LOCATION BASED FIRE DETECTION, WITH NEAREST FIRE FIGHTER FINDER

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Abstract

The lack of fire department makes it hard for most people to contact where the nearest fire department to the scene. Furethermore, when the fire department location was founded it is still a challenge for the fire fighters to find exact location of the fire. For this reason, we used sensitive sensors of fire to the flame. The project used arduino uno microcontrollers, fire sensors, Neo-7m Ublox GPS, ESP8266, and wavecom. As soon as the flame sensor detects the flame, ESP8266 will send the gps data from the home location to the web server www.thingspeak.com which then data from thingspeak is taken to do the nearest distance search using the method of Haversine Formula then send the sms using wavecom sms gammu gameway to the firefighter the nearest fire. The final result of this project shows that the flame sensor can detect a flame of about 75 cm, the GPS accuracy level approaches 100%, ESP8266 can transmit data to Thingspeak by about 20 seconds, accuracy method of accurate formula accuracy calculates Distance near 100% SMS Gateway Wavecom sends sms less than 10 seconds.

Keyword: GPS, SMS Gateway, ESP8266, Fire Sensor, Internet of Things

Introduction

Fires often occur in nearby communities and are an undesirable disaster. Fires caused by electrical short circuit that can occur at any time, often too late to be handled immediately because they are not immediately known. Like the incident at two kiosks on Simongan Raya Street on Sunday, September 10, 2017 that was burned by electric short circuit (metrosemarang.com). Not only that. in the city of Semarang there are only five firefighters only[1], namely in West Semarang District, District Ngaliyan, District Genuk, District Banyumanik, and District Pedurungan. Disadvantages of firefighting posts resulted in the large number of people not yet knowing, making it difficult to carry out reporting in case of fire so that there are often delays in handling.

Internet of Things or IoT can transfer data to the network without any interaction between people. While Arduino is a micro-controller that is open-source. Internet of Things and Arduino are often used for projects such as water cleaning checks, gas leak detection, automatic door openers, and more (hackster.io). Arduino itself has a sensor that is fire sensors to detect fire quickly because the sensitive level can be arranged. Then GPS to send home location of the fire by using SMS to the nearest fire brigade.

With the detection of fire using the Internet of Things and GPS is expected to reduce the occurrence of fire because it has been quickly addressed because of the

sensitivity level of fire sensors and the accuracy of the GPS module that knows the location of the house and then send SMS to the nearest fire brigade so the fire brigade can act quickly.

Literature study

GPS Ublox Neo-7m because horizontal localization accuracy of 2.5m with a sensitivity level of -161dBm when tracking and navigation is being done[2]. It takes about 28 seconds on the module to work. In this project, using GPS Ublox Neo-7m to send the location of the owner's house is then sent data to IoT on ThingSpeak.

The calculation of the search for the nearest fire extinguisher the Haversine method is used to calculate the distance between points on the surface of the earth using longitude and latitude as input variables.[3] The Haversine formula is an important equation of navigation, providing a large circular spacing between two points on the surface of the ball (earth) based on longitude and latitude. Assuming that the earth is perfectly round with the radius R 6.367, 45 km, and the location of the two points in the spherical coordinates (latitude and longitude) are lon1, lat1, and lon2, lat2, then the Haversine formula can be written by equation as follows:

The Haversine formula

x = (lon2-lon1) * cos ((lat1 + lat2) / 2);

y = (lat2-lat1); d = sqrt (x * x + y * y) * R

Information:

x = Longitude

y = Lattitude

d = Distance

R = Earth Radius = 6371 km

1 degree = 0.0174532925 radians

So in this project, used the method of Haversine Formula to search the nearest fire place and then sent sms location of the house where the fire sensor detects the existence of fire in the house. So the fire department can quickly head to the designated location.

Internet of Things or IoT also has the ability to store data efficiently and exchange data by connecting a device through sensors (temperature, gas, humidity, etc.) and the internet. An example of an IoT web service is ThingSpeak. Thingspeak is a web-based open API Internet of Things sourfe information that can store various sensor data and can show output data in graphical form on the website.[4] ThingSpeak can communicate with the help of an internet connection that acts as a data bearer on a tool or thing where ThingSpeak can store, analyze, and observe data already stored in the

cloud. The sensors here can be connected via Arduino, Raspberry-pi, and others. To connect Arduino Uno to the internet is to use ESP8266. ESP8266 is a Wi-Fi module for IoT used to transmit and store data to IoT web service that is ThingSpeak. In this project, ESP8266 is used in accordance with the journal to transmit fire and GPS sensor data on ThingSpeak.

To overcome the spread of fire to various areas then used fire sensors. This fire sensor is very sensitive to fire and also on the fire spectrum.[5] Not only that, this fire sensor has the advantage of detecting fire with wavelength of 760 nm - 1100 nm which is a special distance infrared light with a 60 degree angle and detection distance of approximately 3 feet or can be up to 100 cm. If temperature reaches very high, then output high and low threshold needs to be adjusted accordingly.

Arduino Uno is so popular to use because it can be used to develop interactive objects that are stand-alone and can be connected to a computer and used with the reader to retrieve and send data to and from Arduino.[6] Arduino can be connected to LEDs, dot matrix displays, buttons, switches, motors, temperature sensors, pressure sensors, proximity sensors, GPS receivers, Ethernet modules, or anything that generates data. Since Arduino is open source, any software or hardware or shield will be compatible with it. Arduino Uno has 14 digital inputs used as input and output, 6 analog inputs, USB connector for serial data communications and power connectors. So in this project, Arduino Uno can be powered through an existing USB connector and fits the needs of this project according to the description of the journal.

A project Credit System Semester[7] helps students to get the information easily so developed based student information system using SMS Gateway High School Students. The reason using Gammu SMS Gateway because its a tool for development of SMS Gateway that easy to implement and free. The advantages of using Gammu are can be accessed with windows and linux, many devices or handphones compatible with gammu, and gammu uses MySQL database. So in this project, Gammu can be used to send sms to nearest fire department using Wavecom.

Research methodology

1. Detail Method

More details of the method that will be used to create this project, are required as follows:

Fire detection section

This section discusses the design process and how the fire sensor module works. Where has the function to detect fire prone to fire, especially in the kitchen contained LPJ gas and cooking stove. Here used the fire sensor KY026 and in the process of designing it by connecting it with an Arduino Uno using a jumper and breadboard.

The location determination part (GPS receiver)

This section discusses the process of designing and working the GPS module that serves to search the point of the house location in the form of latitude and longitude by using satellites. But it is more effective when outside the room or room that is not much barrier like wall. Here used the Ublox Neo-7M GPS module and to connect it is used an Arduino Uno using jumper and breadboard.

Wireless data connection to the server

This section discusses about the design process and how the wifi module works to connect to the internet so that the transmission of data by way of wireless or connect to the internet to the server then the data that has been sent will be stored by the server. Here use the Thingspeak web server service. Used wifi module ESP8266 and to connect it used an Arduino Uno using jumper and breadboard.

Section SMS server Gammu

This section discusses the type and manner of SMS server work to send sms or short messages via Gammu server to a mobile phone. Used a Wavecom Q2406B USB modem connected to the computer and XAMPP to store data to a database.

The nearest fire search section

This section discusses how PHP works. Here using PHP that serves to perform data retrieval from Thingspeak kmudian do the calculation of point two locations by using the formula Haversine Formula as follows:

- x = (lon2-lon1) * cos ((lat1 + lat2) / 2);
- y = (lat2-lat1); d = sqrt (x * x + y * y) * R
- Information:
- x = Longitude
- y = Lattitude
- d = Distance
- R = Earth Radius = 6371 km
- 1 degree = 0.0174532925 radian

2. Testing

Performance Test

To test performance, there are five to test which are:

1. Fire Sensor KY-026, test the distance fire sensor can detect fire and how much ideal threshold for fire sensor to detect fire. Will be tested five times at different length: 15 cm, 30 cm, 45 cm, 60 cm, and 75 cm using lighter and candle.
2. GPS Ublox Neo-7M, test the accurate gps can detect the current location. Will be tested five times at different location.
3. ESP8266, test how fast it send data to thingspeak. Will be tested five times using wifi Indihome.
4. Wavecom SMS gateway gammu, takes how many seconds it can send the warning sms to handphone. Will be tested five times using different sim provider.
5. PHP calculate using Haversine Formula, how accurate the calculation from two different location. Will be tested five times from home location to different location.
6. Fire Sensor KY-026 and PHP, how much time needed from detect fire to send sms.

Functional Test

To test four module, which need to be considered is as follows:

1. Red led on fire sensor KY-026, whether stays lit when close to the fire.
2. Blue led on ESP8266, whether blinking when started up and connect to the internet.
3. Yellow led on GPS Ublox Neo-7M, whether blinking when the satelite get the signal.

Result and analysis

1. Performance Test

In the performance test performed five times on the fire sensor KY-026 is to measure the level of sensitivity or threshold by using wax and lighter at a predetermined distance.

Test sensitivity of Fire Sensor KY-026 using candle

From the experiment results it can be seen that the indicator led light on the flame sensor when it detects a flame on the lighter flicker than when it detects a flame on the candle.

Tabel 1: Fire Sensor candle

No	Value Fire Sensor (Threshold)	Jarak (cm)
1	30 ~ 35	15
2	37 ~ 45	30
3	48 ~ 50	45
4	53 ~ 62	60

Fire Sensor KY-026 using lighter

Tabel 2: Fire Sensor Lighter

No	Value Fire Sensor (Threshold)	Jarak (cm)
1	44 ~ 52	15
2	79 ~ 157	30
3	381 ~ 515	45
4	669 ~ 880	60

When detecting a candle flame, the indicator's indicator light on the flame sensor always lights red at a distance of 15 cm to 75 cm. To avoid false alarm from the lighter, the threshold value of the fire sensor to be used is 80 because the sensitivity level of the fire sensors is so sensitive to detect the presence of fire.

GPS Ublox Neo-7M accurate position

In the performance test will be tested five times to check the accuracy level of Ublox Neo-7M GPS module to determine the point of location of latitude and longitude. Which will then be compared with google maps how big errors are obtained.

Tabel 3: GPS Accurate

No.	Start up	Latitude (GPS)	Longitude (GPS)	Latitude (Google Maps)	Longitude (Google Maps)
1	25	-7.055172	110.429748	-7.055228	110.429717
2	20	-7.023381	110.403030	-7.023381	110.403030
3	21	-7.054420	110.430541	-7.054472	110.430551
4	52	-7.062822	110.433580	-7.062746	110.433597

5	78	-7.058649	110.428642	-7.058651	110.428608

No.	Errors Latitude	Errors Longitude	Places
1	5.59E-6	3.10E-5	Kedai Bunda
2	1.6E-6	2.5E-5	Unika Soegijapranata
3	5.19E-6	9.99E-5	Waroeng SS
4	7.6E-6	1.69E-5	Koenang-Koenang
5	2.00E-6	3.39E-5	Setya Dimsum

From the experimental results it can be seen that the Neo-7m Ublox GPS can provide a reasonably accurate location accuracy, but not 100% because it is slightly sliding from the actual location. To start up until satellite signals are obtained, when in the room takes longer time than outdoors.

ESP8266 send to thingspeak

In the performance test on ESP8266 is the process of sending data from arduino to thingspeak by using wifi Indihome.

Tabel 4: WiFi ESP8266

No	Wifi / Hotspot	Send to thingspeak (second)
1	Indihome	20
2	Indihome	22
3	Indihome	21
4	Indihome	20

From the experimental results, it can be seen that ESP8266 can send data to thingspeak by using wifi Indihome with a speed of approximately 20 seconds.

Wavecom SMS gateway gammu

In the performance test Wavecom will try using simcard Indosat IM3 and will try to send sms to five sim provider.

Tabel 5: SMS Gateway gammu using wavecom

No	Send SMS (second)	Provider (send to)
1	13	XL
2	7	Mentari

3	9	Indosat IM3
4	13	Tri

From the experimental results, it can be seen that the gateway Sms gammu using Wavecom which contains simcard Indosat IM3 sends sms less than 20 seconds.

PHP calculate using Haversine Formula

In the performance test of PHP calculation using Haversine formula is to use the position of latitude and longitude in Graha Estetika Raya area with five different locations.

Tabel 6: Haversine formula result

No.	Latitude to	Longitude to	Latitude from
1	-7.061060	110.431113	-7.055172
2	-7.061060	110.431113	-7.023381
3	-7.061060	110.431113	-7.054420
4	-7.061060	110.431113	-7.062822
5	-7.061060	110.431113	-7.058649

No.	Longitude from	Distance (km)	Google Map (km)	Errors (km)
1	110.429748	0.671	0.669	0.0021
2	110.403030	5.21	5.21	0
3	110.430541	0.741	0.740	0.009
4	110.433580	0.335	0.334	0.001
5	110.428642	0.382	0.382	0

From the experimental results, it can be seen that the calculation with the Haversine Formula compared with the calculation of Google's distance measurement is almost 100% accurate. Since there are only 4 errors from 5 experiments below 1 km.

Fire Sensor KY-026 and PHP

In performance test Fire Sensor KY-026 to send SMS gateway gateway is to calculate how long the sensor so detect fire until haversine calculation then send sms.

Tabel 7: Performance fire sensor and php

No	Fire sensor detect fire (second)	PHP Calculate Haversine Formula (second)
1	0.6	0.277
2	0.5	0.342

3	0.8	0.471
4	0.8	0.711

From the experimental results, it can be seen that the detection of fire by the KY-026 sensor works under one second, while for the calculation of Haversine takes under one second.

2. Functional Test

Fire Sensor KY-026

The state of the flame sensor when there is no fire, visible led opposite the bright red led does not light. If the flame sensor is brought close to the flame, the red led indicator will illuminate both.

Illustration 1 Led Fire Sensor

Illustration 2 Led Fire Sensor (2)

ESP8266

When the ESP8266 is turned on, the red led on ESP8266 will always be on in the internet connected state or not.

Illustration 3 Led ESP8266

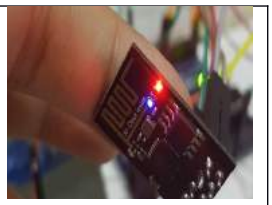

Illustration 4 Led ESP8266 (2)

If the blue led on ESP8266 blinks indicates that it is connecting to the internet. Once connected the blinking blue led light will die, but will blink again when doing data transmission.

GPS Ublox Neo-7M

The red led light on GPS Neo-7m indicates that the module is on, but still in the process of searching for satellite signals. The yellow led light on the bottom right will blink when the GPS has got a satellite signal and can transmit latitude and longitude data of the current location. Here is a module image that is in the room which takes about 2 minutes to get the satellite signal.

Illustration 5 Led GPS

Illustration 6 Led GPS (2)

In the picture below is a picture module that is outside the room which takes about 1 minute to get the satellite signal.

Illustration 7 Led GPS (3)

Illustration 8 Led GPS (4)

Wavecom

Wavecom that has been connected to the computer will appear to work with a red blinking red mark.

Illustration 9 Led Wavecom

Illustration 10 Led Wavecom (2)

Also when use gammu-identify, wavecom that indentified is ready to use.

```
mirabella@mirabella-SVE14A25CVPI:~$ sudo gammu identify
[sudo] password for mirabella:
Device                : /dev/ttyUSB0
Manufacturer          : Wavecom
Model                 : MULTIBAND  900E  1800 (MULTIBAND  900E  1800)
Firmware              : 651b09gg.Q2406B 244 041410 13:45
IMEI                  : 351047888189814
SIM IMSI              : 510014066335890
```

Illustration 11: Identify Wavecom

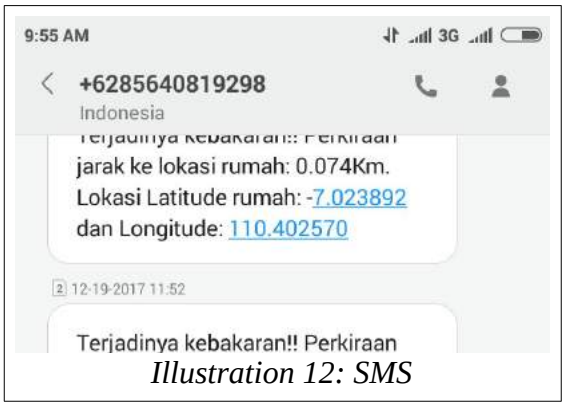

Illustration 12: SMS

Conclusion

1. Conclusion

On Fire Detection using IoT and GPS project using Arduino. From all experiment and implementation it can be concluded that:

1. From the experiment result in chapter 5.2 it can be concluded the optimal range of fire sensor KY-026 to detect a flame of about 60 ~ 75cm with threshold of 80 because to avoid false alarm from lighter flame.
2. From the results of experiments in chapter 5.2 it can be concluded ESP8266 when sending data to thingspeak from the experiment seen delivery of data using wifi Indihome takes about 20 seconds. Fast internet speed is needed, why? Since data delivery to Thingspeak varies depending on the speed of data transmission.
3. From the experimental results in chapter 5.2 we can conclude GPS Ublox Neo-7M the fastest search satellite signals when outdoors and in the room that is not much barrier wall or concrete.
4. From the experimental results in chapter 5.2 it can be concluded Wavecom used for sms gammu gameway with simcard Indosat IM3 can send sms less than 20 seconds so it can quickly inform the fire brigade.
5. From the results of the experiment in chapter 5.2 it can be concluded Calculations of Haversine Formula on PHP used to search the closest distance from the location of the house to the fire location just shifted slightly less than 1 km.
6. From the experimental results in chapter 5.2 it can be concluded that the detection speed of fire in the KY-026 sensor takes about less than 1 second. For the calculation of Haversine takes less than 1 second. So in such a quick time it can quickly inform the nearest fire extinguisher.

2. Further Research

For more research, arduino can be added with camera module. The camera module itself is used to take a picture of the situation when the fire occurred and then send it to the nearest fire department via email. Firefighters can immediately bring some of their fleets in accordance with the size of the fire on the photo. Also can be developed also if detect fire on different floor and room, then will be notified via email of fire on different floor and room.

References

[1] Cholifatunisa, D. H., “Pemeteaan Persebaran Pos Pemadam Kebakaran di Kota Semarang Berbasis Sistem Informasi Geografis (SIG).” Program Studi Survei dan Pemetaan Wilayah Universitas Negeri Semarang. Mar. 2015

[2] Sakpere, W. E., “A Near Field Communication Framework For Indoor Navigation: Deployment Considerations.” Faculty of Informatics and Design Cape Peninsula University of Technology. Mar. 2014

[3] Prasetyo, D., and Hastuti K., “Penerapan Haversine Formula Pada Aplikasi Pencarian Lokasi dan Informasi Gereja Kriten di Semarang Berbasil Mobile.” Teknik Informatika - S1 Fakultas Ilmu Komputer Universitas Dian Nuswantoro Semarang. Nov. 2015.

[4] Pasha, S., “Thingspeak Based Sensing and Monitoring System for IoT with Matlab Analysis.” International Journal of New Technology and Research (IJNTR) ISSN: 2454-4116, Vol.2, Pages. 19-23, Issue-6, Jun. 2016.

[5] Mobin, Md. I., Abid-Ar-Rafi, Md, Islam Md. N., and Hasan Md, R, “An Intelligent Fire Detection and Mitigation System Safe from Fire (SFF).” International Journal of Computer Applications (0975-8887) Vol. 133 - No.6, Jan. 2016.

[6] Hsieh, C., Ye, Z., Huang C., Lee, Y., Sun, C.,Wen, T., and Juang, J., Jiang, J, “A Vehicle Monitoring System Based on the LoRa Technique.”, World Academy of Science, Engineering and Technology International Journal of Transport and Vehicle Engineering Vol:11, No:5, Apr. 2017.

[7] Triyono, R. A., Susila, C. B., “Sistem Informasi Nilai Mahasiswa Berbasis SMS Gateway Pada Sekolah Tinggi Ilmu Tarbiyah (STIT) Muhammadiyah Pacitan.” Program Studi Teknik Informatika, Universitas Surakarta. Journal Speed – Sentra Penelitian Engineering dan Edukasi – Volume 7 No 3 – 2015 – ijns.org.