

RTOS-Based Solution for Smart Home Automation

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Abstract—The paper presents a home automation system with time-critical tasks, shared resources, and, data visualization over the cloud. Since it is difficult to execute the tasks in a sequential and regular system, this home automation system makes use of a Real-Time Operating System to perform the tasks with precision and reliability.

Index Terms—home automation, esp32, RTOS, freeRTOS, sensors, mutex, thingSpeak

I. INTRODUCTION

Over the years, home automation system focusing on wireless control and monitoring have been developed. The system includes communication and control of sensors and actuators respectively through technologies like Bluetooth, Zigbee, GSM, PIC controller, etc. This paper focuses on the responsiveness and reliability of the system using an RTOS kernel, FreeRTOS, and ESP32 microcontroller. The system makes use of several sensors to monitor the environment, and a few output devices to display or alert the people. The system also uses an IoT platform to visualize the live data in the cloud. The paper explains the system component description, RTOS implementation, and analysis of the results. At the end, a conclusion is drawn.

II. SYSTEM COMPONENTS

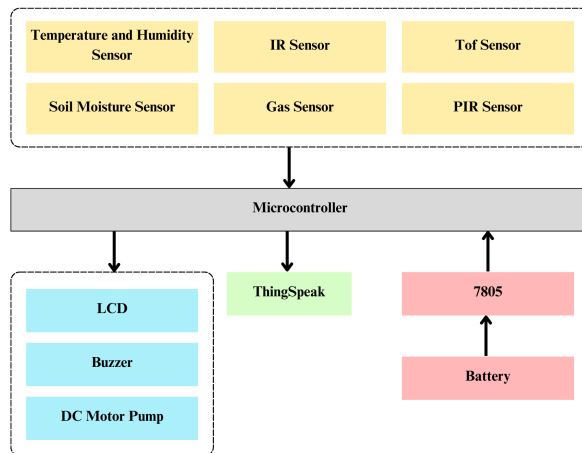


Fig. 1. Block Diagram of Home Automation System

A. Hardware

a) *Microcontroller*: Microcontroller plays a crucial role as the central processing unit or “brain” of the system. Esp32 is used here for this purpose. Esp32 interfaces with all the sensors, collects data, processes it, and analyzes it. It makes decisions and sends out control signals to other devices like actuators, buzzers, and LCDs. It also manages the power distribution, consumption, and efficiency of the home automation system.

b) *Input*: Sensors serve as the input devices. They detect, measure, and monitor various physical and environmental parameters. The system makes use of the following sensors,

- Temperature and Humidity Sensor measures the ambient temperature and relative humidity levels in the environment.
- IR Sensor detects infrared radiation emitted or reflected by objects or individuals within its detection range.
- Tof Sensor calculates the distance to an object by measuring the time taken for a light signal to travel to the object and back.
- Soil Humidity sensor monitors and measures the moisture content or humidity levels in the soil.
- Gas Sensor detects the presence and concentration of specific gases or volatile compounds in the environment.
- PIR Sensor detects changes in infrared radiation caused by movement or motion within its field of view.

c) *Output*:

- Buzzer is triggered by the highest priority task to alert people. Gas and IR sensors are given the highest priority, meaning the buzzer is triggered when a fire or an intruder is detected.
- Liquid-Crystal Display is used to show the live data from the sensors.
- DC Motor pump
- d) *Power Supply*:
 - A 9V volt battery is utilized to power the system. This makes it low-cost.
 - Voltage Regulator, 7805 is used to bring down 9V from battery to 5V, to supply to the microcontroller, gas sensor, PIR sensor, and LCD.

B. Software

a) *Arduino IDE*: The Arduino Integrated Development Environment (IDE) is a popular open-source software platform

widely used for programming and developing applications for Arduino microcontroller boards. It also supports ESP32.

b) *FreeRTOS*: FreeRTOS is an open-source RTOS (real-time operating system) kernel that is integrated into ESP-IDF as a component.

C. Cloud

a) *ThingSpeak*: IoT platform.[Xav22]

III. REAL-TIME OPERATING SYSTEM

Operating System is a system software that manages computer software and hardware resources and provides services to programs. Real-Time operating system is a type of operating system that provides real-time behavior. It is used for time-critical applications.[Hym21] Key characteristics of RTOS are its responsiveness and determinism, the reason it is used over General Purpose Operating Systems in Home Automation Systems. GPOS is not ideal for time-sensitive tasks because of its latency and synchronization problems. On the other hand, RTOS offers -

A. Real-Time Behavior

Home automation system needs to respond and act upon events or triggers instantly or with minimal delay. It needs to continuously monitor sensors and devices and give feedback instantly. Low latency and event-driven architecture are possible using RTOS.

B. Multi-tasking/Processing

C. Task Scheduling

Home automation system automates and schedules specific actions or tasks. These tasks need to occur at predetermined times or under certain conditions, for example, turning on/off the home security system, opening windows when ventilation is required, and watering plants at specific times of the day.

D. Resource Management

Home automation needs to efficiently allocate, utilize, and monitor various resources. Sharing a resource or managing storage between two or more tasks can be done in RTOS. This is done using the concept of mutex (MUTual EXclusion). It is a locking mechanism.[Ope]

The system contains shared resources like buzzer and lcd. LCD is used to display data from DHT, Soil temperature and moisture, PIR, and Tof sensors. If one of the tasks wants to use the LCD, the task must have the key(mutex). Let's suppose one of the tasks already has the key, all the other tasks will have to wait for the key to be returned.

IV. IMPLEMENTATION

A. Figures and Tables

V. RESULTS AND ANALYSIS

VI. CONCLUSION

ACKNOWLEDGMENT

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