IoT based Kitchen Monitoring and Control System

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ABSTRACT
The evolution of humans has witnessed a tremendous surge in recent years with the help of high end technologies put into proper use. There has been a huge dependency on technology and the internet for almost everything and it would not be an exaggeration to say that there are systems to automate and monitor every aspect of our life today. A kitchen is a crucial place for any household and dicey one at that. In recent times, many accidents have been witnessed due to improper handling and utilization of kitchen appliances. The objective of proposed work is to develop a kitchen monitoring system that aims at identifying and addressing gas leakage, uncontrollable fire, excessive temperatures to prevent potential hazards and mishaps. A part of this system's objectives to also be able to monitor other kitchen appliances like ovens, lights and refrigerators remotely. In the proposed work, a NodeMCU ESP8266 Module and multiple sensors as per need have been used for the implementation. The sensor data is monitored using ESP-Dash Application. It is also possible tosend commands from the dashboard to control kitchen appliances. Through this work, the aim is to achieve a well-developed system that is capable of detecting gas leakage, fire accidents and intimates the user using the cloud for prevention. The subsequent implementation of this model has led to the results whereby temperature, air quality and gas leakage have been monitored and controlled using ESP32 Microcontroller and the results are displayed on the designed dashboard.

Keywords
Kitchen Monitoring, IoT, ESP32, User-interactive dashboard, ESP-Dash

1. INTRODUCTION
Nowadays, there is a huge meaning connoted with the term 'Smart home technology'. People have evolved so much that everything has been digitized to a greater extent. In layman terms, a smart phone is the one that is embedded with sensors, actuators and systems enabling information andcommunication management which in turn enables remote control. This new agetechnology claims to enhance the quality of living and it hassignificantly been able to do that for quite some time now. It provides the user with the flexibility to control not just small electronic appliances but appliances like refrigerators, air conditioners, televisions also fall under this paradigm. With the advent of smartphones, life has been simplified furthermore. It is now possible to monitor these appliances remotely using smartphones i.e. their statuses are under constant surveillance. This also saves electricity to a large extent.

These systems operate using sensors as already mentioned and sensor readings conspicuously give out a lot of information pertaining to the user's habits. For example, in a kitchen monitoring system, using the sensors it is possible to detect the gas leakage, if any. Further innovation is also plausible by using motion sensors to check if there is a person in the kitchen while the appliances are being operated.

One of the most important aspects of life is food and to produce eatable food every day we need a proper functioning kitchen. Those were the days when only the elderly were subjected to the risks that come along with the food preparationprocess in a kitchen. Nowadays, even kids are under the same if not more risk. As science enthusiasts, it becomes a necessity for us to ensure the safety of everybody that gets involved in this basic activity of life, namely cooking. Given the amount of technological growth that this world has witnessed, it is not wrong to say nothing is impossible to come up with. Even the fusion of great technologies is possible these days. Hence, the development of a system with suitable sensors to monitor the precarious aspects of the kitchen now and then becomes vital.

But the job does not stop only with the detection of a mishap. There has to be a technology with which users can be intimated and accidents can be prevented from occurring. This is where the role of IoT comes into play. The ESP32 is a very efficient System used as a general purpose microcontroller that comes along with some peripherals including Wi-Fi andwireless Bluetooth capabilities. Sensors are connected to ESP32 microcontroller and collected information is transferred to ESP-dash board using Wi-Fi. ESP-Dash application will display them and if thereis an alarming situation, say a gas leakage, the user will clearly be able to notice the status on thedashboard and can remotely turn off the gas knob in the kitchen via the dashboard.

The proposed work mainly focuses on developing a prototype using ESP32 Wi-Fi module and ESP - DASH to ensure kitchen safety in the easiest way possible. The gas leakage and temperature are constantly monitored and the users are intimated about the status continuously via the web server. This prevents the occurrence of accidents due to gas leakage and fire. In addition to this, even other kitchen appliances like refrigerators and ovens can be monitored by connecting them to the relay and the status will again be displayed using ESP-DASH. In this way, kitchens can be automated and monitored holistically.

2. RELATED WORKS
The main advantage of using an automated system is to facilitate user communication through a network (Internet). Not only does it make communication easier, but it also decreases human intervention and manages the tasks singlehandedly. The following are few of the works that are based on this field of automation combined with the Internet of Things (IoT):

Kumar Keshamoniet al [1] proposed the Smart Gas Level Monitoring, Booking & Gas Leakage Detector over IoT where the gas booking/order is done with the help of IoT and the continuous weight measurement is done using a load cell which is interfaced with a Microcontroller. For ease it has even been added with an RF TX & Rx module which is bound to give the same information. When it comes to the security of the kit/the gas container. An MQ-2 gas sensor, LM 35 temperature sensor, which detects the surrounding environment for any chance of error. Whenever the sensors are subjected to any change, a siren (60db) is triggered.

Suwardjono et al [2] proposed the Design of a Home Fire Detection System Using Arduino and SMS Gateway which aims to build a prototype system that quickly helps house owners and firefighters to detect fires and gas leaks. This home fire detection system is utilized to measure room temperature and gas levels in a room, and then the output of this system is sending information of short messages and alarms. The results revealed that the prototype room with a scale of 1:25, 1:50, and 1:75 which uses a temperature sensor and a gas sensor could run as desired. In 10 testing trials, the system works according to the designed plan, which means the system could interpret the temperature and gas leakage of a room, then the system will send a short message and ring the alarm.

Chandramohan et al [3] proposed the intelligent operation for lamps and fans. Here the system is connected with temperature control and lamp control. Light dependent resistor (LDR) and Temperature sensor (LM35) are the main components for this automatic control of lamps and fans. In this work, the LDR is responsible for lamp control and LM35 is responsible for controlling the operation of the fan. The proposed home energy control system designs intelligent services for users and provides comfort. The system proposed in this work [1] is implemented with smartphones.

Pavithra.D et al [4] proposed an efficient implementation for IoT (Internet of Things) used for monitoring and controlling home appliances via the World Wide Web. This work aims at controlling home appliances via Smartphone using Wi-Fi as communication protocol and raspberry pi as server system. The user here moves directly with the system through a web-based interface over the web, whereas home appliances like lights, fan and door lock are remotely controlled through easy websites. The server is interfaced with relay hardware circuits that control the appliances running at home. The communication with the server allows the user to select the appropriate device. The communication with the server permits the user to pick out the acceptable device. The server communicates with the corresponding relays. If the web affiliation is down or the server is not up, the embedded system board still will manage and operate the appliances domestically. The proposed concept is extremely clichéd and lacks sound design principles.

Poongothaiet al [5] proposed the Implementation of IoT based Smart Laboratory which aims to develop a smart laboratory system in CIT campus based on IoT and mobile application technologies that operates in an intelligent manner. This provides a platform that allows devices to be connected, sensed and controlled remotely across a network infrastructure.

3. PROPOSED MODEL

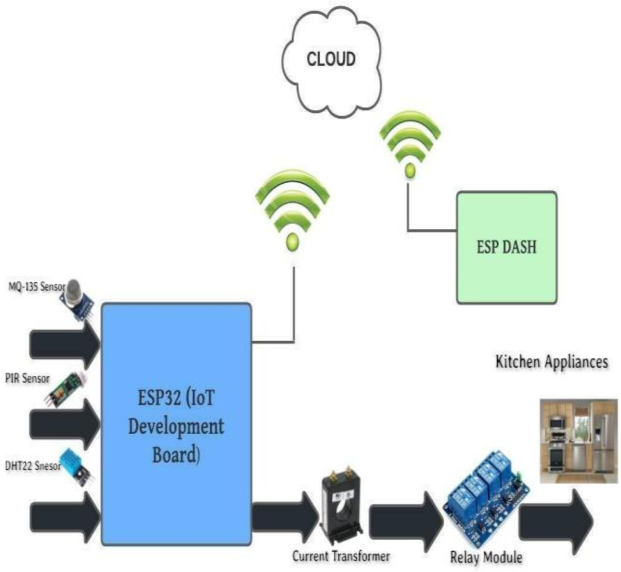

Figure 1: Block diagram of the proposed model

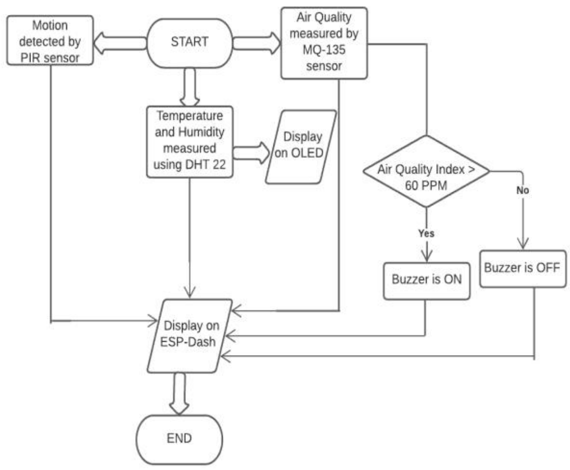

Figure 2: Flow Diagram

Figure 1 shows the block diagram of the proposed system. This system aims at automation and constant monitoring of the kitchen appliances using different sensors like temperature and humidity sensor(DHT22), MQ-3 sensor, PIR Motion Sensor. The sensors are all connected to the NodeMCU board and the sensor readings are displayed both on the LED and ESP Dash Web server. A buzzer is used as an alarm to monitor gas level, i.e. when the level is exceeded the buzzer acts as an alarm and intimates the user.

The room temperature and humidity level are sensed using the DHT22 sensor. It consists of an IC, a component to sense humidity and a thermistor. The component to sense humidity has two electrodes. When the humidity level changes, the resistivity or the conductivity between these two electrodes changes which is then processed by an IC and sent to NodeMCU to be read. A thermistor is used to measure the temperature.

The air quality inside the room is monitored using MQ-135 sensor.The air quality sensor has two outputs: analog output and TTL output. The TTL output can be accessed through the IO ports on ESP8266. The analog output is nothing but a concentration, i.e. increasing voltage is directly proportional to increasing concentration.

The motion of objects is detected using PIR Sensor (via infrared rays). It detects infrared radiation from the environment. Once there is infrared radiation from the human body particle with temperature, it causes the pyroelectric device to generate a sudden electrical signal.

These sensor data are processed by the ESP8266 Wi-Fi module after which the temperature, humidity and air pressure are displayed on the OLED module.

Meanwhile, ESP8266 Wi-Fi chip is used in Soft AP Mode and therefore internet or Wi-Fi is not required separately to monitor and control the appliances. After processing all the data, the temperature, air quality and humidity will be displayed graphically on ESP-Dash. It will also show whether the buzzer is turned ON or OFF along with the information as to whether there is anybody present inside the room or not.

3.1 Hardware Setup

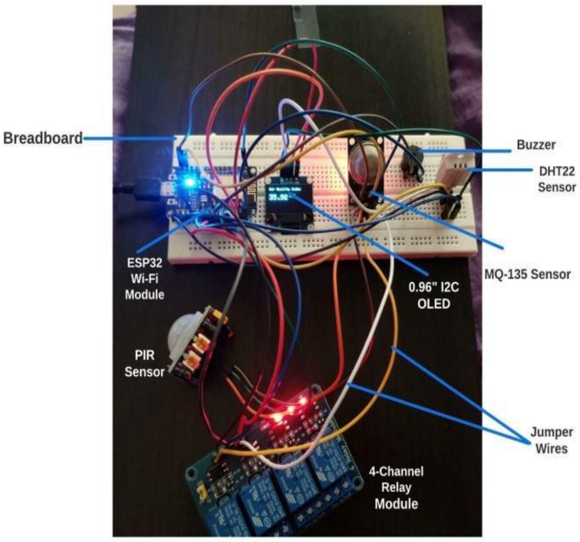

Figure 3: Hardware Setup of the Proposed Model

ESP8266 Wi-Fi Module:

It is a low cost device which can be used to provide internet. It can act as a hotspot and at the same time can connect to Wi-Fi, hence it can easily fetch data and upload it to the internet. It can also fetch data from the internet using API's hence accessing any information that is available on the internet is possible.

DHT22 (Temperature and Humidity Sensor):

It is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and gives out a digital signal on the data pin.

MQ-135 Sensor:

It is used in air quality control equipment and is suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2. It has both digital and analog data pins. Here, air quality is measured in PPM and hence an analog pin is used. The analog pin is TTL driven and works on 5V and so can be used with most common microcontrollers.

Passive Infrared Sensor:

It uses a pair of pyroelectric sensors to detect heat energy in the surrounding environment. These two sensors are close to each other, and when the signal differential between the two sensors changes (if a person enters the room, for example), the sensor will engage. This change is indicated by the activation of an alarm here.

0.96" I2C OLED :

It can be interfaced with any microcontroller using I2C/IIC protocol.In contrast to LCD technology, OLED does not require a backlight.

4- Channel Relay Module:

It is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load.

4. RESULTS AND DISCUSSION

Using the system proposed in this paper, all kitchen appliances are monitored by the user using a mobile phone or a PC. These are all integrated through an IoT platform. The appliances are all monitored continuously and the statuses are noted down and displayed on the ESP-Dash dashboard.

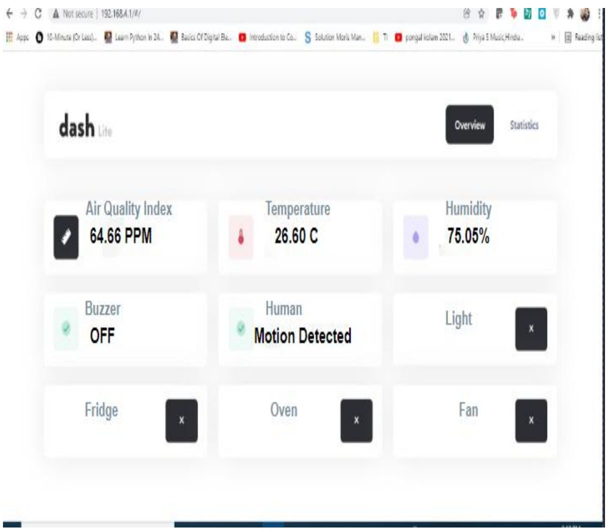

Figure 4: ESP Dashboard

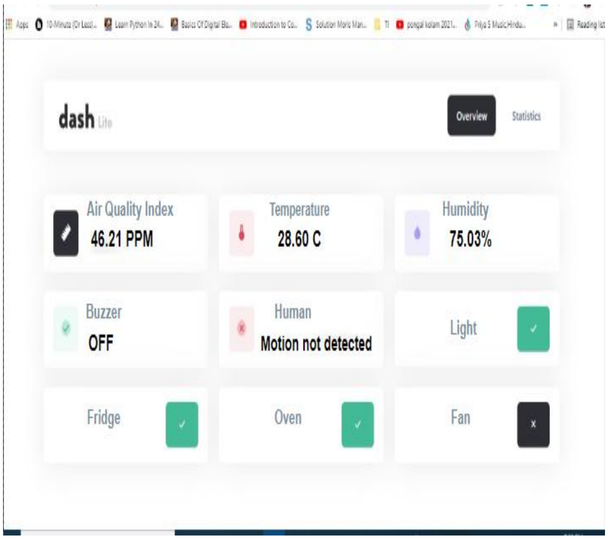

Figure 5: ESP Dashboard

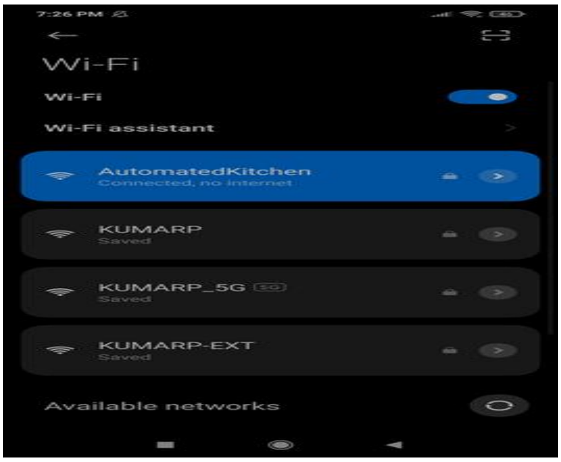

Figure 6: Wi-Fi Network

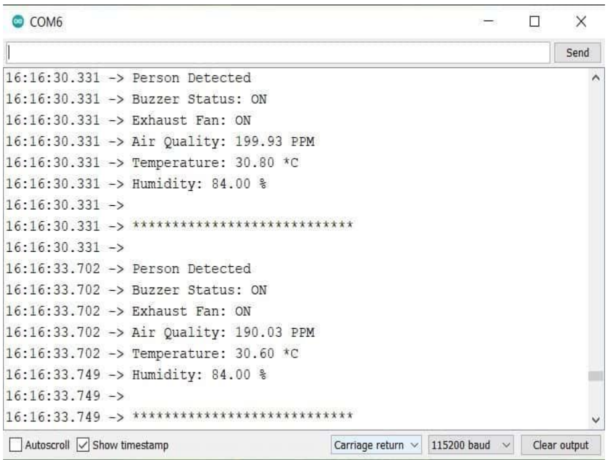

Figure 7: Serial Monitor

Figures (4) and (5) show the dashboard that displays the temperature and humidity conditions inside the kitchen. These are measured by sensors connected to NODE-MCU which acts as a client. The ESP-dash dashboard acts as an output window that shows the actual status of all the connected devices.

Figure (7) shows the output of the serial monitor. This displays the temperature and humidity sensed by the sensors.

The data displayed on ESP-Dash and Serial Monitor is samples taken at two different instances of time. The Serial Monitor displays an air quality index of 190.03 PPM. This is well above the range and hence both the buzzer and exhaust fan are turned on. This indicates that a gas leakage has been detected and the proportion of gases in the air has varied to an extent which is alarming because of which both the buzzer and the exhaust fan are turned on.

5. CONCLUSION

In this work, the proposed system facilitates the users to control the kitchen appliances by giving commands through a smart ESP-Dash dashboard. Thus all devices can be controlled universally, and the status of the devices can bevisualized.

This feature will help the user to analyze the status of these devices anytime and anywhere. It reduces human intervention in monitoring the devices. This system can be further extended for automatic ON and OFF of appliances in commercial sectors depending on the required usage. This system can also be used for helping out the physically challenged people with the activities of the kitchen.

Future work involving the usage of this model in the medical, chemical industries, where the monitoring of the parameters mentioned above plays a huge role, can alsobe carried out further.

6. REFERENCES

[1] Kumar Keshamoni, SabbaniHemanth, “Smart Gas Level Monitoring, Booking & Gas Leakage Detector over IoT “, 2017 IEEE 7th International Advance Computing Conference.

[2] Suwarjono, S.; Wayangkau, I.H.; Istanto, T.; Rachmat, R.; Marsujitullah, M.; Hariyanto, H.; Caesarendra, W.; Legutko, S.; Glowacz, A. Design of a Home Fire Detection System Using Arduino and SMS Gateway. Knowledge 2021, 1, 61–74. https://doi.org/10.3390/knowledge1010007

[3] ChandraMohan,R.Nagarajan,K.Satheeshkumar,N.AjithKumar,P.A.Gopinath,S.RanjithKumar . 2017 “Intelligent Smart Home Automation and Security System using Arduino and Wi-Fi” , International Journal of Engineering and Computer Science, vol 6,issue 3, pp.20694-20698.

[4] Pavithra, D. and Balakrishnan, R . 2015, “IoT based monitoring and control system for home automation”,IEEE Global Conference Communication Technologies (GCCT) in 2015, pp 169-173.

[5] M. Poongothai, A. L. Karuppaiya, R. Priyadharshini,”Implementation of IoT based Smart Laboratory”, International Journal of Computer Applications (0975 – 8887) Volume 182 – No. 15, September 2018

[6] Ms. AkankshaRajendraSurve , Mr.Sampat Vaidya, “Research Paper on Android based Home Automation using Raspberry Pi”, Scientific Journal of Impact Factor (SJIF): 4.72”, Volume 4, Issue 6, June -2017.

[7] Satria, APriadi, M.Wulandhari, L.A. and Budiharto, W. 2015, “The Framework of Home Remote Automation

System Based on Smartphone",International journal of smart home, vol.9, issue 1, pp.53-60.

[8] NagapuriSrilekha ,P.Venkateshwarlu, " Designing of A Monitoring System for Kitchen Environment ", International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391.

[9] https://www.elprocus.com/esp8266-wi-fi-module/

[10] https://community.wia.io/d/56-how-to-connect-a-pir-sensor-to-an-esp8266

[11] https://randomnerdtutorials.com/how-to-install-esp8266-board-arduino-ide/

[12] https://howtomechatronics.com/tutorials/arduino/dht11-dht22-sensors temperature-and-humidity-tutorial-using-arduino/

[13] https://randomnerdtutorials.com/guide-for-oled-display-with-arduino/

[14] https://www.mybotic.com.my/module/relay-module/4-channel-5v-relay-module

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