adjustment of the environment. Therefore, the data acquisition of temperature, humidity and light is mainly used to control the household equipment such as air conditioner, humidifier and lighting etc.[1].

3. Overall system
The basic framework of an IoT system consists of the perception layer, the network layer, and the application layer. This environment monitoring system is mainly composed of ZigBee wireless sensor node network (sensing layer), protocol converter (network layer), DIGI device cloud server and Android mobile terminal (application layer). The overall frame structure of the system is shown in Figure 1. The collection process of system data is roughly as follows: The T/H/L sensor terminal node located in the sensing layer is responsible for real-time collecting the temperature, humidity, and light intensity data of the current environment and transmitting it to the ZigBee coordinator via the XBee adapter. A protocol converter (gateway) at the network layer converts the data collected by the coordinator into network protocol data. Finally, the DIGI Cloud server at the application layer will access the data transmitted by the network layer, and the user can read the real-time data of the remote environment by accessing the Android mobile terminal of the cloud API.

4. Hardware of the system

4.1. T/H/L sensor terminal
The T/H/L (temperature/humidity/light intensity) sensor of DIGI is chosen as the sensor node of the sensing layer of the system. The T/H/L sensor is one of the XBee series sensor modules, which can be used to collect the temperature, humidity and light intensity data of a certain place in real time. The sensor collects data using the wireless transmission protocol ZigBee for short-distance transmission.

4.2. Gateway

As the core of the network layer, the gateway functions include managing nodes, implementing various information interactions (TCP, HTTP, UDP, SMTP, SMS, etc.), orderly recording and managing various types of information, etc., thereby connecting the lower layer of the sensing layer with the upper layer of the application layer [2-4]. The gateway of the system adopts DIGI
international company XBee Gateway - ZigBee to Ethernet/Wi-Fi, and ZigBee technology can connect other ZigBee XBee modules with the gateway to realize the data collection of the terminal node. In the hardware part of the gateway, the i.MX28 ARM9 model processor developed by Freescale is selected as the core processor and XBee S2C ZigBee module developed by DIGI as coordinator to realize network information interaction. The hardware structure of the gateway is shown in Figure 2.

5. Software of the system

5.1. DIGI Cloud
The device cloud is located at the highest level of the IoT architecture system—the application layer. As the core of the application layer, it integrates a large amount of data and manages it in an orderly manner. The device cloud of this system adopts Device Cloud of DIGI Company. It is a device hosting service platform with PaaS (platform and service) capabilities for analyzing, processing, storing and displaying data information [5-6]. Not only can it connect with the gateway to obtain terminal data and perform storage management, but it can also exchange information with the client application through the HTTP protocol [7]. The T/H/L real-time data and historical data display sources of the Android mobile terminal of the system are the data streams of the DIGI device cloud, and the DIGI device cloud provides access to up to 1000 past measurements sets.

5.2. Android mobile APP design
Qt is an application framework that can be developed across platforms, based on C++, providing an open source software development environment. The Android mobile development of this system selects Qt as the development platform, and uses Qt on Android to design the APP. The programming framework and language use Qt Quick Controls 2 and QML respectively. The language is suitable for developing mobile clients compatible with different screen sizes, and it supports C++ integration. It allows expressions and methods to be defined using JavaScript functions. It can be directly imported into JavaScript files and used the code in it.

![Program flow diagram.](image-url)
The DIGI Cloud provides a standard API interface for the mobile terminal. The mobile APP can obtain the data stream in XML or JSON format from the DIGI cloud through the API interface, and parse the data from the sensing layer and display it on the mobile interface. The data can also be obtained from the historical data in the database SQLite that comes with Qt. The data in XML format is parsed by the parser, and the data in JSON format is parsed by standard JavaScript functions. The Android mobile software includes a number of modules, in which a T/H/L data display module is the core. The basic flow chart of the APP running is shown in Figure 3.

5.3. T/H/L data display module
The T/H/L data display module is the core module in the environment monitoring system mobile application. The data display mode is divided into two types: real-time data display and DIGI Cloud historical data display. Both data are from the data stream of the DIGI Cloud. The real-time data shows the latest updated data from the time of the query. The historical data shows the summary of data collected at a fixed time frequency in a certain time range in the past. The historical data display can intuitively reflect the changes of environmental data over a period of time. According to two different data display modes, the module is designed with two data display interfaces.

5.3.1. Real-time data display mode
The real-time data comes from the XML file of the DIGI device cloud and is parsed and read by XmlListModel. XmlListModel creates a read-only model from the XML file data, which can be used as a data source for View. When used, the QtQuick.XmlListModel module is imported into the program. XmlListModel is a read-only model. When the data information of the XML file is changed, reload() is called to refresh the model data marked as "Key" in the program. The real-time data display interface displays the data collection location, data update time, device ID and name, and temperature, humidity and light intensity data. These data are marked as "Key". When the mobile client accesses the network, it can update and view real-time data at any time. The real-time data display interface is shown in Figure 4.

5.3.2. DIGI Cloud historical data display mode
The cloud historical data comes from the JSON data stream of the DIGI device cloud. The maximum number of times the device cloud stores the stored data is 1000. When the data reaches the storage upper limit, the cloud automatically clears the previous historical data. In the program, the cloud data stream is parsed by a JavaScript function, and the historical data is displayed through the ScatterSeries in QtCharts, which is simple and intuitive. The horizontal axis of the historical data diagram shows the time point of data collection. The data are recorded at a frequency of once in per 30 minutes. One page shows 6 data points in a time span of 3 hours. The user can click on “View Next Curve” to view the historical curves of the three data. The DIGI cloud historical data curve display interface is shown in Figure 5. (a),(b),(c).

Figure 4. Real-time data reads. Figure 5. Cloud historical data diagram.
6. Program versatility test
In order to ensure the compatibility of the program with different systems when running on different Android platforms, three different brands of Android phones (Android version is above Android 5.1.1) was selected in this test: Redmi Note 4, Honor play 5X, vivo X6S. After evaluating the compatibility, running speed and other characteristics of this program after running on three different mobile platforms, we verified the adequacy of the program’s compatibility, running speed and of other characteristics.

7. Conclusions
This paper outlines an environment monitoring system based on the Internet of Things Android platform. The system uses T/H/L sensor of DIGI to collect real-time temperature, humidity and light intensity in three different local environments of Guangzhou University Town, Guangzhou Wushan and Huizhou GDUT University Research Institute. XBee Gateway - ZigBee to Ethernet/Wi-Fi and Device Cloud are chosen respectively as gateway and cloud server. Through the ZigBee wireless transmission network, the gateway finally uploads the data collected by the sensor terminal to DIGI Cloud, and then the Android mobile client developed based on the Qt platform accesses the API of the DIGI Cloud, so that the user can obtain the current environmental data in real time conveniently. At present, there are some defects in the system. For example, in terms of data transmission, LAN consumes a relatively large amount of energy, it’s better to try to find a WAN with lower energy consumption. The environmental monitoring system also has defects in ensuring the security of equipment and achieving information interoperability. In the future, it still needs to be improved in this respect to improve the adaptability to different environments.

Acknowledgement
This work was financially supported by Guangdong Provincial Science and Technology Plan Project (2016A010101025) and Huizhou Education Bureau project (Huizhou Internet of Things Information Technology Laboratory).

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