ISSN: 2472-3703 DOI: 10.6911/WSRJ.202101_7(1).0015

Intelligent Waterlogging Control System for Urban Underground Garage based on Internet of Things

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Abstract

This paper aims to reduce the loss of vehicles and other properties which are damaged by flooding in urban underground garages, Based on this, we propose a kind of system that is used to prevent waterlogging in urban underground garage. This system uses STM32F103C8T6 as the master device and we can achieve data by external rain sensor, water level sensor, CO sensor, smoke sensor. Due to the large area of the underground garage, we use ZigBee module to build network, so we can monitor multiple areas within the urban underground garage, and can get more accurate data. At the same time, ESP8266 module was used to connect Gizwits and transform information. APP and WeChat small program were developed. The two terminals provide users with remote remote monitoring and remote control.

Keywords

The Internet of things; Gizwits; Wechat Mini Program; STM32.

1. INTRODUCTION

In recent years, the ownership of cars has been on the rise, and the parking of cars is relying more and more on underground garages [1]. Extreme rainfall which is long duration will cause disasters, and there is a growing trend. In the south of China, the water level is sometimes as high as one meter. Because of the topography around the underground garage, the pavement, and the irregular design of the block size, most of the urban underground garage is difficult to withstand a long period of rain. The environment of underground garage is relatively closed, with many times of vehicle traffic and poor in air flow. Therefore, the concentration of CO in the garage is easy to exceed the standard within a short period of time, which is harmful for people's health [2].

At present, most waterlogging prevention technologies for underground garages focus on physical design and how to improve drainage performance as much as possible. However, due to the actual differences of different terrain, many good designs are very difficult to apply.

Part of the technologies are also automated [3], but these are generally controlled by floating balls and fixed water level points. Users and administrators can not know the specific height of the water level [4] and the speed of the water level rising, they can get timely alarm information and do not know whether the drainage capacity is enough, so they have no way to take precautions in advance.

Based on the above phenomenon, we developed an intelligent waterlogging prevention system for urban underground garages. STM32 is adopted in the design of this product. Through the ZigBee module, multiple nodes are set to monitor multiple places in the underground garage. Through ESP8266 module, the data is collected by Microcontrollers and is sent to Gizwits, and

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the data are checked on the APP or Wechat Mini Program.At last we have realized remote monitoring and control.

2. OVERALL INTRODUCTION OF THE SYSTEM

The overall technical design of the system is based on the three-layer structure of the Internet of Things.

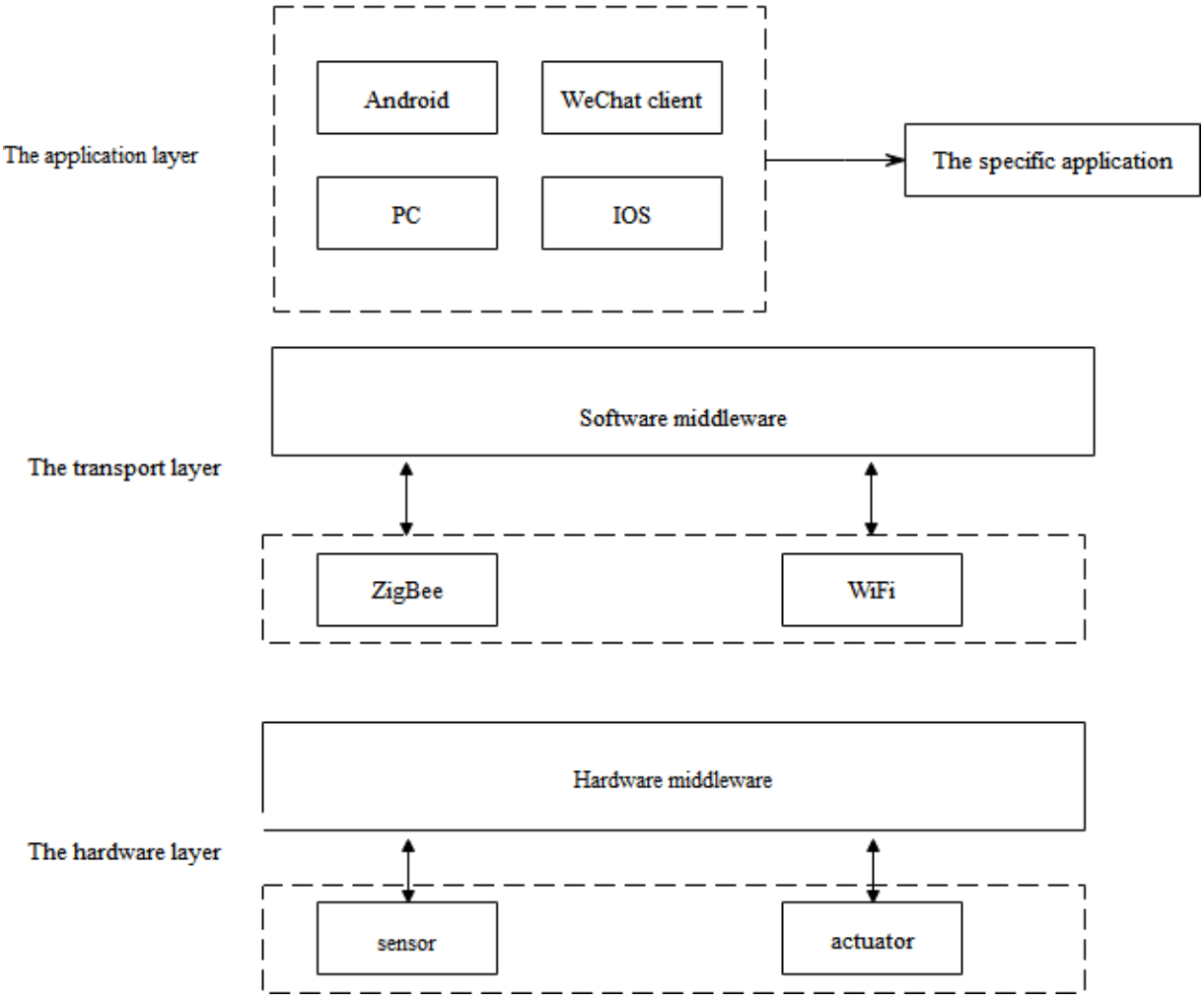

Figure 1. Overall technical architecture

The hardware layer includes sensors and actuators [5]. The former is used to collect the water level data of multiple points in the warehouse, rainfall data outside the garage, smoke concentration and CO concentration in the garage, etc. The latter contains equipment such as buzzer alarm device and LED, indicator lights, pumps in the garage, etc. Among them, the hardware middleware layer provides a unified interface for data interaction.STM32 is a widely used hardware middleware and can handle various common communication interfaces, so it can be connected with common standard sensors and actuators.

The transmission layer of this system is mainly to realize the communication between hardware and background as well as between hardware. At present, ZigBee modules and WIFI modules are the most widely used in the market, with fast transmission speed and moderate distance [6].

The software intermediate layer is responsible for integrating data. we can use APP or WeChat small program to interact with this system.

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3. SYSTEM HARDWARE DESIGN

3.1. Acquisition Node and Hardware Network

The system is mainly composed of Gizwits, SIM800C module and ZigBee network nodes. The gateway is mainly responsible for Data interaction between ZigBee sensor network and cloud server. Data will be transmitted to tact clouds server and wechat applet via ESP8266 module.

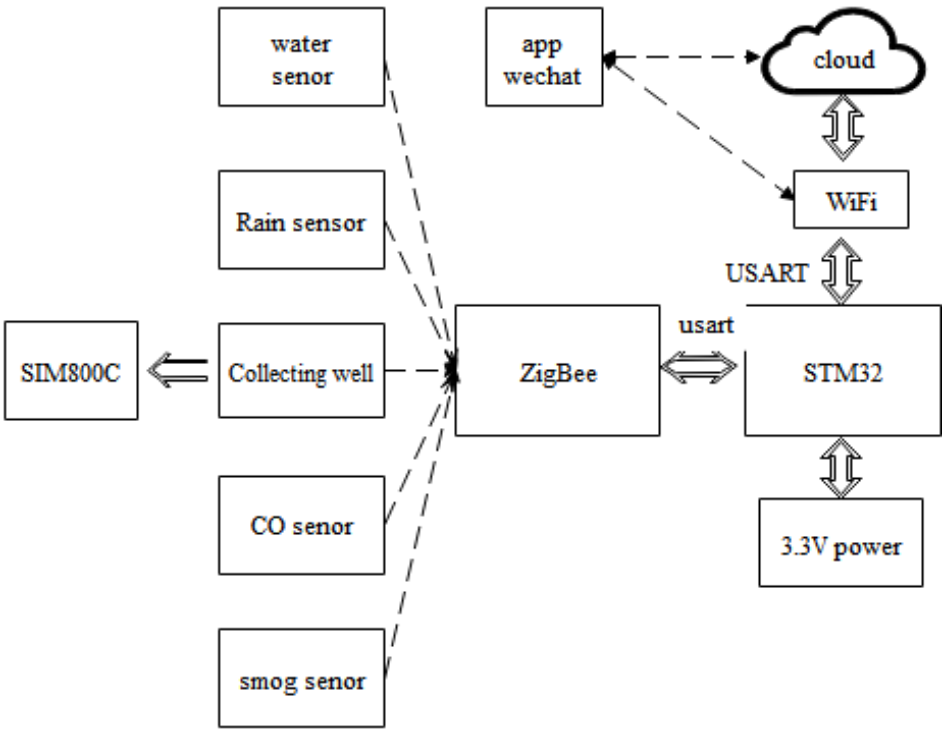

Figure 2. Data acquisition network

3.2. Multi-node Water Mark and Rainfall Circuit Outside the Garage

In this system, the working voltage of the water level sensor is 5V, and the interface 2 and 3 is connected with STM32, which can be used to collect liquid mark.

The rainfall sensor adopts double-sided material with a large area of 5.0*4.0cm. In this system, the analog voltage of the sensor is used as the output to judge the rainfall in the garage. The 4-pin is connected to the PA1 port of STM32 as the analog signal output of the sensor, and then the outdoor rainfall can be obtained by analyzing the voltage signal.

3.3. Smog, CO, and SIM800C Circuits

This system USES MQ-2 and MQ-7 sensors to measure the air quality in the garage. These sensors choose the analog output voltage value to judge the air quality, the higher the concentration, the higher the voltage. The working voltage in the system is 3.3V, and smog concentration and CO concentration can be collected by connecting STM32 PB8 and PB9.

The SIM800C module is powered by 3.3v voltage [7], and STM32 makes data communication through the USART. The led lights give instructions when sending and receiving data. The modules are basically controlled by sending AT instruction through USART. In this system, The SIM800C module alerts the management personnel by SMS and reminds them of the fault on the APP, informs them to deal with the fault as soon as possible.

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3.4. Zigbee Node Circuit and Wifi Module Circuit

This module adopts TI's CC2530 chip, which conforms to IEEE 802.15.4 protocol [8]. It supports wireless transmission.

Wifi module Uses 3.3V voltage to supply power to the module. Wifi module communicates with STM32 through USART, so The USART3 of STM32 is connected to the serial port of Wifi module.

4. SYSTEM SOFTWARE DESIGN

4.1. Zigbee Node Network

This module uses usart interface as the data information interaction interface between the device and the server. The interface baud rate is set as 115200 in this system, which can communicate with the serial port of STM32.

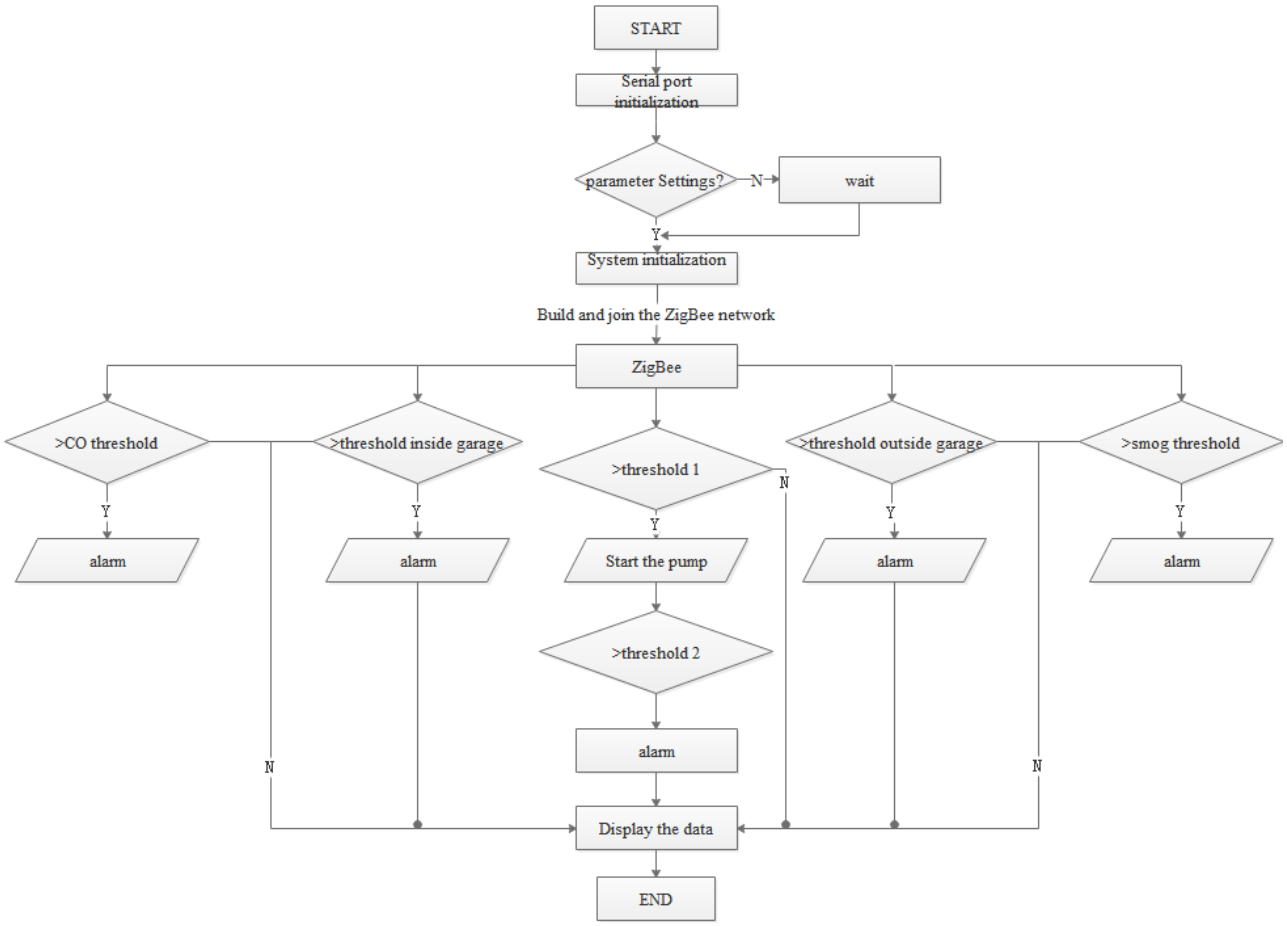

Figure 3. Intelligent node flow chart

4.2. WeChat Mini Program Design

In the mini program module, the function mainly includes: user identity operation, data display and other information.

1) User identity operation includes user registration, user login, device setting, and log-in;

2) Data display includes: the latest water level data, rainfall data, CO concentration, smog (combustible gas) concentration, real-time weather data;

3) Other information includes: future weather information, security status of the garage, security Settings of the garage, details of the garage, binding equipment, subscription reminder, contact customer, get to know us and exit;

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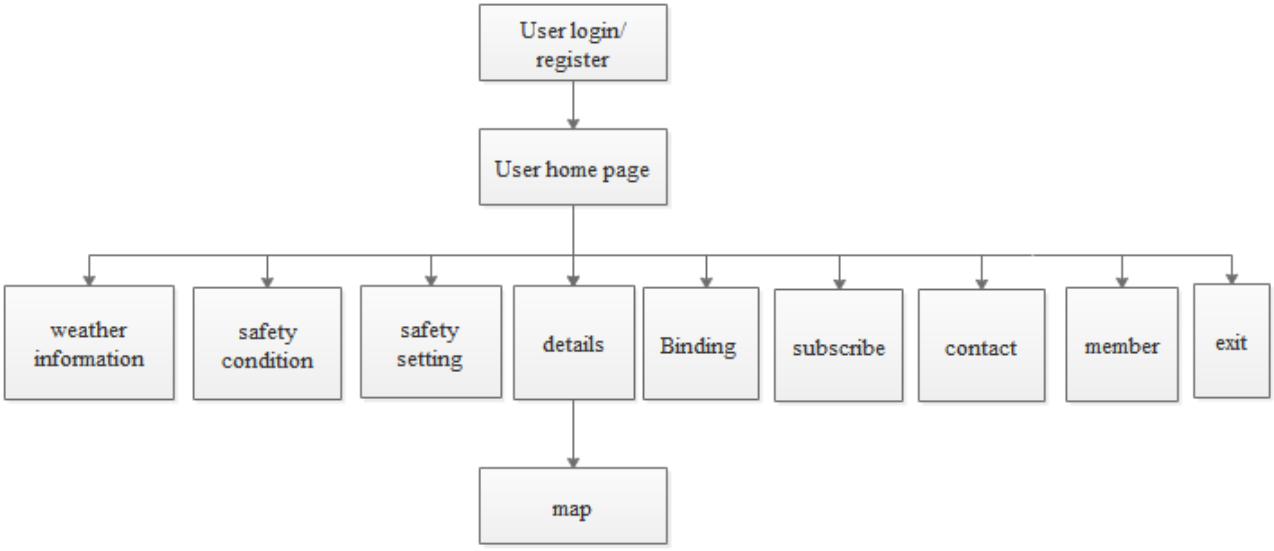

Figure 4. Page of wechat

ACKNOWLEDGEMENTS

According to the current market demand, and there are few existing product schemes in the market. The intelligent waterlogging prevention system of urban underground garage based on Internet of things is designed to realize the real-time monitoring, real-time display and intelligent control of water mark, rainfall data, CO concentration and smog inside and outside the underground garage, modify the drainage facilities and change alarm threshold of the underground garage.

The system is expected to have been basically completed, but there are still some improvements to be made:

1) The monitoring points inside and outside the garage support remote image capturing and video calling;

2) Data collected by big data analysis equipment. The historical water mark can be fitted and the possibility of waterlogging in urban underground garage can be predicted according to rainfall conditions.

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