

Project Proposal: Microcontroller & Interfacing

Wireless Home Automation System

BSCE22 | Spring 2024 | Department of Computer & Software Engineering

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# Introduction and Brief

In this project, we aim to develop an innovative home automation system utilizing STM32 Black Pill along with ESP01 Wi-Fi to serial adapter, MQTT protocol and Home Assistant. The system will also use various other sensors, relays and actuators. The system will primarily focus on enhancing comfort and security by integrating various sensors and actuators. The system will consist of three devices and a server running EMQX as the MQTT broker and Home Assistant as the home automation platform. The system will also be able to connect to the internet and receive alerts on phone and trigger commands. Leveraging the proposed idea, the project aims to seamlessly blend comfort and security, offering occupants a heightened level of convenience and peace of mind.

# Scope of Project

The scope of this home automation project encompasses the design, development, and implementation of a wireless system utilizing STM32 microcontrollers and MQTT protocol. The primary focus of the project is to create an intelligent environment that enhances comfort, convenience, and security within a residential setting. The project will consist of three devices , each tasked with a different operations.

The **first device** is a versatile device that will be responsible majorly for **sensing** various parameters in a room or house and will include a dedicated humidity and temperature sensor as well as an optional presence sensor. STM microprocessor will detect these parameters and send the values to MQTT broker using its own ESP Wi-Fi to serial adapter from there these values will be picked up by Home Assistant and appropriate tasks will be done. Additionally, to bolster security measures, the system optionally will deploy sensors to detect open doors or windows when armed, triggering alarms for immediate attention. Using presence/motion detection, any unauthorized attempt to access the property/room will also be detected through this comprehensive approach.

The **second device** will be responsible for ensuring optimal comfort conditions and the set conditions in Home Assistant are met. This device will consist of **relay and switches** to control various objects such as fans, lights or even Air Conditioning. This device will also have its own Wi-Fi adapter and will receive commands from home assistant to turn on or off its relays. This device can also activate both audible alarms and lighting alerts, fortifying the home's defense mechanism.

The **third device** is a **smart bell** that will enable the synchronization of house lights with doorbell activity as well as provide data about whether a door is open or closed, enhancing both convenience and visual alertness. Furthermore, it may also have the option of locking or unlocking the door/gate.

# Implementation & Sequence

1. **Implementation of Humidity and temperature-based Fan/AC Control:** Utilizing humidity and temperature sensor we aim to automatically turn on/off fan/air conditioning.
2. **Integration of Smart Bell System:** Traditional bell system only works if a person is already present at the house but if the house is empty and someone visits, there is no way of knowing what happened. Therefore, when the bell is pressed, we want to notify the user and optionally be able to open the door to allow access to the house. Also, in another possible scenario, we want the house to be locked as soon as we leave the house and the security system to be armed.
3. **Door and windows Status Monitoring:** Incorporating sensors to detect open doors and activate alarms for security purposes. This will be handled by the bell as well as the sensing device to detect if the window/door is open or not, to detect forced entry.
4. **Motion Detection using presence sensor for Unauthorized Access and control:** Utilizing motion detectors to trigger alarms and raise alarms if unauthorized access is attempted. Also, turning off lights if no motion is detected in a room to save electricity.

# General Block Diagram

# Distribution of Tasks

Each member will work on creating one device each.

M. Waleed Hussain -> Sensing Device

Ariba Mumtaz -> Relay and Control Board

Rameeza Rahim -> Smart Bell

# Methodology

## Hardware Setup

Selection and configuration of STM32 microcontrollers and requisite sensors and actuators will be used as well as a serial to Wi-Fi adapter will be used in each device to connect to wifi.

### Tentative list of Hardware:

|  |  |
| --- | --- |
| Item | Quantity |
| STM32 Black Pill | 3 |
| ESP01 | 3 |
| DHT22 or BME680 | 1 |
| 2 wire NO NC Magnetic Reed Sensor | 2 |
| 4 channel Relay Board | 1 |
| Rechargeable Batteries | 3 |
| Push Button | 1 |
| LEDS | As desired |
| Motion or Microwave radar sensor | 1 |
|  |  |

Apart from this list, some example items such as a table lamp or small fan may be shown to display actuation at the time of presentation.

## Software Development

Code for each of the STM32 boards will be developed in collaboration. The objective is to be able to send data over Wi-Fi using mqtt protocol as well as use all of the available GPIO of the board efficiently and effectively.

## System Integration

Each device will be integrated in Home Assistant using EMQX as the MQTT broker. Each device will be able to communicate bidirectionally through EMQX. Server running EMQX and home assistant is pre-deployed using docker on an independent server by one of our group members, hence deployment of these is not a cause for concern in this project. This project focuses on utilizing STM32 platform to the best of its ability.

## User Interface Design

User interface and mobile app of Home Assistant will be used as user interface for human interaction. Therefore, no separate interface display need to be developed.

# Resource links for reference

1. <https://www.emqx.io/> (EMQX)
2. <https://www.home-assistant.io/> (Home Assistant)
3. <https://www.instructables.com/Getting-Started-With-the-ESP8266-ESP-01/> (getting started with esp01)
4. <https://www.microchip.ua/wireless/esp01.pdf> (ESP01 Datasheet)
5. <https://www.mouser.com/pdfDocs/ProductOverview_DFRobot-DFRobot-STM32F411-BlackPill-Development-Board.pdf> (STM32 Black Pill Datasheet)