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DESIGNING A HOME INTERNET OF THINGS SYSTEM USING ESP32 CONTROLLER

In today's world, there is a growing demand for automation and connecting various devices into a unified network to ensure convenience, efficiency, and safety in life. The Internet of Things (IoT) is becoming an increasingly popular solution for implementing these tasks, allowing devices of different purposes to be connected for data exchange and remote control via the Internet. One of the critical components of an IoT system is controllers, which act as the brain of the network, managing the interaction between devices.

The relevance of this topic is determined by the need for the development of modern automation technologies for home environments, particularly in managing lighting, heating, security, and other aspects of household comfort. Implementing such a system contributes to convenience and efficiency in life and can lead to resource savings and increased home security.

ESP32 is an excellent choice for our project due to its high performance and versatility. Its built-in Wi-Fi and Bluetooth modules allow easy integration of devices into a wireless network and remote control. Moreover, the ESP32 has sufficient memory to store software and data, making it ideal for our purposes. The controller also supports various communication protocols, allowing us to interact with sensors and devices. Its relatively low cost and availability make it an economically advantageous solution for creating a home IoT system. Additionally, ESP32 is actively supported by the developer community, ensuring quick responses to potential issues and a wide range of available libraries and resources for development.

To create an efficient home IoT network using the ESP32 controller, it is essential to define the main requirements for the system first. First and foremost, the system must be reliable and stable to guarantee the uninterrupted operation of devices and ensure convenient use for the user. Additionally, the system must integrate with various devices, such as sensors, lighting equipment, security systems, etc. This will provide the ability to manage different aspects of the home environment from a single interface.

Remote management over the Internet is also necessary for the system's proper functioning. This allows users to monitor and control their devices from a distance, providing additional comfort and security.

Several vital components were selected to implement our home IoT network system. First, temperature and humidity sensors were used to measure indoor climate conditions. We also employed light sensors to control lighting. Motion detectors and sensors for home security for doors and window openings were installed. Additionally, the Wi-Fi module in the ESP32 controller was utilized to ensure communication between devices and the outside world. Expanding the system with various additional modules and sensors that can be connected to the ESP32 through different interfaces was also considered.

The architecture of the home IoT network system with ESP32 includes a central ESP32 controller, which acts as the main control unit for the entire system. This controller is

connected to various sensors and devices through different interfaces, such as Wi-Fi, Bluetooth, and GPIO. The controller collects and processes data from the sensors, which can be sent to a server or stored on a local storage device.

The system also can interact with users through a mobile application or a web interface. Users can control devices, receive information about the system's status, and adjust operating modes using these interfaces. The system employs various encryption and authentication methods to ensure data security and protection against unauthorized access.

The software in the system is developed using the C/C++ programming language and the Arduino IDE framework. A web server will be used to create the user interface and process data, which will be accessible via the Wi-Fi network. The central controller program will include code for connecting to the Wi-Fi network, reading sensor data, controlling actuators (e.g., lighting or heating), and interacting with other devices in the network. Additionally, a mobile application or web interface will implement remote system control. The built-in flash memory of the ESP32 controller will be used to store settings and device states. All data will be stored in an encrypted form to ensure security.

Security is one of the critical components of any Internet of Things (IoT) system. In a home IoT network system with an ESP32 controller, it's crucial to protect data from unauthorized access. Various methods, such as data encryption and secure communication protocols, can be used. Additionally, regularly updating the controller's firmware is essential to patch potential vulnerabilities. Another aspect of security is protection against network-level attacks. Using strong passwords for the Wi-Fi network and switching off unnecessary ports can help prevent unwanted access to the system.

The system will be tested to verify its functionality, reliability, and security. The system is expected to be tested at various stages of development, from component integration to functional and load testing. Initially, individual components of the system will be tested to ensure their proper operation. Subsequently, integration testing will be conducted to check the interaction between components and the system's overall stability. Functional tests will help ensure the system meets established requirements and performs all planned functions correctly. Security tests will also be conducted to check the system's resilience against various attacks. Load testing will help determine the system's performance limits and ensure it can handle many simultaneous requests and loads. Specialized testing tools, such as JUnit for functional tests and Apache JMeter for load tests, will be used to analyze the test results.

As a result of this project, a home IoT network system based on the ESP32 controller has been developed. This system meets modern requirements for automation and security in human life, providing convenience, efficiency, and safety in managing household devices.

REFERENCES

1. «ESP32 Technical Reference Manual», Espressif Systems.

2. «Home Automation and IoT: A Review of Concepts, Technologies, and Applications», International Journal of Smart Home.

3. «Arduino Programming Language,» Arduino official documentation.

4. «IoT Security Best Practices,» Internet of Things Security Foundation (IoTSF)

5. «Testing Computer Software» by Cem Kaner, Jack Falk, and Hung Q. Nguyen