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Scion IoT Smart Home – Smart Smoke Detector

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*Abstract*- Internet of things is an evolutionary idea which connects different physical things to the internet. It has huge business opportunity in the regards of home automation, as we become more automated on every other sector. It would be essential for our future to adapt IoT in to the building sector. When considering our homes, providing the household equipment’s the ability to communicate each other, will make it more secure and smarter. Through this project our goal is to design a smart device for smoke detection at home. A smoke detector makes use of different sensors in order to detect a smoke. We have a Raspberry pi with scion server installed on it as a central controlling device, also we have used an ESP module for establishing the communication between the smoke detector and Raspberry Pi. According to the data received from the smoke detector the ESP module will determine whether it is a test alarm or a genuine one, and the whole setup will be constantly in communication with other smart devices and will be monitored by a controlled local machine.

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# INTRODUCTION

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he project objective is to develop a smarter smoke detector by enhancing a conventional photo electric smoke detector available in the market. The normal smoke detectors don’t have the functionality to instantly inform you about the danger if you are not at the specific place. So, in a smart home environment our task is to identify whether the detector is indicating the actual smoke or a simple test alarm and also to inform about the situation to the customer instantly. The project has two ends, one server end which has the Raspberry Pi and on other end, an ESP 8266 module is attached to the smoke detector. The ESP 8266 module is Wi-Fi based low-cost microchip, which is used to avoid the wired connection between the Raspberry Pi and the Smoke detector. The ESP 8266 module will transmit the data received from smoke detector to the Raspberry Pi through the Wi-Fi. Additionally, the ESP 8266 and the smoke detector would made in to a single compact product “Smart Smoke Detector”, so it would be more beneficial for the households to use the developed system instead of conventional smoke detectors. Moreover, a Graphical User Interface (GUI) using Node-Red (a Flow based GUI tool) is developed to visualize the readings from the smoke detector.

# Literature Survey

In the scope of this project, the initial goal is to gain enough knowledge about the working of smoke detectors and Microchip modules. The smoke detector used in this project is a normal photo electric smoke detector. These detectors make use of light to detect the fire. Inside the detector, there is a light-sensing chamber. In this chamber, a LED projects light in a straight line, when smoke enters this chamber it cuts the LED straight line inside the chamber which rings the alarm. The whole process is controlled by an IC- MC 146010.

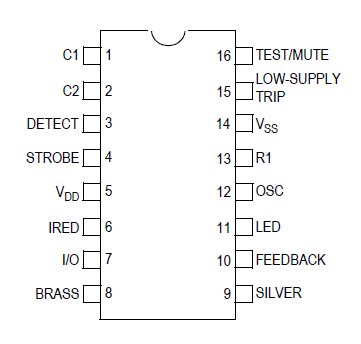


Figure 1. Pin Diagram of MC 146010

The MC 146010 IC has 16 pins, each one has its own purpose. For this project, the I/O pin is read continuously to ensure whether a smoke is detected or not. When a smoke is detected or tested the I/O pin gives a high output signal.

The ESP8266 is used for the communication part, which is a cheap Wi-Fi based microchip. The ESP 8266 has two mode of operations -Station and Access Point modes, where Access point mode allows the ESP to create its own network and on the other hand the station mode allows the ESP to connect to a Wi-Fi network.

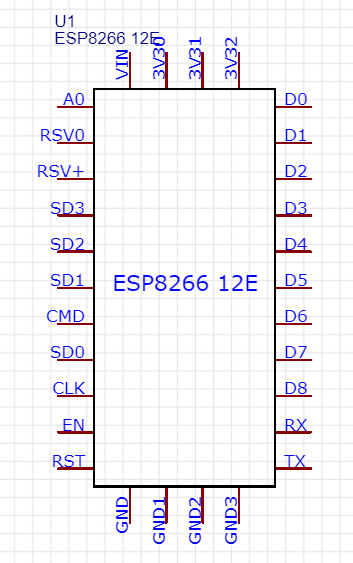


Figure 2. Pinout of ESP 8266

The ESP 8266 uses Wi-Fi for the data transmission, which is highly power consuming in order to tackle with this issue the IC provides different sleeping modes

## Modem Sleep

Modem sleep mode is enabled only when the ESP is setup in Station mode. While in modem sleep mode the ESP will disable the modem with maintaining a Wi-Fi connection. The ESP stays connected to modem through DTIM beacon mechanism. The usual DTIM beacon interval of the modem is 100ms to 1000ms. The modem sleep is usually used in applications where the CPU powered on.

## Light Sleep

The light sleep mode is very similar to the modem sleep mode, the difference is that the ESP will also power off clock and suspends the internal CPU in order to reduce the power consumption in modem sleep mode.

## Deep Sleep

In deep sleep mode the system will turn off everything the only working module would be RTC (Real Time Clock). The deep sleep mode can be activated by connecting the RST pin to D0 pin.

# Circuit Design

This chapter discuss in detail about the project’s circuit design.

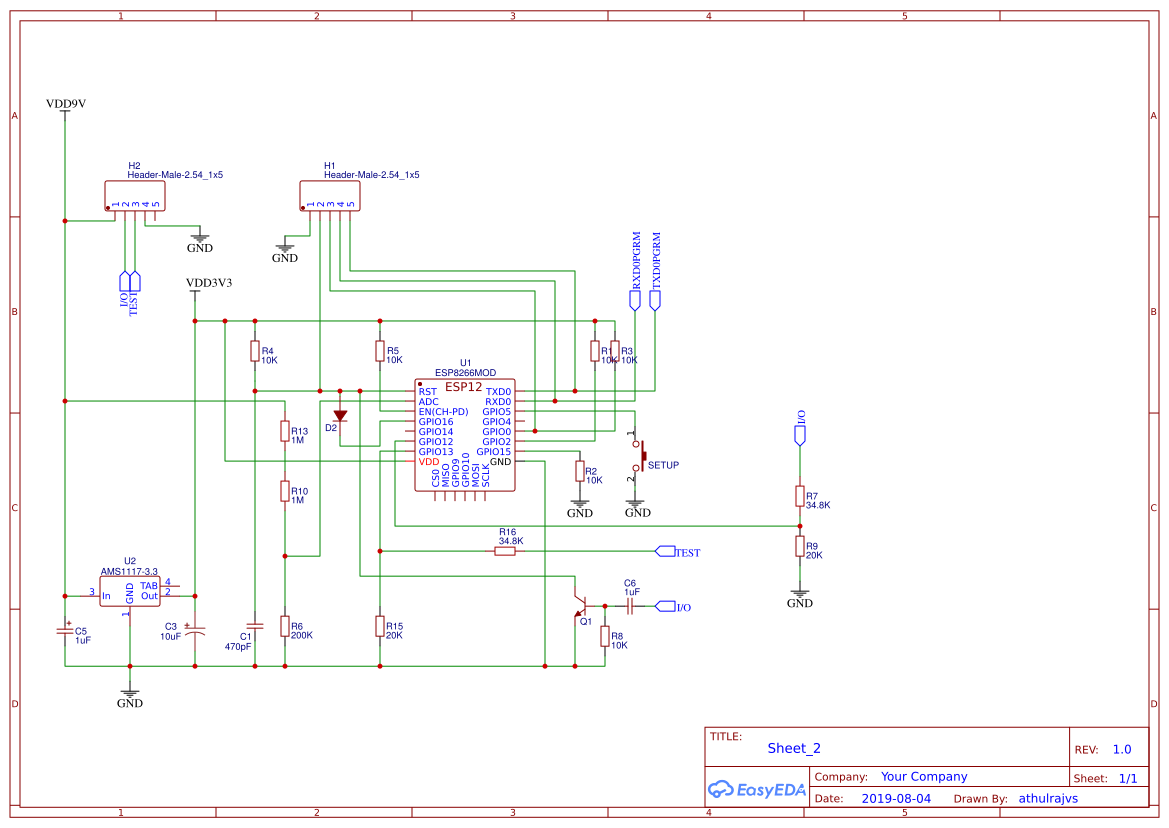


Figure 3. Circuit Diagram

This circuit design can be divided into three integral parts.

## The Circuit setup for Deep Sleep mode

According to the power concerns, deep sleep mode would be the most applicable mode for this project. The deep sleep mode can be achieved by connecting the RST pin to D0 pin. If the ESP 8266 is in deep sleep mode, the D0 pin could not use for any other purposes.

## The circuit setup to get reading from smoke detector

The I/O pin from smoke detector IC is connected to the GPIO 12.

# PCB Design

This chapter discusses about the PCB design.

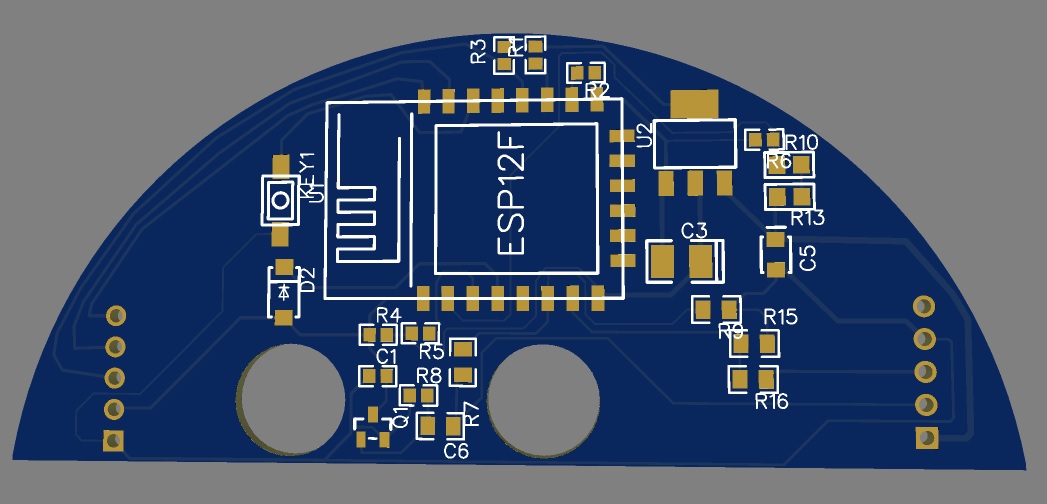


Figure 4. PCB Design

# Wi-Fi Manager

The ESP 8266 has two modes of operations- Station mode and Access Point mode. Initially, when the ESP 8266 is starts up it is configured in Station mode and tries to connect to a Wi-Fi network which is previously saved in ESP 8266. If the ESP8266 is brought up into a new Wi-Fi network, it won’t be connected to the new network. Then it should be made configured in to Access Point mode, so the ESP 8266 will open up a DNS and a webserver. The ESP 8266 then can be connected to the new network by using a Wi-Fi enabled device.

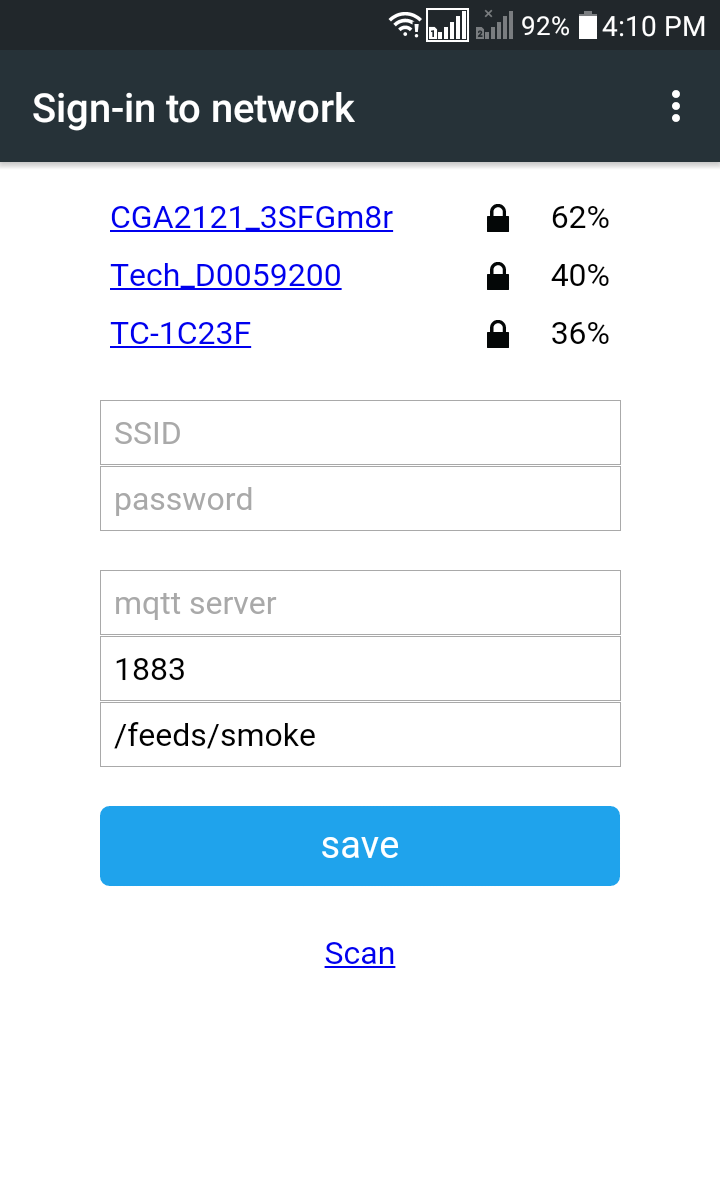
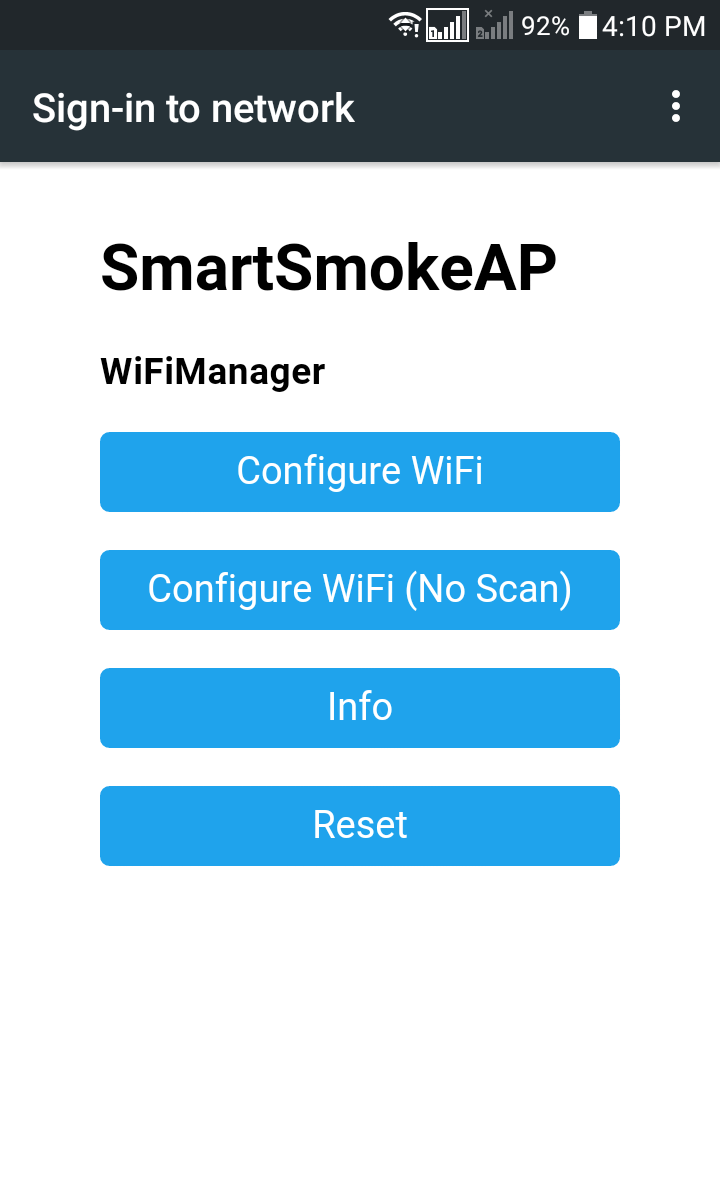


Figure 5. Wi-Fi Configuration

Once the ESP 8266 is connected to a network the credentials would be saved in to the ESP 8266 EPROM. If the module again comes under the same network, it would connect automatically through Station mode of operation.

# Battery Performance Calculation

In this projects scopes, making the whole system in to a stand-alone product had great importance. For that the same battery used in the smoke detector should be use to power the ESP 8266. This has a great concern; the Wi-Fi communication would make the battery to drain quickly. Making the ESP8266 to work on deep sleep mode will reduce the battery drainage and reducing the data transmission would also be beneficial. The ESP will send the data only when there is a smoke is detected or when the smoke is tested. It would also check the battery percentage once in day. According to these operations, the battery consumption for this project could be calculated.

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# Code Logic

## The ESP8266 is using the MQTT protocol for the data transmission. So, for the interaction between the Raspberry and the ESP 8266 a MQTT broker/client environment must be setup. The raspberry would be programmed as a MQTT broker. In MQTT protocol the main important participates are Publishers and Subscribers, a broker can act as both Publisher and Subscriber. In this project the ESP 8266 is assigned as a Publisher which will publish a topic and the Raspberry pi as subscriber which would be subscribed in to that topic.

# Node-Red Flow

Node-Red, a flow-based GUI tools based on JavaScript is used to visualize the data received from Smoke Detector. The GUI is developed in a local machine ´which would be useful for the user get information about the current situation.

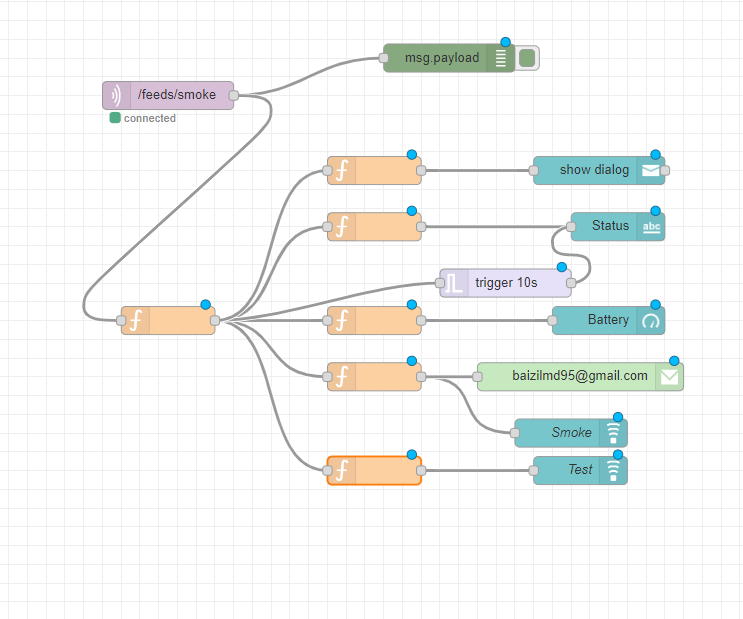
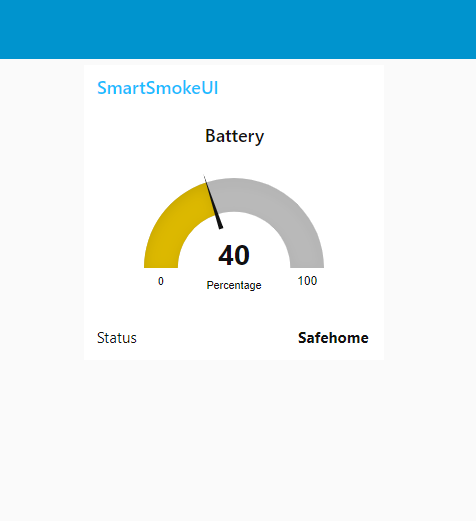
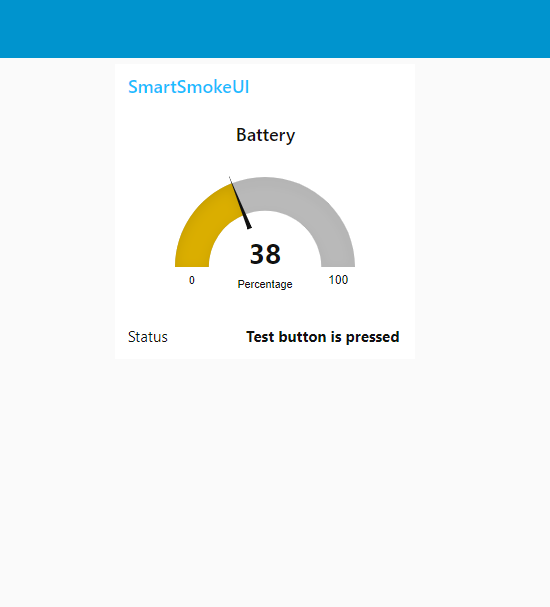


Figure 6. Node-Red Flow

The data from the smoke detector is received through a MQTT- in node. Which is then separated according to the data, each message is displayed in the dashboard. The battery percentage is displayed using a gauge node. When the detector detects smoke, an immediate warning is displayed in the GUI using a notification node along that an Email is sent in to the users mail id through mail node in the node red.

# Conclusion and further works

Appendix

Appendixes, if needed, appear before the acknowledgment.

References

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Mr. Author’s awards and honors include the Frew Fellowship (Australian Academy of Science), the I. I. Rabi Prize (APS), the European Frequency and Time Forum Award, the Carl Zeiss Research Award, the William F. Meggers Award and the Adolph Lomb Medal (OSA).

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