

SMART HOME AUTOMATION

Group 22

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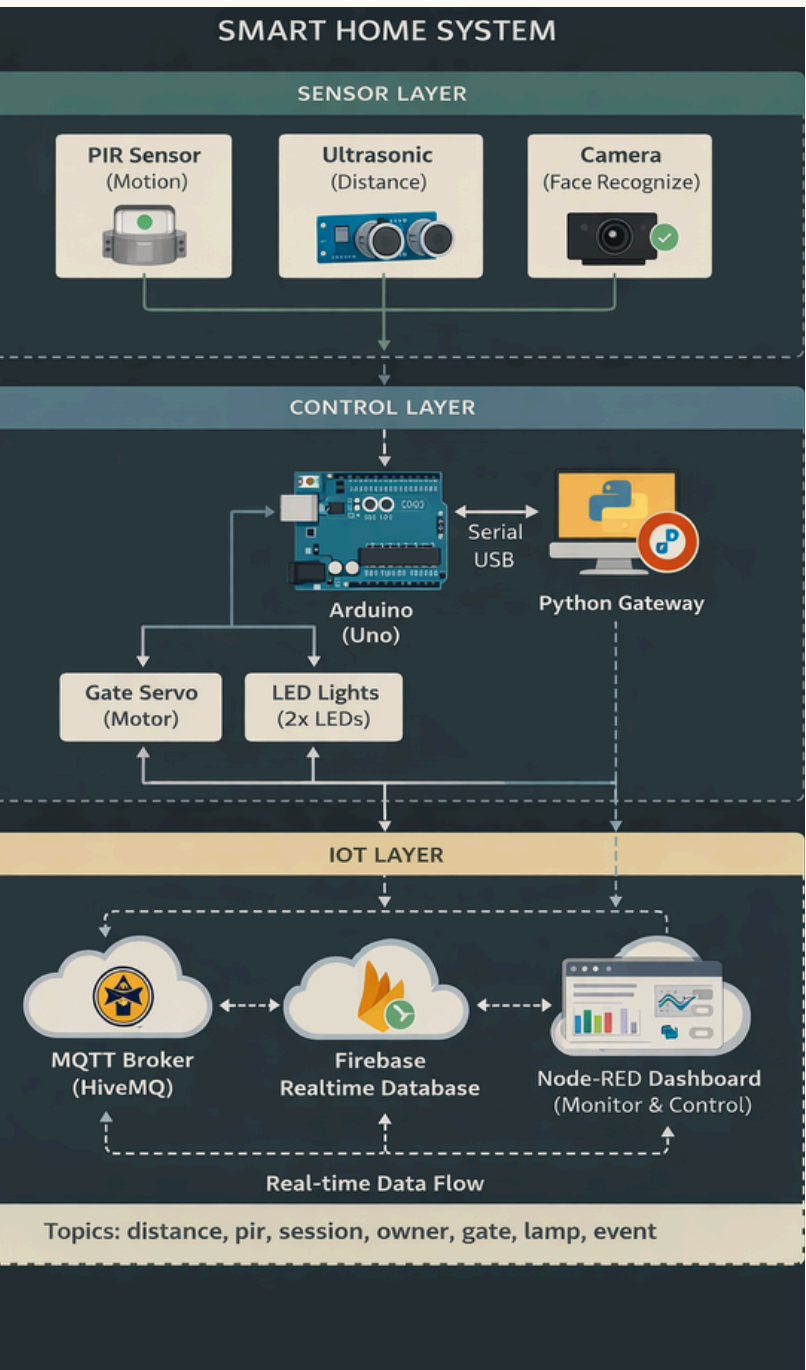
01 Problem

Manual gate and lighting control systems are inefficient and insecure, as they rely on human intervention and lack intelligent authorization mechanisms. Unauthorized access to restricted areas and unnecessary energy consumption often occur due to the absence of automated detection, real-time monitoring, and smart decision-making.

02 Objective

- To develop an automated gate access system for authorized users only
- To integrate motion, light, and camera sensors for intelligent control
- To use machine learning for owner recognition
- To enable remote monitoring and data logging using cloud services

03 Architecture



04 Hardware & Sensor Configuration

- PIR Motion Sensor: Detects human or vehicle movement and triggers the system
- Ultrasonic Sensor: Measures the distance of approaching objects to ensure accurate gate activation
- Camera: Captures images for owner recognition using machine learning
- Servo Motor: Controls the opening and closing of the gate
- LED Light: Simulates household lighting that automatically turns on when the authorized owner enters the area, improving convenience and energy efficiency.
- Microcontroller (Arduino Uno): Processes sensor data and manages communication with the cloud

05 Data Pipeline Architecture

Sensor and camera data are transmitted using the MQTT protocol. Firebase Cloud is used for real-time data storage, system status updates, access logs, and remote monitoring through a dashboard.

06 Data Flow and Sample Logs

- Motion detected by PIR sensor
- Camera is activated
- Owner recognition is performed
- Gate opens if authorized
- Lights turn on if low-light condition detected
- Events and timestamps are stored in Firebase

07 Analytics / Decision Logic

- If motion is detected → activate the camera
- If the object is close to the gate → continue verification
- If the owner is recognized → open the gate
- If the owner is not recognized → deny access
- If access is granted → turn on home lights
- If access is denied → log the event
- All system activities are updated in real time for monitoring

08 Security & Privacy Considerations

- Owner recognition is used instead of manual access
- Data transmission secured via MQTT authentication
- Access logs stored in cloud for monitoring
- Camera data is processed only for authorization purposes

09 Results and Observations

The system demonstrates reliable performance by accurately detecting motion and distance using PIR and ultrasonic sensors, which helps reduce false triggers. The camera is activated only when detection conditions are met, allowing efficient owner recognition using machine learning. Authorized users are granted access as the gate opens automatically and home lighting turns on upon entry. Communication between Arduino and the Python gateway remains stable, while MQTT enables real-time data transmission. System events are logged in Firebase and visualized through a Node-RED dashboard, resulting in improved security, faster response time, and better energy efficiency.

10 Conclusion and Future Enhancements

The smart home automation system improves security, efficiency, and convenience. Future enhancements may include mobile app integration, multi-user authorization, license plate recognition, and AI-based behavior prediction.

11 References

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