

IoT Smart Home Management System Based on Embedded Devices

Xinfeng Chen^{1,*}, Zicheng Zhang¹, Suchong Ma¹, Zhoujing Wu¹

¹Wenzhou Polytechnic, Wenzhou 325000, China

* Corresponding Author

Abstract: This project is the use of Internet of Things technology how to better serve people's home life, which is a wide range of application prospects, social and economic benefits of the research direction. The system is mainly designed based on the planning of multiple detection points of the home environment, so as to provide personal intelligent housekeeping services from temperature, humidity, purification, cleaning, audio and visual for home life. Provide a set of solutions for smart homes, continuously optimize the comfort and services of the home environment, so as to improve people's home life.

Keywords: Internet of things, Embedded device, Wireless communication, Remote control.

1. Introduction

The emergence of smart devices has greatly facilitated people's clothing, food, housing and transportation, which solved the limitations of urban management in time and space. It realized mutual development, and made cities more intelligent. In the future, it is necessary to accelerate the pace of smart city construction, effectively improve the speed and quality of smart city construction, and promote the sustainable development of cities

The Internet of Things (IoT) enables remote monitoring and management of performance of machines, vehicles, homes, processes, etc., thereby facilitating service business models. However, companies in emerging and transition economies face particular challenges when applying IoT, not only in relation to the use of technology, but also especially to the need for new business models [1].

2. Systematic Design of smart home

2.1. Requirement of smart home

Smart home mainly gives full play to the advantages of computer technology, and works in tandem with home appliances, so that home equipment can be switched and adjusted through remote control. For example, you can remotely turn on home electrical equipment through mobile phones and computers, adjust the room temperature, and adjust electrical equipment such as air conditioners and TVs.

In addition, the smart home can detect various indicators of the internal environment of the home, starting from the aspects of temperature, humidity, light intensity, etc., collecting data through sensors, and then creating the most suitable home environment. Smart homes can also use their security care functions to take care of the elderly, children and pets at home, which is cost-effective.

2.2. System design

Smart home is to create a more safe, convenient, comfortable and intelligent home environment for people, while considering the performance of the device, but also taking into account the required cost, design a safe and reliable smart home control device, but also consider the user's specific requirements for the control device to adjust part of the function of the device The information system in the smart home is mainly based on sharing information through smart devices (IoT) and embedded sensors [2]. In summary, the control device designed by the paper should follow the following design principles:

(1) Cost-effective: smart home to people's lives, first of all, users must pay attention to the price, too high price is easy to make people feel prohibitive, this design in the guarantee of not sacrificing the performance of the device under the premise of minimizing the cost of development, so that the feasibility and significance of the design can also be reflected, lower the threshold of use, so that more families can have a smart and convenient living environment.

(2) Safety and reliability: safety is the top priority of everything, but also the premise of our design of this device, we need the smart home control device to run all day to serve us, so we have to consider the stability and power consumption of the required devices, and at the same time let the control device can quickly and accurately feedback the function of operation.

(3) Intelligent and convenient: intelligent is the purpose and core of this design, the control device designed in this paper needs to add some functions of artificial intelligence, making the design more humane, such as intelligent voice can liberate our hands, voice interaction can save people from using their hands to operate cumbersome, voice commands can complete many of the desired functions as shown in Figure 1.

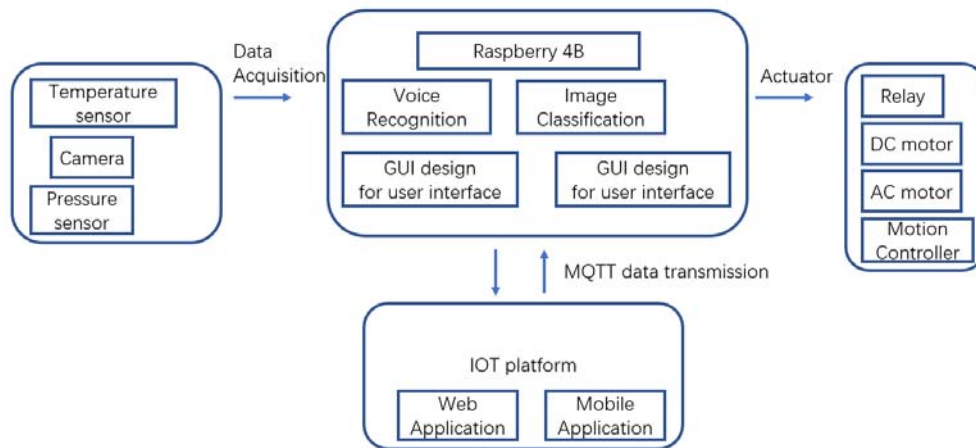


Figure 1. Systematic design

2.3. Cloud platform establishment

As an emerging technology, the Internet of Things is also evolving with this concept in line [3]. This device uses Alibaba's IoT platform, Alibaba Cloud is becoming the preferred service to meet customer cloud server needs. Alibaba Cloud IoT platform can provide secure and reliable connection and communication capabilities for devices, and can provide cloud APIs upwards, and send instruction data to the device through API calls to achieve remote control; Downward, a large number of devices can be connected to support device data collection to the cloud. In addition, Alibaba IoT Platform also provides other value-added capabilities, such as device management, rule engine, data analysis, edge computing, etc., providing great development space for developers in various IoT scenarios and industries.

2.4. Voice assistant design

In terms of intelligent voice, an anthropomorphic natural language interaction system is used to realize communication between humans and machines. Exclusive voice assistants serving individual users stimulate adoption of consumers regarding to artificial intelligence voice assistants [4]. Voice assistant function will be deployed into the system which would be waked up by hot words. The flow of voice recognition and command execution is presented in figure 2. Voice assistant would be listening in background before active. When the hot word detected by program, the voice assistant would request user to speak command. After user finish speaking, the audio would be saved in file. Then, the audio would be processed by Alibaba API to translate into text. The text would be responded by rule based command set, which are demonstrated in figure 3.

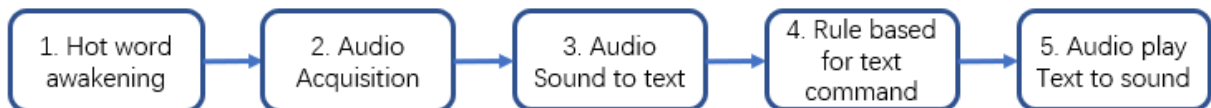


Figure 2. Voice assistant processing flow

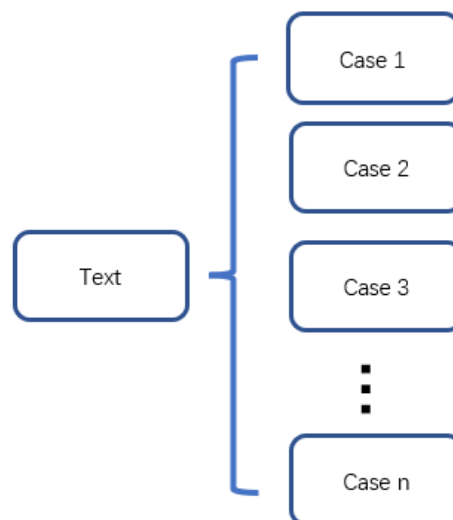


Figure 3. Rule based command respond system

2.5. Energy management

The smart home network is equipped with all the

appliances and devices with high electrical energy requirements. This energy demand is growing and the need

for other energy sources is identified such as solar and wind[5]. The goal of smart appliance automation is to save energy consumption and improve resource utilization. Energy-based smart home was designed by researchers. These systems are improved and optimize by executing the architecture level change or integrate the optimization model into an existing system[6].

2.6. Sensor data collection

The data acquisition of water supply system is accomplished by retrofitting the existing water meter and installing electromagnetic flowmeter, which can measure both the instantaneous flow rate and the accumulated flow rate. Most of them communicate data by RS485 or blue teeth. At the same time, in order to monitor the running state of the water supply system in real time, the pressure gauge is installed in the water supply system.

The data acquisition of power supply system assist government online collect data without field inspection. Powermeter collect data and send data via RS485.

2.7. Data visualization

Data collect in local computer such as STM32 or other Linux devices. This project use raspberry pi 3B to collect data by python 3.8, a GUI was developed via PYQT5, local data

has its own advantage which is much safer then online. And a center control panel can be visualized in screen for user browse and control.

Nevertheless, data can be upload to Cloud platform as well. In the python 3.8 script, most of environment data are uploaded to Alibaba IoT platform. Also, a Web application was designed in IoT studio. In this project, a fantastic Web application was built first because people are keen to use mobile control.

2.8. Multi-room interaction

In this project, a multi-room IoT device interaction is considered. It means each room has a function or assess to control other room. Therefore, voice assistant should be deployed in each room.

3. Result

In figure 4, data are uploaded to Alibaba cloud via MQTT and visualize data in web, which displays important data basing on raw data collection.

Using mobile terminate such as cell phone or computer, project add friendly interface for user to remote control device, which assist people to manage the whole house.

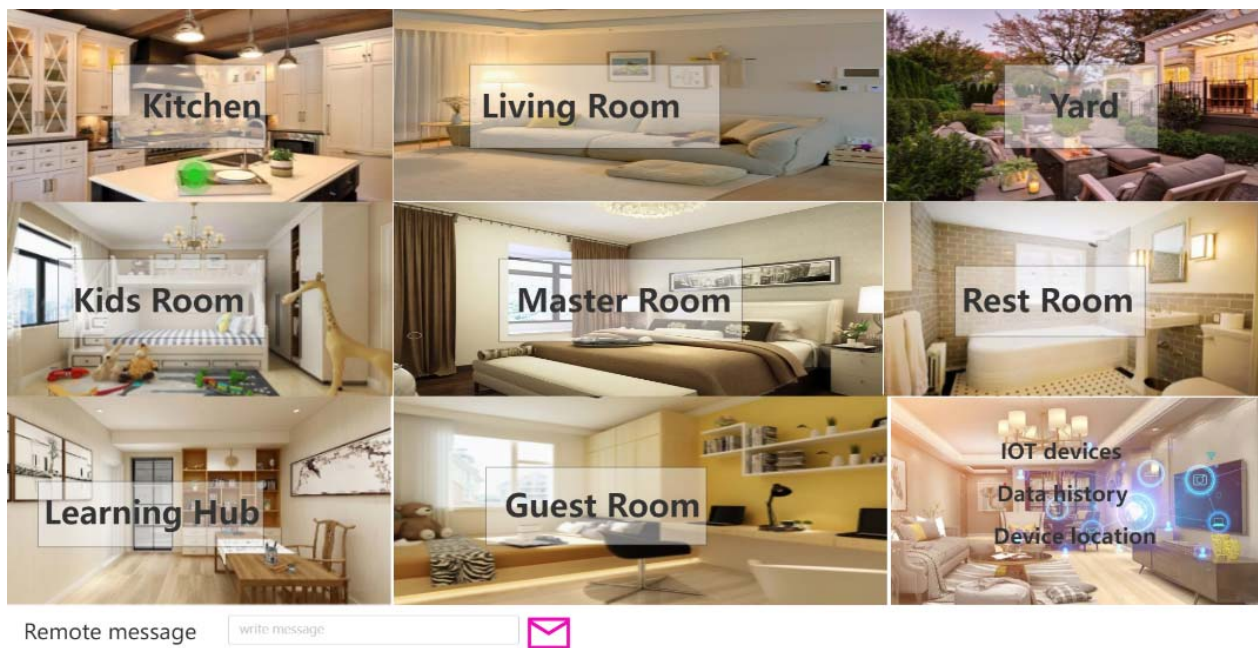


Figure 4. Data visualization and remote-control web application

Wherever you are, Master can browse website <http://smarhome.cntayin.com> to get real data and remote control light system and other systems. Now it is open access for anyone.

Each room have a remote switch that can control light or other device control.

People can leave message in web and send message to iot devices which can play audio from text content.

People can ask voice assistant to activate other devices.

Voice assistant can be modified basing user requirement.

4. Conclusion

With the rapid development of the Internet of Things, smart homes are also emerging with the popularity of Internet of

Things technology. Smart home control devices such as embedded linux devices as the core of smart homes will definitely play an important role in the future. Using raspberry pi 3B as a main controller could establish wonderful IoT tool which can collect data, upload data, proceesing command, voice assistant deployment to give better communication for people and device. And multi iot device interation can be constructed via Ethernet, which can upload data to Web application and receive data from iot platform.

Acknowledgment

Wenzhou Polytechnic gives fund to this project (WZY2021035 and WZYCY2005).

References

- [1] Haaker Timber, Ly Pham Thi Minh, Nguyen-Thanh Nhan, Nguyen Hanh Thi Hong. Business model innovation through the application of the Internet-of-Things: A comparative analysis [J]. *Journal of Business Research*, 2021, 126.
- [2] Amraoui, Nouredine, Zouari, Belhassen. Securing the operation of Smart Home Systems: a literature review [J]. *Journal of Reliable Intelligent Environments*, 2021 (prepublish)
- [3] Lei Wang. Data on Cloud Practice Based on Alibaba Cloud IOT Platform [C] // *Proceedings of 4th International Conference on Wireless Communications and Applications (ICWCA 2020) Part II*, 2020: 148-152. DOI: 10.26914/c.cnkihy.2020.070075.
- [4] Benedict G. C. Dellaert, Suzanne B. Shu, Theo A. Arentze, Tom Baker, Kristin Diehl, Bas Donkers, Nathanael J. Fast, Gerald Häubl, Heidi Johnson, Uma R. Karmarkar, Harmen Oppewal, Bernd H. Schmitt, Juliana Schroeder, Stephen A. Spiller, Mary Steffel. Consumer decisions with artificially intelligent voice assistants [J]. *Marketing Letters*, 2020, 31 (prepublish).
- [5] K. Moser, J. Harder, S.G.M. Koo, Internet of things in home automation and energy efficient smart home technologies, in: *IEEE international conference on systems, man, and cybernetics (SMC)*, 2014, pp. 1260–1265.
- [6] Saroha, P. and G. Singh, A study on functional capabilities and recent advancements in smart home environment. *Materials Today: Proceedings*, 2022.