

SE4IoT - SOFTWARE ENGINEERING FOR INTERNET OF THINGS



SMART HOME AUTOMATED CONTROL AND MONITORING SYSTEM

Github Repository:

<https://github.com/Twiggiermaen21/Smart-Home-Automated-Control-And-Monitoring-System-IoT.git>

SUBMITTED TO:

**Prof. Davide Di Ruscio
Department of Information Engineering,
Computer Science and Mathematics,
University of L'Aquila**

SUBMITTED BY:

David Urban

david.urban@student.univaq.it

Kacper Pudelko

kacperhenryk.pudelko@student.univaq.it

Introduction

Smart homes represent the next leap forward in how we live, blending technology and convenience to create intelligent, interconnected living spaces. At the heart of this innovation lies the ability to automate everyday tasks, making life more efficient, secure, and comfortable.

With smart home technology, you can:

- **Automate lighting** that adjusts to your presence.
- **Control heating systems** that learn your ideal temperature.
- **Enhance security** with systems that monitor your home in real-time.

These features seamlessly respond to sensor data and your preferences, all while being managed effortlessly from your smartphone. Whether you're aiming for greater energy efficiency, enhanced safety, or a touch of futuristic convenience, smart homes offer endless possibilities to personalize your living environment and elevate your lifestyle.



Project Scope

This project focuses on developing a comprehensive IoT-enabled smart home system that integrates advanced components for lighting, heating/cooling, and security management. The aim is to deliver enhanced convenience, energy efficiency, and safety for households while leveraging real-time monitoring, control, and automation.

Objective

- Develop and deploy an IoT-based smart home system that integrates lighting, heating/cooling, and security functionalities, ensuring a safe, energy-efficient, and comfortable living environment.
 - Provide a user-friendly platform for homeowners to monitor and control their smart home systems remotely.
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Project Deliverables

1. Smart Lighting System

IoT Sensors:

- Install motion sensors, dusk sensors, presence sensors, and light intensity sensors to automate lighting based on occupancy and environmental conditions.

Smart Light Sources and Controllers:

- Deploy smart bulbs for customizable brightness, color, and temperature.
- Install LED strips for targeted lighting (e.g., cabinets, ceilings, and stairs).
- Implement smart switches and dimmers for easy manual or remote control.

Real-Time Monitoring and Automation:

- Enable automated lighting based on presence detection, daylight availability, or pre-set schedules.

2. Heating and Cooling System

Smart Thermostats:

- Integrate smart thermostats for remote control, temperature scheduling, and energy usage reports.
- Include geofencing to adjust climate settings based on user proximity.

Environmental Sensors:

- Deploy temperature sensors, humidity sensors, and air quality sensors to monitor and maintain indoor comfort.
- Utilize motion sensors for zone-specific heating/cooling.

Smart Heating Components:

- Install smart radiator valves for individual room control.

- Integrate underfloor heating and heat pumps with thermostat systems for efficient temperature regulation.

Smart Cooling Components:

- Include smart air conditioners, ductless mini-split systems, and ceiling fans with automated settings.

3. Smart Security System

Smart Cameras:

- Deploy indoor and outdoor cameras equipped with features like motion detection, night vision, two-way audio, and weatherproofing.
- Integrate cameras with sirens and spotlights for enhanced security.

Smart Locks:

- Provide keyless entry using PIN codes, smartphone apps, or biometric authentication.
- Enable remote lock/unlock functionality for added convenience.

Security Sensors:

- Install window/door sensors, motion sensors, and glass break sensors for intrusion detection.
- Use smoke, carbon monoxide, and flood sensors to ensure safety from environmental hazards.

Alarms and Sirens:

- Deploy standalone sirens with configurable alerts and automated activation based on sensor inputs.

Smart Blinds and Curtains:

- Automate blinds to enhance privacy and security by blocking visibility during specific times or when the house is unoccupied.

Features and Functionalities

Centralized Dashboard:

- Develop a dashboard for homeowners to monitor and control lighting, heating/cooling, and security systems in real time.
- Provide data insights and trends for energy optimization and security monitoring.

Automated Alerts and Notifications:

- Configure alerts for abnormal temperature, air quality, intrusions, or safety risks.
- Send real-time notifications to mobile devices for immediate action.

Remote Control and Integration:

- Enable remote management of systems via mobile apps or voice assistants (e.g., Amazon Alexa, Google Assistant, Apple Siri).

Energy Optimization:

- Use data from sensors to optimize energy consumption by automating heating/cooling and lighting based on occupancy and environmental conditions.
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Exclusions

- Maintenance of Infrastructure: The project excludes maintenance or repairs of physical infrastructure, such as pipelines, HVAC systems, or building structures.
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Potential Use Cases

Scenario 1: Evening Automation

- Lights turn on automatically at dusk and adjust brightness based on room occupancy.
- Heating adjusts to maintain a comfortable temperature based on the user's geofenced location.

Scenario 2: Vacation Mode

- Smart locks and sensors ensure the home is secure.
- Lights and blinds simulate occupancy for added security.

Scenario 3: Emergency Alerts

- Smoke detectors alert the homeowner and trigger safety protocols (e.g., unlock doors, turn on lights).
 - Cameras stream live footage to assist in monitoring the situation.
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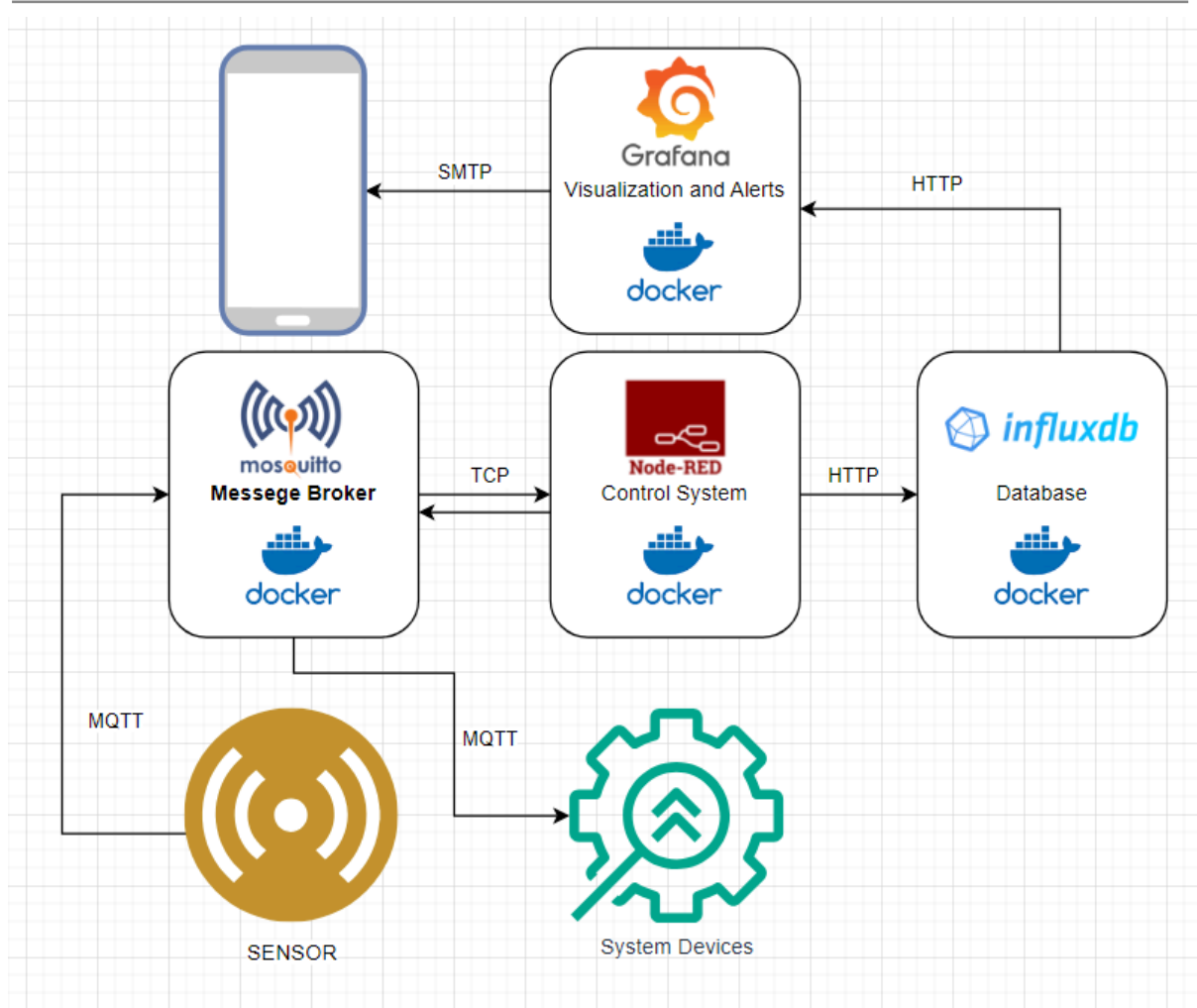
Success Metrics

- Energy Efficiency: Reduction in energy bills due to optimized lighting and HVAC usage.
- Response Time: Time taken for alerts and automated responses during

- security or safety events.
- User Satisfaction: Positive feedback from homeowners regarding system usability and reliability.

ARCHITECTURE SYSTEM

The diagram below shows our IoT Smart Home Automated Control And Monitoring System.



Components of the Smart Home System

Smart Lighting System

1. Sensors:

- Motion Sensors: Automatically turn lights on when motion is detected.

- Dusk Sensors: Adjust light activation based on natural daylight levels.
- Presence Sensors: Detect presence in a room for more advanced automation.
- Light Sensors: Measure light intensity in the environment for optimal brightness.

2. Controllers and Light Sources:

- Smart Bulbs: e.g., Philips Hue, IKEA TRÅDFRI, Xiaomi Yeelight, capable of changing color, brightness, and color temperature.
- LED Strips: Provide accent lighting for cabinets, ceilings, stairs, and other spaces.
- Smart Lamps: Lamps with built-in smart functionalities.
- Smart Switches and Dimmers: Replace traditional switches for enhanced control and dimming capabilities.

Heating and Cooling System

1. Smart Thermostats

- Allow remote control of heating and cooling systems.
- Advanced features:
 - Temperature Scheduling
 - Learning Algorithms
 - Geofencing
 - Energy Reports

2. Sensors

- Temperature Sensors: Measure room temperature for precise zone control.
- Humidity Sensors: Monitor and maintain humidity levels to prevent mold.
- Motion Sensors: Adjust heating/cooling based on room occupancy.
- Air Quality Sensors: Detect CO2, VOCs, and particulate matter, triggering ventilation or purification.

3. Heating Components

- Smart Radiator Valves: Individual control of radiators for zoned heating.
- Underfloor Heating Systems: Integrated with smart thermostats for precise heating.
- Smart Boilers: Remote monitoring and scheduling of water/space heating.
- Heat Pumps: Energy-efficient systems for heating and cooling, controlled by smart thermostats.

4. Cooling Components

- Smart Air Conditioners: Mobile app or voice-command control (e.g., Midea, LG ThinQ).
- Ductless Mini-Split Systems: Zoned cooling systems with smart integration.

- Ceiling Fans with Smart Controls: Automatically adjust fan speed or direction.
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Smart Security System

1. Smart Cameras

- Indoor Cameras: Monitor interiors with motion detection, two-way audio, and night vision.
- Outdoor Cameras: Weatherproof with wide-angle lenses, motion detection, spotlights, and sirens (e.g., Arlo, Ring, Blink).

2. Smart Locks

- Keyless Entry: Unlock doors using apps, PIN codes, or biometric verification (e.g., fingerprint, facial recognition).
- Remote Access: Lock/unlock doors via mobile app.

3. Window and Door Sensors

- Detect when windows or doors are opened or closed, sending real-time alerts.

4. Motion Sensors

- Indoor: Trigger alarms or activate cameras when movement is detected.
- Outdoor: Paired with floodlights or cameras to deter intruders.

5. Smart Alarms and Sirens

- Standalone Sirens: Loud alarms activated by sensors.
- Custom Alerts: Configurable tones and mobile notifications.

6. Glass Break Sensors

- Detect sound frequencies associated with breaking glass, alerting you to intrusions.

7. Smoke, Carbon Monoxide, and Flood Sensors

- Smoke Detectors: Notify you of fires, capable of distinguishing between smoke and steam (e.g., Nest Protect).
- CO Detectors: Monitor carbon monoxide levels and send alerts.
- Water Leak Sensors: Detect leaks or floods and notify immediately.

8. Smart Blinds and Curtains

- Automate to enhance privacy by blocking outside views at night or during absence.

Software

1. Database Management

- Purpose: To store and manage data collected from sensors, devices, and user inputs.
 - Responsibilities:
 - Collecting sensor data (e.g., temperature, humidity, motion) for historical analysis.
 - Storing user preferences, schedules, and system configurations.
 - Maintaining event logs for security-related activities (e.g., door openings, motion detection).
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2. Visualization Dashboard

- Purpose: To provide users with tools to monitor, control, and configure smart home systems.
 - Responsibilities:
 - Displaying real-time data, such as temperature, light levels, or energy usage.
 - Allowing users to adjust settings (e.g., light brightness, thermostat temperature, security alarms).
 - Visualizing trends and analytics, such as energy consumption patterns or air quality over time.
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3. Data Processing

- Purpose: To analyze raw data from sensors and generate actionable insights or automated actions.
 - Responsibilities:
 - Real-time data processing (e.g., motion detection, temperature thresholds).
 - Applying algorithms to learn user habits (e.g., optimal temperature or lighting patterns).
 - Predicting conditions based on historical data, such as detecting anomalies in security.
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4. Control Software

- Purpose: To send commands to smart devices in response to user actions, schedules, or automated triggers.
- Responsibilities:

- Communicating with IoT devices using protocols like Zigbee, Z-Wave, MQTT, or HTTP REST API.
 - Ensuring commands are executed correctly (e.g., turning on lights, adjusting temperature).
 - Managing fallback mechanisms in case of device communication issues.
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5. Notification and Alert System

- Purpose: To inform users about significant events or anomalies in the smart home.
 - Responsibilities:
 - Sending alerts for security threats (e.g., door/window opening).
 - Warning about risks (e.g., smoke detection, high CO levels, water leaks).
 - Providing routine updates (e.g., maintenance reminders, energy-saving tips).
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Functional Requirements

1. Data Collection:
IoT sensors monitor various environmental parameters and system states, such as room temperature, motion, light intensity, and air quality.
 2. Data Transmission:
Sensor data is transmitted to a central hub or cloud platform using IoT communication protocols like Zigbee, Z-Wave, Wi-Fi, or Bluetooth.
 3. Data Processing:
A middleware processes the data to enable automation, such as adjusting heating based on occupancy or dimming lights according to ambient brightness.
 4. Notifications:
Alerts and notifications are sent to homeowners for events such as security breaches, fire alarms, or abnormal temperature or humidity levels.
 5. Visualization:
A comprehensive dashboard allows users to view real-time and historical data about lighting, heating, cooling, and security systems, with options for trend analysis and usage insights.
 6. Control Signals:
Commands are sent from the system to devices such as smart thermostats, cameras, locks, or lights to execute automated actions or user-defined instructions.
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Non-Functional Requirements

1. Performance:
The system must ensure near-instant response for critical functions like security alerts and lighting control, with latency below 1 second for key operations.
2. Scalability:
Capable of integrating multiple devices and sensors across large homes or commercial properties, with support for additional components as needed.
3. Reliability:
The system is built to be highly dependable, ensuring smooth operation almost all the time. Backup mechanisms are included to maintain functionality during power or network interruptions, providing continuous and reliable performance.
4. Security:
Ensure strong encryption and secure communication between devices and the platform to prevent unauthorized access or data breaches.
5. Energy Efficiency:
Use low-power IoT devices and optimize automation algorithms to reduce energy consumption and extend battery life.
6. User-Friendly Design:
Provide intuitive interfaces on mobile apps and dashboards, ensuring accessibility for users of varying technical proficiency.
7. Compliance:
Adhere to local and international safety and security standards for home automation systems.

REFERENCES

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2. <https://www.customcontrols.co.uk/blog/benefits-smart-home-system/>