

# Proceedings of International Conference on Applied Engineering 2018

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Batam, Indonesia  
October 3<sup>rd</sup> - 4<sup>th</sup>, 2018



**Organized by:**  
Politeknik Negeri Batam



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IEEE Indonesia CSS/RAS Joint Chapter

**Proceedings of**  
**The 2018 International Conference on**  
**Applied Engineering**  
**(ICAE)**

*Batam, Indonesia, October 3-4, 2018*

**ICAE** International  
Conference on  
Applied  
Engineering

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# **The 2018 International Conference on Applied Engineering (ICAE)**

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IEEE Catalog Number CFP18VAJ-ART  
ISBN 978-1-5386-8066-7

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# IoT-based Gas Leak Detection Device

Metta Santiputri  
Informatics Engineering Department  
State Polytechnic of Batam  
Batam, Indonesia  
metta@polibatam.ac.id

Muhammad Tio  
Informatics Engineering Department  
State Polytechnic of Batam  
Batam, Indonesia  
m.tio.seedling@gmail.com

**Abstract**—LPG gas is one of the household things in daily life. The decree of the Ministry of Energy and Mineral Resource number 1971/26/MEM/2007 dated May 22, 2007 contains the requirement of the conversion from the petroleum (kerosene) into LPG as an effort to shift from the limited natural resources from fossil energy to the more abundant natural resources. However, LPG gas is highly flammable. There have been many accidents due to leakage of LPG gas. The trigger varies from the incorrect installation to the use of defective gas cylinders. This paper aims to provide a solution to this problem by building a device that utilizing sensors connected to NodeMCU. The device performs area monitoring continuously. The gas sensor provides data to NodeMCU, and then the results are displayed as a warning to the user via an Android-based smartphone device. Using this device, users will be able to prevent accidents that occur due to gas leaks so that accidents can be avoided.

**Index Terms**—LPG gas, sensors, NodeMCU, Android

## I. INTRODUCTION

LPG is one of the household needs in daily life. It acts as an alternative to petroleum, which continues to decrease. With this transition, there are several problems caused by gas leak that may cause accidents. To prevent this from happening, a device that can detect gas leak is necessary.

The previous devices only detect gas leaks through the gas sensor [1]–[3]. This method has some drawbacks. One example is if there is a gas leak that causes the house occupants to lose consciousness, then the device becomes useless. Furthermore, it needs help from other parties to prevent this from happening. Therefore, additional devices are needed such as human detection sensors and fire detection sensors so prevention of accidents can be more efficient, fast and precise.

Internet technology can make communication between devices faster. By utilizing this connectivity on a regular basis, the device is able to provide a solution of any existing problems.

Therefore we propose a device to overcome the problem called the Gas Leak Detection device based on IoT (Internet of Things). It will monitor the content of flammable gas in the air, the presence of humans, and the presence of fire in the house continuously. With this device, it is expected that the number of future accidents can be reduced and will not cause major losses.

## II. SENSORS

### A. NodeMCU

NodeMCU is an open-source IoT platform. It consists of the hardware, in the form of ESP8266 System on Chip from ESP8366 made by Espressif System, and the firmware, which is Lua scripting programming language. The NodeMCU is analogous to the Arduino micro-controller combined with the ESP8266 module. NodeMCU has advantages compared to other micro-controllers, namely:

- NodeMCU has the capability to access WiFi, for example the ability to connect to WiFi that is within close proximity. This device can also create an access-point that can be used by other devices.
- Use USB for serial communication. Programming on this device can be performed by connecting the device to a computer using a USB cable that is usually used on smartphones, namely USB cable with Micro-B type.
- It has a small size but contains complete features as a micro-controller, which makes NodeMCU very suitable for developing IoT (Internet of Things) devices.

### B. MQ2 Gas Sensor

The gas sensor is a module used on the micro-controller to detect gas in the air. There are several types of gas and gas sensors that can be identified by the module also vary. To detect household gases, M2 gas sensors are used to detect Methane, Butane, LPG and cigarette Smoke. The MQ2 gas sensor is shown in Fig. 1.



Fig. 1. MQ2 Gas Sensor

The way the gas sensor works is by using an electronic circuit that is sensitive to the gas content in the air, thus when the gas concentration in the air is getting higher then the resulting voltage is also getting higher.

### C. Fire Sensor

According to Yayan (2016) [4], a fire sensor is a sensor that can detect the presence of a fire and convert it to an analog quantity of its representation. This flame sensor is different from the heat sensor, where the heat sensor uses temperature parameters while the fire sensor measures the flame. Fig. 2 shows an example of a fire sensor.



Fig. 2. Fire Sensor

### D. Outcome Data

Data generated from the gas leak detection device is the gas content values in the air, in parts per million (or ppm). Fig. 3 is an example of the results of measuring gas content in the air using an MQ2 gas sensor where measurements are made in normal air conditions.

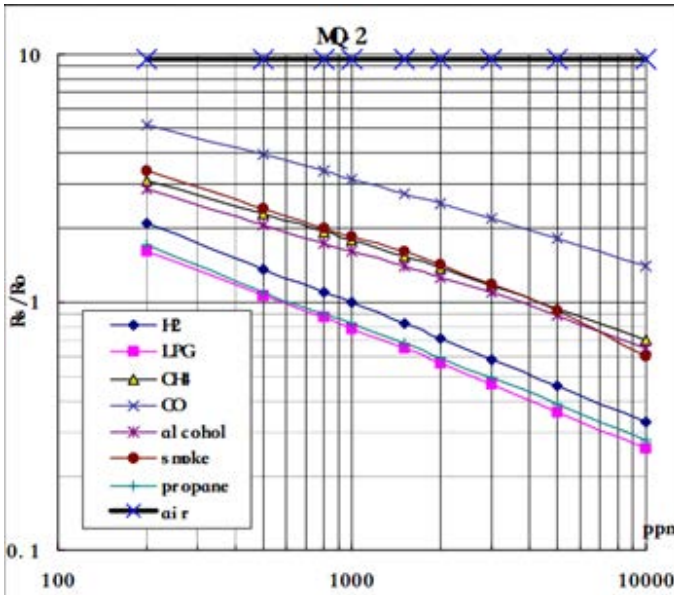


Fig. 3. Gas Sensor Outcome Data (source: [http://wiki.seeed.cc/Grove-Gas\\_Sensor-MQ2/](http://wiki.seeed.cc/Grove-Gas_Sensor-MQ2/))

## III. SYSTEM DESCRIPTION

This application can be used by anybody, without any prior knowledge of any hardware or software programming needed. Fig. 4 presented the gas leak detection device general description. The device monitors the gas content in the air and any flame before displayed to the user.

The workflow of this system is straightforward. The gas sensor and fire sensor installed on the NodeMCU device monitor the gas content in the air and the existing flame continuously. When the gas content in the air exceeds the normal limit or any flame is detected, the device sends a notification to the user based on the type of the detected value.

### A. Notification

The notification generated by the Gas Leak Detection Device is categorized into four types as follows:

- 1) Android bar notification  
This notification will be shown as a message in an Android device, without any vibration or sound. This message is shown as a regular notification usually shown in an Android device.
- 2) Alarm notification  
This notification will be shown as a regular alarm notification in an Android device. It will produce vibration and sound.
- 3) Notification on the gas leak detection device  
This notification will produce a “beep” sound. It can only be received when the user is in close proximity with the device.
- 4) Message notification  
This notification is sent to the users registered on the receiver list in the Android device.

### B. Hardware

In the design of the hardware, the proposed system will be able to detect the gas content in the NodeMCU, which connected to a fire sensor and a gas sensor. These two sensors will send the data obtained to the NodeMCU device. The block diagram of the device is illustrated in Fig. 5.

### C. Decision Table

NodeMCU is connected to two sensors, namely gas sensor and fire sensor. Therefore, there are several conditions that will occur and under these conditions the system will take action in accordance with the prevailing conditions. Value of 1 means the sensor detects the content of the material that exceeds the limit and value of 0 means that the material content in the surrounding environment is still within normal limits. Action value of 1 means that the action will be performed by the system and a value of 0 means that the action will not be performed. The complete decision table is presented in Table I.

TABLE I  
DECISION TABLE

Condition	TC1	TC2	TC3	TC4
Gas sensor active	1	1	0	0
Fire sensor active	0	1	1	0
<b>Action</b>				
Send notification to user	1	0	0	0
Activate alarm on Android device	0	1	1	0
Activate alarm on NodeMCU device	0	1	0	0

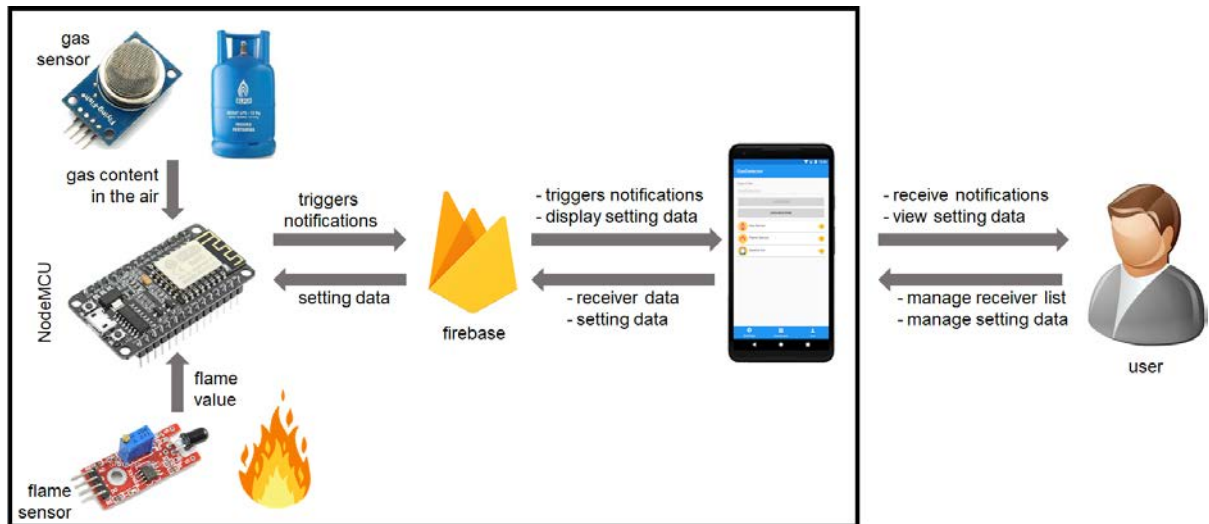


Fig. 4. System Description

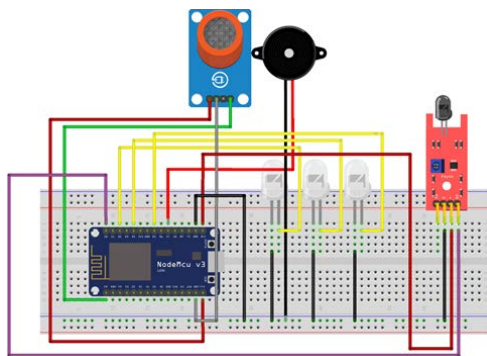


Fig. 5. Device block diagram

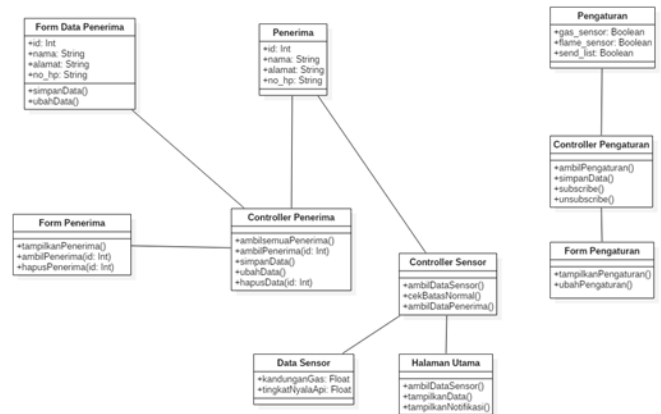


Fig. 6. Software class diagram

#### D. Software

The proposed software is a software that will be embedded in a smartphone with an Android operating system. This application will be used to set the notification receiver list. On the other hand, the Android-based smartphone is also used as a notification receiver when the hardware detects substance which exceeds the limit value. The class diagram of the software is presented in Fig. 6.

#### IV. IMPLEMENTATION AND EVALUATION

The gas leak detection device is shown in Fig. 7. When the device is started, the yellow LED is turned on. This signifies that the device must be setup first. The setting necessary to turn on the device is to connect an Android-based smartphone to the WiFi that has been created on the device (Default SSID: GasDetector). After the device is connected, the user must access the website page using IP 192.168.4.1 to register the settings. The necessary settings is registering the device on the WiFi that provides Internet access and registering to the topic that will be used. The setup on the Android-based smartphone



Fig. 7. The gas leak detection device

is performed using an Android-based application. Some of the interface of the application is presented in Fig. 8.

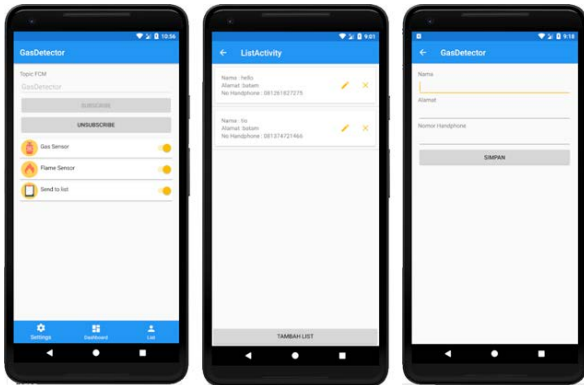


Fig. 8. Device software interface

The types of notification received by users through their Android-based smartphone are as follows:

- 1) Android bar notification
- 2) Alarm: with this type of notification, the Android-based smartphone will produce vibration and alarm sound.
- 3) message sent to the users registered in the receiver list. This notification is sent through an sms gateway. When the device detects gas, the device will access the gateway and sent the data with POST method. Next the gateway will run a python file that contains commands to send a message through Gammu.

#### A. Testing Procedure

Testing was performed to test each function and process to uncover the possibility of errors occurring in each function. The description of the testing procedure is as follows:

- 1) Hardware testing
  - a) Perform registration of the hardware (NodeMCU):
    - (a) Connect the hardware to Internet (WiFi);
    - (b) Register the topic that will be used.
  - b) Test gas detection.
  - c) Test fire detection.
- 2) Software testing
  - a) Perform registration in the Android-based application:
    - (a) Register to the appropriate topic (the same topic as the hardware).
    - b) Add receiver list.
    - c) Observe notifications.

#### B. Testing Results

The testing procedure was performed successfully. Each condition resulted in notifications sent to the users in the user list. Fig. 9 shows the notifications received by the user: (a) as an Android bar when a gas leak is detected; (b) as an alarm when fire is detected; and (c) as a message to the homeowner also when fire is detected.

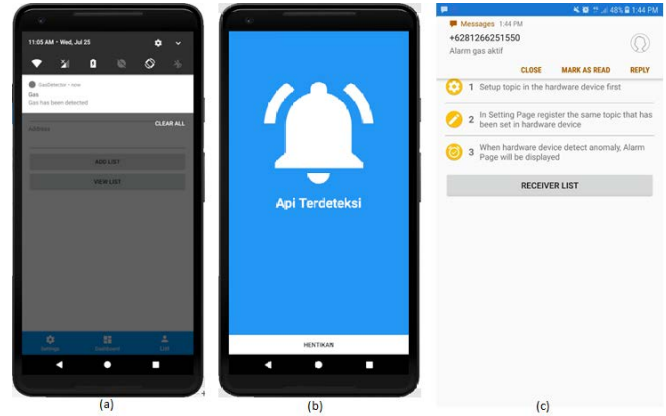


Fig. 9. User notifications: (a) bar notification; (b) alarm; (c) message

## V. CONCLUSIONS

LPG gas is preferable as fuel in many households and to support the effort to shift from the limited natural resources from fossil energy to the more abundant natural resources. However it is highly flammable. The Gas Leak Detection Device can provide information about dangerous conditions such as gas leaks and the presence of fire so that it can be quickly detected by homeowners. The device is built using NodeMCU and connected to Android-based smartphone using Firebase as connector. The gas leak detection device is able to send notifications to its users using Android bar, alarm or messages. Displaying notifications on an Android-based smartphone is the right choice so that users or homeowners can immediately find out if there is a gas leak.

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