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Internet of Everything System Based on Linux and Harmony

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Abstract: *This project intends to design a Linux and Harmony based Internet of Everything system, which can form a complete Internet of Everything system by controlling the main control board to operate various modules and sensors. The main control chip of this project adopts I.MX6ULL as the central processor, and controls peripheral configuration modules such as ZigBee module, fingerprint lock module, camera module module, and language broadcast module. Through the collaboration of each module to serve the community and family, it makes the community management and service more efficient and the residents' life more convenient, creating a smart community and smart home combined with the Internet of Everything system, reducing the consumption of human resources, making technology services to life and improving work efficiency.*

Keywords: *Internet of Everything; Linux; Smart Community; Smart Home*

1. Introduction

With the acceleration of urbanization, community management has become the focus of urban management nowadays, and many communities have involved community members and the public in self-governance, which has greatly increased the enthusiasm of residents' self-governance, but also exposed the problem of community management with few community staff and difficulties in undertaking refined work, a problem that is also particularly prominent in the impact of this new crown pneumonia outbreak on the community [1]. In addition to this, the serious deficit of community owners' committees, inadequate community support facilities, and prominent parking problems are all key community problems, which implies the need for adequate and strong property management staff to address community management issues and community infrastructure development. Most urban communities can have sufficient staff, but they cannot meet the requirement of being on the job, so they will face the problems of unscientific staffing, advanced age of community staff, low education level and unstable work. This will directly affect the efficiency of community management. Based on these human resource issues, infrastructure issues, the Everything Connected System was born.

In response to this series of problems, this team aims to create two aspects of smart community and smart home and link them together to solve the above current community management problems and infrastructure problems. After analysis, the key to the problem lies in how to do the most with the least amount of people. This project creates an Internet of Everything system where various projects can operate in concert to make property management more efficient. This project is very diversified, which includes smart lighting, smart fire fighting, garbage can monitoring, water room monitoring, environment monitoring, manhole cover monitoring, power distribution monitoring, smart meter reading, parking space monitoring and AI video monitoring, etc. And the integration of these multiple modules of our Internet of Everything system can solve the above problems of work redundancy encountered in community management, and this high degree of integration can unify the problems, thus greatly reduce the community's human and material resources.

Finally, as the IoT technology can be accumulated and upgraded continuously, the industry chain is also gradually improved and matured, coupled with the cyclical factors driven by infrastructure construction, basic industry transformation and consumer upgrading, fields and industries at different levels of development alternately keep advancing the development of IoT, driving the global IoT industry as a whole to show explosive growth [2]. This shows that there is a general trend to create an Internet of Everything market in terms of project support and fully illustrates the market potential of Internet of Everything systems.

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2. Preliminary Research

2.1 China Internet of Everything Market Structure Scale

According to IDC research data, the global IoT spending reached USD 690.47 billion in 2020, of which China's market accounted for 23.6%. IDC predicts that the global IoT market will reach USD 1.1 trillion by 2025, with a compound annual growth rate of 11.4%, of which China's market share will increase to 25.9%, and the IoT market scale will be the first in the world [3].

2.2 Analysis of the size of the smart home market

From a global perspective, the world smart home market size was about $46.3 billion in 2018 and is expected to increase rapidly to $78.2 billion by 2022. China's smart home has a low penetration rate and high growth rate, and the market space is vast. China's market penetration rate in 2018 was 4.9%, while the smart home penetration rate in the United States reached 32.0% during the same period, and the increase in domestic penetration rate will provide strong momentum for the growth of smart home market size [4]. The smart home field has both opportunities and challenges, and branded, specialized and scaled enterprises will have more market prospects.

2.3 Analysis of smart community market scale

Smart community users are eager to realize the safety, comfort, efficiency, energy saving and convenience of home and community life through intelligent applications. The traditional community model has the drawbacks of single management mode, lack of means of smart community services and information silos; through the construction of smart community, it can not only provide a safe, comfortable, convenient and intelligent living environment for community residents, but also balance the needs of business, smart community environment and society, and optimize the allocation of resources for smart community. China's smart community market scale continues to grow rapidly, there are currently about 296,000 communities in the country, according to the budget of about 300,000 per community, the overall scale of smart communities is about more than 80 billion, and the overall scale of China's smart community market is expected to reach 681.6 billion yuan in 2023 [5].

3. Research content

This project takes smart community and smart family as the entry point to create a system of interconnection of all things. Smart community and smart family are closely connected by cell phone app. Smart community provides convenience for residents' life and smart family makes property management more efficient.

This project uses IMX6ULL as the main control chip, first of all, it has to be developed on bare metal to realize its control of various hardware modules. The bare-metal development requires mastering its basic peripherals, such as LEDs, buttons and buzzers, in addition to UART serial communication, I2C communication and SPI communication protocols, which are key for different devices to work directly with each other.

Linux development requires system porting, the main steps are: building a cross-development environment, bootloader selection and porting, kernel configuration, compilation, porting and root file system creation. After porting the system Linux system is no image interface, we will use Qt for software development, to achieve the acceptance of the data returned by Hi3861, and made for the rise and fall trend graphs, based on algorithms to add predictive features to achieve control of the Hi3861 chip, so as to control the working equipment. qt is a cross-platform C++ development library, mainly used to develop graphical user interface programs , Qt can draw a beautiful interface (including controls, layout, interaction), but also contains many other features, such as multi-threading, access to databases, image processing, audio and video processing, network communication, file manipulation, etc., which Qt has built-in.

The project uses the Hi3861 chip as the development of the sub-controller chip, Hi3861 is a chip with an integrated Harmony core, able to Harmony development, and comes with WiFi, NFC and expansion IO port, etc., for the development of the project has a huge role. Able to expand the module on Hi3861, the monitoring data through WiFi wireless transmission back to the host computer, to achieve the purpose of remote work, greatly developed the application field(Figure 1).

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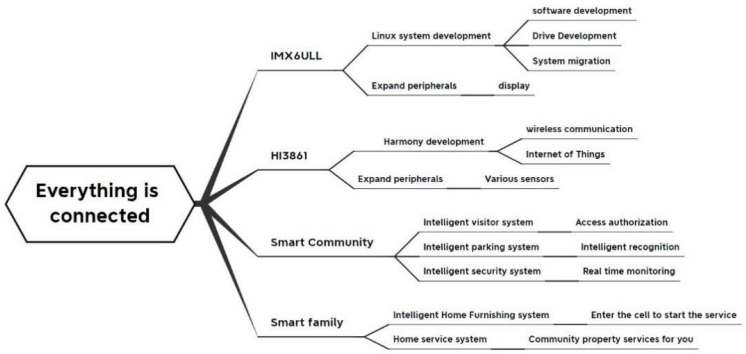

Figure 1: Project mapping

3.1 Smart Home

(1) Smart home system

When residents enter the community, they can automatically turn on the air conditioner, turn on the lights and curtains after entering the home, and monitor the safety of the home environment in real time, when there is a gas leak, fire and other situations, the first time to notify the administrator to protect personal safety and reduce property losses.

Smart home system has a hardware part and software part, hardware we intend to use Hi3861, ESP8266 development board, temperature and humidity sensors, smoke sensors, temperature and humidity sensors, OLED display, lights, relays, fans and servos and other components to build the prototype of smart home. The advantages of Qt development are that it is cross-platform and can be used in embedded, mobile and PC at the same time without too much modification to the code, but the disadvantages are that Qt is not very good for the ecology of Android, and the stability is slightly insufficient compared with other platforms; the advantages of small program development are that it is light and efficient, and WeChat has a large number of The disadvantage is that it needs to rely on the WeChat platform and does not have cross-platform functions.

(2) Family service system

Family service system adopts the form of pure software, mainly to provide a bridge for communication between property owners and owners, and provide various functions on this basis, so that owners can live more conveniently and properties can manage more efficiently (Figure 2).

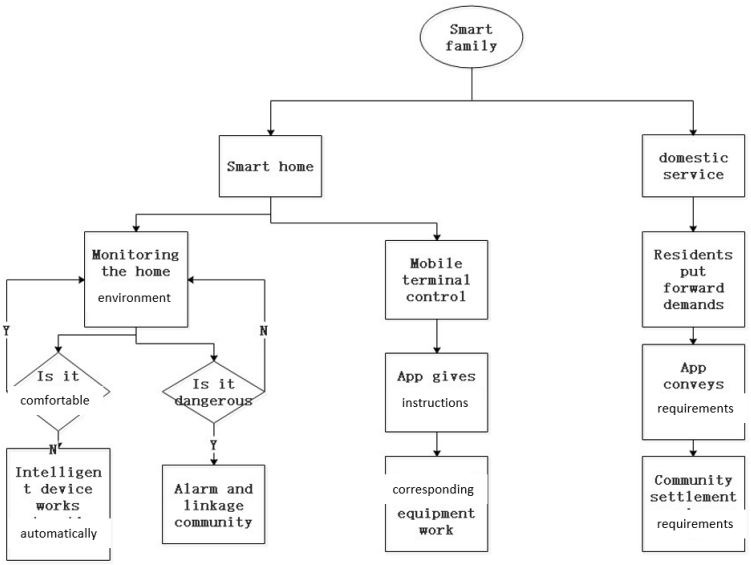

Figure 2: Smart Home

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3.2 Smart Community

(1) Smart Visitor System

When a friend wants to enter the community, the resident sends the authorization code to the friend, and the friend can open the door of the community after entering the authorization code to achieve independent and efficient management.

The function of the app is to store the information of the head of the household, the head of the household can create a QR code or authorization code in the app, when the access control recognizes the QR code and matches with the database, the correct match will open the access control and record the information of the head of the household.

(2) Smart parking system

Residents can view the idle parking spaces in the community in real time after logging into the app, and can choose a parking space, and if it is their own parking space, they can release the lease to maximize the use of resources. When entering the parking lot, the license plate is automatically recognized, the door is automatically opened, and the idle parking space is automatically prompted.

The realization of the function lies in the work of hardware identification single and the communication work between different identification, the camera returns the collected data to the chip for analysis, and the chip then controls the helm.

(3) Wisdom security system

Install security system in the community fence and other places that are easy to enter the community, when there is illegal entry of outsiders, the first time to notify the administrator, so that the security of the community is guaranteed(Figure 3).

This function is mainly accomplished by sensors (such as human infrared sensors), arming sensors in the fence and other areas, if the sensor collects abnormal data will return the data to the host computer, the host computer to take appropriate measures.

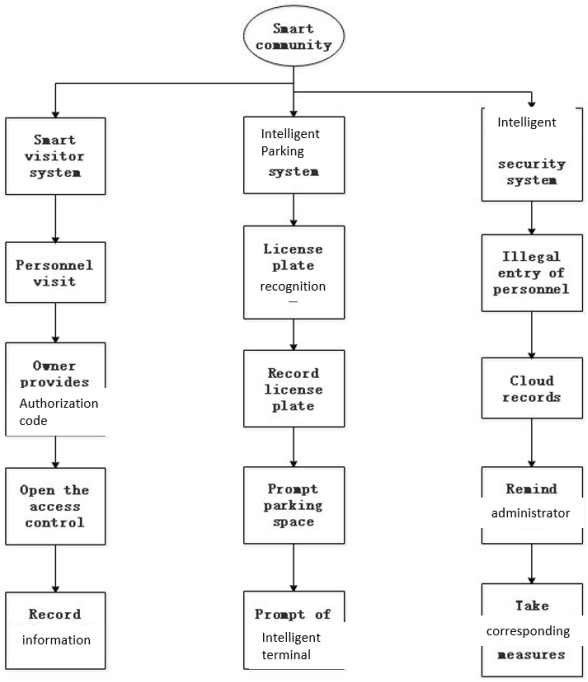

Figure 3: Smart Community

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4. Technical Analysis

4.1 Understanding the use of I.MX6ULL microcontroller with Cortex-A7 core

The project uses the I.MX6ULL microcontroller with Cortex-A7 core to control the whole system, and the driving principle of the I.MX6ULL microcontroller must be mastered. The functions used in this project are IO port multiplexing, IIC communication, PWM wave output, serial communication, timer interrupt, external interrupt, timer, etc. The correct use of these functions must be based on the project members' proficiency in the I.MX6ULL microcontroller.

4.2 Hardware structure design

In this project, in order to realize the wireless monitoring and working system, the dual chip control mode is used, which is divided into both main chip and sub-chip, and the modules and working devices are built together with the sub-chip, while the main chip is used as the total control to control the whole system. Different modules are installed on multiple sub-chips to jointly complete the basic functions of monitoring and working of the Internet of everything.

4.3 Software Programming

The software program design is divided into the program for chip control and the program design for APP software development. The program of chip control is developed in C language, which can be programmed in Visual Studio Code and burned into the system through HiBurn software. APP software development uses Qt development, which is based on C++ development and requires the developer to have a solid C++ foundation.

4.4 Control system circuit stability and its rationality

Design of this project because of the use of multiple modules, for different modules use no communication protocol, so in the circuit design, it is necessary to connect different modules to the appropriate IO port according to the hardware resources available in different IO ports to maximize the use of hardware resources.

5. Results

5.1 Intelligent lighting

By transforming the ground street light, it can be equipped with ambient light sensing and remote switch function, and realize single light control in the management background, keep dark light and energy saving at night, and gradient dimming when someone approaches.

5.2 Intelligent Fire Fighting

Smoke monitoring: real-time monitoring of smoke parameters in unattended areas, automatic alarm on the cloud platform, rapid response to eliminate safety hazards.

5.3 Intelligent security

Border invasion infrared monitoring: real-time monitoring of border invasion (for example, whether someone over the fence into the community), in the cloud platform will be alarmed in order to facilitate timely processing and eliminate security risks.

5.4 Intelligent parking supervision

Emergency channel illegal parking monitoring: real-time monitoring of emergency channel illegal parking, when there is illegal parking in the cloud platform will be alarmed in order to deal with and eliminate the security risks in a timely manner.

Monitoring of the number of ordinary parking spaces: real-time monitoring of the number of cars in

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and out of the community, so as to facilitate the number of statistical parking spaces for parking management.

5.5 Intelligent environment monitoring

Weather conditions/noise monitoring: real-time monitoring of air pressure, PM2.5, temperature and humidity, rain and snow, noise and other information, in the cloud platform display and alarm, so as to facilitate timely processing and eliminate security risks.

6. Conclusion

This project is based on the rapid development of technology in the era, and is associated with the problem of service between the community and the residents, so the design of a Linux and Harmony-based Internet system for everything is proposed. The design itself has a wider application level, not only limited to the community and family context, but also to the mountain, forest, city and other environments. However, the design can not completely replace the manual in the actual working environment, and we hope to do further development and upgrading in the future study and research, so that the system can better serve the actual application.

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References

[1] Feiyun Wu, Kunde Yang, Xueli Sheng Optimized compression and recovery of electrocardiographic signal for IoT platform [J]. Applied Soft Computing Journal, 2020, 96.
[2] Kang Mengyu, Zhou Zhangbing, Li Xiaocui et al. Energy-Efficient Boundary Detection for Continuous Objects in Collaborative Edge Networks [J]. IEEE ACCESS, 2021, 9.
[3] Xianyu Zhang, Xinguo Ming, Dao Yin Application of industrial big data for smart manufacturing in product service system based on system engineering using fuzzy DEMATEL [J]. Journal of Cleaner Production, 2020, 265.
[4] Xiaoke Chai, Zhimin Zhang, Kai Guan et al. A hybrid BCI-controlled smart home system combining SSVEP and EMG for individuals with paralysis [J]. Biomedical Signal Processing and Control, 2020, 56.
[5] Constantinos Marios Angelopoulos, Gabriel Filios, Sotiris Nikoletseas et al. Keeping data at the edge of smart irrigation networks: A case study in strawberry greenhouses [J]. Computer Networks, 2020, 167.