Automation and Monitoring Smart Kitchen Based on Internet of Things (IoT)

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Abstract. The kitchen is one of the important places in a house. Safety factor is the main aspect that must be taken into account during the activity in the kitchen. The existence of gas leakage, uncontrolled fire and excessive temperatures must be quickly identified and addressed. The purpose of this research is to make prototype of kitchen security system using Internet of Things. The system is designed using 4 types of sensors and Arduino UNO. DHT 11 sensor is used to monitor temperature and humidity, IR Flames sensor is used to detect fire, MQ-135 sensors are used to detect gas leakage, and PIR sensors are used to detect human activities in the kitchen. The sensors output are then connected to the Arduino which will control the relay. The relay acts as a fan switch in the event of a gas leak, uncontrolled fire and excessive temperature increase. Under these conditions, Arduino will also turn on the alarm and the led, and send information to the server. The results show that the system can work according to the desired specifications.

1. Introduction

1.1. Background
Nowadays the existence of the Internet of Things (IoT) has already changed the human life. IoT is a concept that allows objects around us to communicate with each other [1]. This capability will make objects understand what humans need without any command, including providing important information wherever we are [2] [3].

In everyday life, people perform various activities. One of the places where human activity is the kitchen. With a variety of activities conducted in the kitchen, will certainly make the kitchen temperature conditions quickly changed. In addition to temperature, the use of gas stoves has a high fire risk. Based on that, the use of IoT in the kitchen is necessary to keep the kitchen air condition always be comfortable and to reduce risk due from the use of gas stoves.

1.2. Journal Review
Many research and projects have been made regarding this smart kitchen. As research by Vu Trieu Minh and Riva Khannadari from Tallinn University of Technology. And Mutsalklisana Chaiyaorn from Northeastern University, Boston, USA.

From some previous research, these research mostly only reveal a concept, some research that succeeded in making a system that can work but still use ATmega32 as a microcontroller with a limited sensor. In this paper, Explain about designing an IoT based automation and monitoring system using
Arduino UNO as microcontroller and ESP8266-01 as data communication device using wireless fidelity (Wi-Fi) network.

1.3. Proposed
Based on background and review from research that has been described, we need a system that can monitor and send various information about the condition of the kitchen continuously, even though we are in a place far from the kitchen.

This project created a system which can detect changes in temperature and fire caused by the use of gas stoves in the kitchen. In the system, the DHT11 sensor is mounted to detect temperature changes, an MQ-135 gas sensor to detect Liquefied Petroleum Gas (LPG) leak, IR flame sensor to detect fire, and passive infrared (PIR) sensors to detect human activity in the kitchen. In this system, there is also a relay to control the fan that serves to control the temperature and blow out of gas in the event of a gas leak or smoke from the kitchen in case of fire. This system can be controlled and monitored via the internet directly from laptops or smartphones anytime, even from a place far from the kitchen. In case of fire or gas leak, this system will provide a warning in the form of alarm, as well as information to be sent via short message service (SMS), e-mail, or in-app notification on a smartphone.

2. Method
The project of this system is built by some architecture, starting from hardware architecture, software architecture and system architecture.

2.1. Hardware Architecture
Figure 1 shows the design and schematic of this system. The main components used in this circuit are Arduino Uno, ESP8266-01 (wifi module), DHT11, MQ-135, IR Flame sensor, PIR sensors, buzzer, three pieces LED, Relay module and A DC Fan.

![Figure 1. Schematic Installation](image)

2.1.1. Arduino Uno. Arduino Uno is a microcontroller that is currently popular. Arduino Uno uses ATMEGA328 as its microcontroller, has 14 digital I / O pins and 6 analog inputs. To program it, the Arduino is connected to the computer using USB type A to type B or what we often call the printer cable [4].

2.1.2. ESP8266. ESP8266 is a wifi module that serves as a microcontroller enhancement such as Arduino to connect directly to wifi and create TCP / IP connections. This module requires about 3.3v power with three modes of wifi namely Station, Access Point and Both (tools). This module is also equipped with processor, memory, and GPIO where the number of pins depends on the type of ESP8266 we use. On this system, This device is used as Wi-Fi shield for Arduino which will connect to Wi-Fi
network from available hotspot router. This device will send the collected data from Arduino to the server.

2.1.3. Temperature and Humidity Sensor (DHT11). DHT11 uses a capacitive humidity sensor and a thermistor to measure ambient air. DHT11 sends output data in the form of digital output without requiring analog pins. This sensor is very easy to use but has a measurement limit of only up to 60 °C [5]. In this system, DHT11 is used to detect temperature and humidity.

2.1.4. Gas Leakage Sensor (MQ-135). Gas sensor MQ-135 is very useful to detect a gas leak in the kitchen. This sensor can detect flammable gases such as LPG, CH4, CO, Propane to detect smoke from fire. It has a very quick response to gas leakage, but it takes a long time when it first starts up. In this sensor, there is a potentiometer that serves to regulate the sensitivity of the sensor. When the sensor detects a gas leak, the sensor's conductivity will increase depending on the amount of gas concentration detected [6]. In this system, MQ-135 is used to detect leaks on LPG gas.

2.1.5. IR Flame Sensor. In this system, IR flame sensor functions as a fire detector. This sensor will detect fires based on the infrared wave spectrum generated by the fire.

2.1.6. Passive Infrared (PIR) Sensor. In this system, the PIR will serve to determine the presence of human activities in the kitchen. This sensor determines the presence of human activities based on the infrared emission from the human.

2.1.7. Power Supply. This system uses an adapter that will work on 100 - 240V. The resulting output is 5V, 1A. This power supply will be connected directly to the microcontroller. Figure 8 shows the power supply.

2.2. Software Architecture
Software that is used in this system is Arduino IDE, Cayenne web server.

2.2.1. Arduino IDE. Arduino Uno is programmed using the Arduino Integrated Development Environment (IDE). Arduino IDE is a software developed by Arduino. This program is used to design various processes related to Arduino programming [4]. Not only the Arduino device, ESP 8266-01 is also programmed using the serial monitor available on the Arduino IDE.

2.2.2. Cayenne web server. Cayenne is an application and web server to create project internet of things. Cayenne has features for monitoring and controlling the objects connected to it. Using Cayenne is very easy to use because it is only with visual drag and drop. On this system, Cayenne use to show all data from the sensor, control the relay fan and send warning notices to the mobile device via E-mail and SMS.

2.3. System Architecture
The system architecture of the smart kitchen system is shown in figure 2.
Figure 2. Architecture of Smart Kitchen System

- The power supply is connected directly to Arduino. The sensor powered from pin 5V (VCC) and pin 3.3 V in Arduino.
- The sensor used in this system is DHT11 to detect temperature change, MQ-135 to detect LPG gas leak, IR flame sensor to detect fire, PIR sensor to detect human activity in the kitchen. Data received by the sensor will be sent directly to the Arduino via digital or analog pins.
- Arduino Uno serves as the controlling center in this system, all data sent by the sensor will be processed to become a reference in the next action. Data received by Arduino will also be sent to the Cayenne server.
- ESP8266 is used as Wi-Fi shield that will connect the Arduino to the server via Wi-Fi.
- Fan Relay functions as a fan controller. This relay will work according to Arduino command. The Arduino will command the Fan to turn on when the DHT11 sensor detects air temperature > 25 °C, MQ-135 sensor detects LPG gas leakage, IR flame sensors detects a fire, and when a command from a mobile device passes through the Cayenne server.
- Alarm works when there is a gas leak or a fire occurs.
- The indicator lights consist of three different lamps, each light indicator having different functions. A red light indicates a fire, yellow lights indicate a gas leak, green lights indicate the kitchen safely.
- Cayyene serves as a web server that will accommodate various information transmitted by Arduino via Wi-Fi connection. Cayenne will process the information and will be displayed on the dashboard. The dashboard is a view of the page or application that shows the information received by the Cayenne server. In the dashboard, there is also a section that can control the components connected to the Cayenne server. In this system, which can be controlled by the Cayenne is fan relay. Cayenne also has a trigger function. Trigger function will send notifications in the form of SMS and Email based on sensor readings that have been determined.
- The mobile device serves as the receiver and information viewer of the smart kitchen system through the Cayenne server.
3. Result and Discussion
To determine the performance of this system, the smart kitchen prototype that will be placed in a miniature kitchen, as shown in figure 3. The layout of each indicator and sensor is adjusted to the actual system condition. Prior to use in this system, the sensor was independently tested to determine its eligibility.

The test results show that the system can work properly. Each sensor can work correctly. All data sent by the sensor can be accepted by Arduino to determine an action for the output device. Output devices such as Fan, alarm, and indicator lights can work according to their function. The data that received by Arduino is also sent to the Cayenne server via Wi-Fi. Data received by the Cayenne instantly displayed on the dashboard. Data displayed on the dashboard can be seen in figure 4.

Figure 3. Kitchen Miniature

Figure 4. Display of Cayenne Web Dashboard
The dashboard displayed can be customized. The data displayed will also be stored on the server. The stored data can be viewed by opening the chart menu at the top right of each sensor data on a dashboard. The data that received by Cayenne is also displayed on the dashboard in the Cayenne app on a mobile device. The in-app dashboard display can be seen in figure 5.

![Smart Kitchen Dashboard](image)

**Figure 5.** Cayenne application Display

The dashboard displayed in the app can be customized but simpler than Web cayenne dashboard display. The warnings notification in the event of a fire and gas leak also works correctly, as shown in figure 6.
The system will send warning notification directly to mobile devices via Email and SMS.

4. Conclusion and Future Work

4.1. Conclusion
Based on the design and test of this system, the following conclusions can be taken:
- Based on the test, each of sensors contained in this system works well. After installing, calibration should be done so that the results can be in accordance with the expected.
- All collected data can be displayed on the web and apps. In the delivery of such information, is strongly influenced by the quality of Wi-Fi networks used.
- In simulated fires and gas leaks, the fan can function properly. A warning system can work. Email and SMS can be received directly by the mobile device.

4.2. Future Work
The addition of variant sensors to measure various information about the kitchen is needed. The addition of security systems also needs to be improved. One of the security systems that can be embedded in this system is a fire extinguisher or automatic gas lock.

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