Investigation on the Application of IoT Based ESP-12E in Monitoring Motorcycle for Safety, Security and Comfortable Use

Muhammad Yusuf and Riyani Prima Dewi
Study Program of Electronics Engineering, State Polytechnic of Cilacap, Cilacap, Indonesia

Keywords: ESP-12E, Firebase, Internet of Things, Monitoring.

Abstract: The increasing number of motorbikes has also triggered the crime of motorcycle theft, as well as an increase in motorcycle accidents. So far, users often forget to check the air pressure on the motorbike tires, and change the engine oil so that it is not easily damaged. Therefore, a location monitoring system, oil change schedule remainder, engine temperature and wind pressure were made on motorbikes to make it easier for motorcycle users. The system functions to track the location of motorcycle, minimize accidents and maintain the quality of vehicle engines via smartphones. The processor uses Atmega8 and ESP-12E as the receiver of sensor data, then it is sent to Firebase using the internet network via Wi-Fi and then displayed on the smartphone application. The experimental results show all sensors can work well and the difference between the sensor and the measuring instrument is not much different. Sensor GPS can detect the location of the vehicle with result show that the error measurement less than 5%, the DS18b20 temperature sensor can detect the vehicle engine temperature, the proximity sensor can detect the vehicle wheel rotation to detect vehicle mileage, and the pressure sensor can detect air pressure of the tires. Moreover, all that measurement can be monitored in smartphone.

1 INTRODUCTION

Motorcycles are one of the most widely used transportation for Indonesian people. In addition, Indonesia is one of the countries that produces the most motorcycles so that almost the entire people in Indonesia have this type of transportation (Fatimah, Oneng. 2016). The increasing population of motorbikes in Indonesia indicates that motorbikes are starting to become a primary need for the community which makes traffic more crowded and results in traffic accidents. Moreover, the increasing number of motorcycles will certainly trigger the crime of motorcycle theft.

To overcome the theft of a motorbike, the owner uses double security keys such as padlocks. Unfortunately, the thief still manages to take the motorbike away even though it is equipped with additional security. One of the solutions for this problem is by install a device that can track the motorcycle every time. There are many technologies has been used to track the whereabouts of missing motorcycles, yet they are relatively expensive. In conclusion, it is important to add a device or systems in our motorcycle that can monitor its location but it can install easily and cheaper than existing tools.

One of the most crucial factors that can causes accidents is the tire pressure on the motorcycle. Tires on each vehicle already have a standard air pressure that has been set by the factory. Maintaining the standard tire pressure is one way to get tire performance at the optimum level. Maintaining tire pressure is not only for safety, but also for ability and comfort in driving. Tires that are under pressure or exceed the standard will result in a fatal accident. (Aris et al , 2018).

Motorcycle users often forget or miss to change engine oil, hence that will damage the vehicle when we are too late to change the oil because some indicate will happened in our motorcycle such as the engine heats up quickly, the engine power feels heavy and may causes excess exhaust fumes. These indicate can be avoided by changing the oil regularly after reaching a mileage of about 2000 km or adjusting the resistance of the type of oil used. (Aditiya, 2019). (Nova et al, 2011).

The overheating machines can affect the performance of the machine so that the machine can turn off suddenly. Overheat can be caused by engine oil that has not been changed, weak radiator fan

Yusuf, M. and Dewi, R.
Investigation on the Application of IoT Based ESP-12E in Monitoring Motorcycle for Safety, Security and Comfortable Use.
DOI: 10.5220/0011843700003575
In *Proceedings of the 5th International Conference on Applied Science and Technology on Engineering Science (iCAST-ES 2022)*, pages 589-596
ISBN: 978-989-758-619-4; ISSN: 2975-8246

rotation, motor carrying too much weight, driving on uphill roads and driving in hot weather during the day plus severe traffic jams. This happened due to the vehicle owner does not know whether the engine temperature is normal or not. Whereas keeping the vehicle temperature normal is important. (Bagus Rachmanto. 2018).

This research was conducted to answer the above problems. The aim of this research is to design a device that can monitor the location of the motorcycle while monitoring the engine temperature and the mileage that will be used as a reference for reminders of the engine oil change schedule. This device is intended for the security and comfort aspects of its users.

2 METHOD

2.1 Component Used

2.1.1 GPS

Use *GPS (Global Positioning System)* is a navigation satellite system as well as determining the position or presence *continuously*. This system is designed to provide three-dimensional position and speed and information about time continuously around the world regardless of time and weather, for many people simultaneously. *(*Tjhin, Santo et al. 2014). *PS* can provide position information with varying accuracy, ranging from millimeters (order zero) to tens of meters. *GPS* works by transmitting signals from satellites to *GPS* (*smartphones* equipped with *GPS* for example). (Dwi, Edwin; et al. 2016).

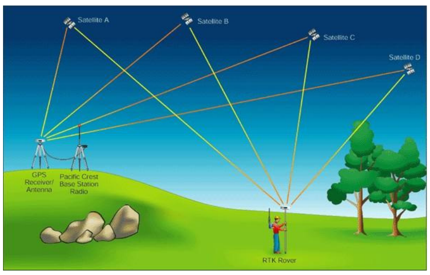


Figure 1: Works Steps for *GPS.*

Figure 1 show GPS works (Aji Noor, 2013):

1. Using the *"triangulation"* from the satellite.
2. Used for *triangulation calculations, GPS* measures distances using the *travel time* of radio signals.
3. Used to measure *travel time*, *GPS* requires high time accuracy.
4. Used for distance calculations, the position of the satellite and the altitude in its orbit are required.
5. Finally, we must correct *delay* of the signal traveling time in the atmosphere until it is received by *the receiver*.

2.1.2 GPS uBlox Neo 6M

Module *GPS* is a family of *stand-alone GPS receivers* that feature high-performance positioning tools. This module has a size of 16 x 12.2 x 2.4 mm. With optimal architecture, *power*, and *memory,* this module is very suitable for *devices* that use batteries as a power source. *GPS* uBlox used can be seen in Figure 2:

Figure 2: *GPS* uBlox Neo 6M.

2.1.3 GPS uBlox Neo 6M

ESP-12E is a microcontroller that has been integrated with the Wi-Fi module and belongs to the ESP8266 type, the type used is ESP-12E based on *firmware* eLua. The ESP-12E has a 10-bit ADC with only 1 *input* because it requires *a multiplexer* to read more than one analog input. *input* on the ESP-12E has a maximum voltage of 3.3Volt. (Arafat. 2016). The ESP-12E used can be seen in Figure 3:

Figure 3: ESP-12E NodeMCU.

2.1.4 Microcontroller Atmega8

ATMega8 is a low power 8-bit CMOS microcontroller based on RISC architecture. Instructions are executed in one *clock cycle,* ATMega 8 has *a throughput of* close to 1 MIPS per MHz, this makes ATMega 8 able to work at high speeds even with low power usage. The Atmega 8 microcontroller has several features or specifications that make it an effective controller solution for various purposes (Setiawan, Santoso. 2017). The Atmega8 microcontroller used can be seen in Figure 4:

Figure 4: Atmeg8 Microcontroller.

2.1.5 Wireless Module NRF24L01

NRF24L01 is a long-distance communication module consisting of 8 pins using a radio frequency band of 2.4-2.5 GHz ISM (*Industrial Scientific and Medical*). This module uses the SPI interface to communicate and work with a voltage of 5 volts DC. The NRF24L01 has a *baseband logic Enhanced ShockBurst hardware protocol accelerator* that supports high-speed SPI interfaces for application controllers. This module also has a *true ULP (Ultra Low Power) solution* that allows months to years of battery life. (Shobrina, Upik; et al. 2018). *wireless module* used can be seen in Figure 5:

Figure 5: NRF24L01.

2.1.6 MPX 5700ap

Sensor The MPX 5700AP sensor is a pressure sensor designed for various applications, especially applications based on a microcontroller or microprocessor with analog or digital input. This sensor combines *micro machining*, thin film metallization and bipolar processing in it to provide an accurate signal and analog output level that is proportional to the applied pressure. The measured pressure ranges from 15-700 kPa (2.18 - 101.5 psi), and the output voltage is in the range of 0.2-4.7 volts (Datasheet MPX 5700 Series. 2012). The MPX sensor used can be seen in Figure 6:

Figure 6: MPX 5700AP.

2.1.7 Proximity Sensor

The *proximity sensor* is a sensor or switch that detects the presence of a target (metal type) without any physical contact, this type of sensor usually consists of a *solid-state* tightly wrapped to protect it from excessive vibration, liquid, chemical and corrosive effects. The *proximity sensor* has 3 pins, namely Gnd, *Signal*, Vcc (Susilawati, Elfi; et al 2017). The *proximity* sensor can be seen in Figure 7:

Figure 7: *Proximity* Sensor.

2.1.8 DS18B20 Temperature Sensor

DS18B20 temperature sensor is *suitable* for measuring temperature in wet places because it has waterproof capability. Due to its *output* is digital data, there is no need to worry about data degradation when using it for long distances. The DS18B20 provides 9 bit - 12-bit configurable data. Because each DS18B20 sensor has *silicon serial number,* several DS18B20 sensors can be installed in one bus. (Zaky, EL; et al. 2017). The temperature sensor used can be seen in Figure 8:

Figure 8: Temperature Sensor DS18B20.

2.1.9 Firebase

Firebase is a *platform* application *real-time*. *Firebase* has *library* (library) for most *platforms* and *mobile* can be combined with various *frameworks* such as *node*, *java*, *java script*, and others. *Application Programming Interface* (API) for storing and synchronizing data will be stored as *bits* in the form of *JSON* (*JavaScript Object Notation*) on the *cloud* and will be synchronized in *real time. (*Firebase, “Firebase Product”. 2020). (Rawal, Dinesh. 2017).

2.1.10 Kodular

Kodular is *an open-source platform* that can create web-based android applications. *platform* serves to create various types of android applications easily and quickly without programming in writing. *platform* does not need to write conventional program codes, namely text-based code to create android applications.

2.2 System Design

2.2.1 Block Diagram

This block diagram will later be used as an outline for making the final project. The block diagram used can be seen in Figure 9.

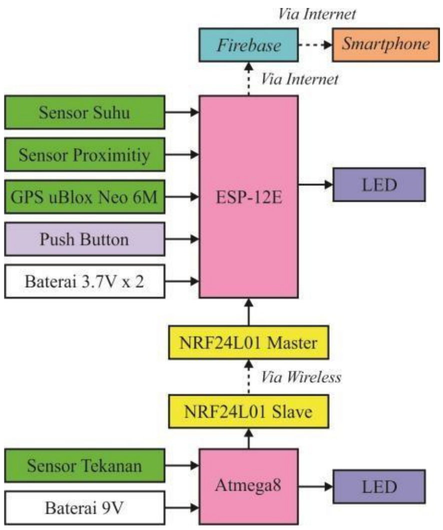


Figure 9: System Block Diagram.

Figure 9 is the working process of this tool system consisting of several main parts, among others:

1. Process Tool
   Includes ESP-12E as data reception for several sensors and sent to firebase. Atmega8 as a data receiver from the pressure sensor.
2. Power Supply Source
   Two power supply sources are used, namely 9v battery and 2x 3.7v battery.
3. devices Input
   Include temperature sensors, proximity modules GPS, push buttons and pressure sensors.
4. Devices Output
   Includes led indicators and smartphones as system information media.
5. Communication Devices
   Include NRF24L01 as communication medium for Atmega8 with ESP-12E

2.2.2 Flowchart System

flowchart will later describe in more detail about the manufacture of this tool. The flowchart below will describe the process from beginning to end of this system working. The following shows flowchart a general system design flowchart can be seen in Figure 10.

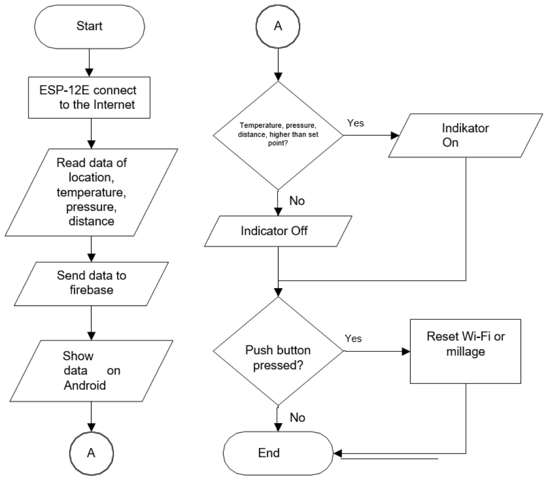
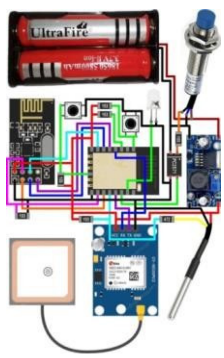


Figure 10: *Flowchart* System.

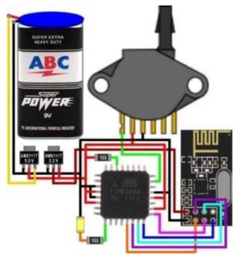
System will work when the ESP-12E is connected to the internet. ESP-12E will read all sensor data which will then be sent to the firebase database every 5 seconds. Then it will be displayed on the android smartphone application. There is a normal limit indicator for each sensor and the indicator will light up when the sensor value exceeds the predetermined normal limit. The push button on the device is used to reset the Wi-Fi connection on the device and is used to reset the mileage.

2.2.3 Overall Design System

The overall design is a complete picture of the tool to be made. The design of the whole tool is made using 2 microcontrollers, namely ESP-12E and Atmega8. Figure 11 shows the system design using the ESP-12E microcontroller and using the Atmega8 microcontroller as follows.



(a)



(b)

Figure 11: System design (a). Design with ESP-12E (b). System design with Atmega.

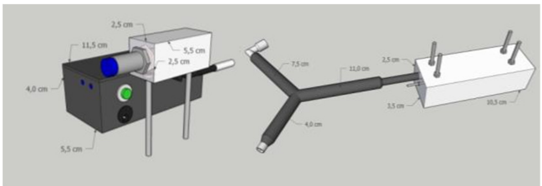


Figure 12: Hardware design.

2.2.4 Application Display

There are 4 pages in application display, they are *login page,* list, *home*, and info page. On the *login page,* there is a column to enter the *username* and *password* for the account that has been registered to enter the *home*.page view *login* can be seen in Figure 13 (a).

If you do not have an account, press the *sign up* on the page and it will go to the register page. The page contains fields to fill in the *username* and *password.* The list page view can be seen in Figure 13 (b).

After *logging* in to the account, you will go to the *home page.* On the *home* there is information on temperature, pressure, mileage. In addition, on the *home* there are also *maps* to find out the location of the vehicle, and there is a user profile in the upper right corner which is used to view user info and application makers. The appearance of the *home* can be seen in Figure 13 (c).

On the info page, there is some information that will be displayed on this page, namely application user profiles and application developer profiles. Button *log out* which is used by the user to exit the account from the application. The display of the info page can be seen in Figure 13 (d).

(a) (b)

(c) (d)

Figure 13: *Smartphone* (a). Page Display *Login* (b). List Page View (c). *Home* (). Display Info Page.

3 RESULTS AND DISCUSSIONS

3.1 Testing of GPS Sensor

This test aim to compare whether the results displayed on the smartphone match the position of the motorcycle or not. Testing on the application displays data results in the form of latitude, longitude and displays markers at the location of the motorcycle. GPS sensor smartphone by displaying the latitude longitude application smartphone can be seen in Table 1.

Table 1: GPS Sensor test result.

No	Place	Location on Google maps	Location detects by tools	firebase
		Latitude		
		Longitude		
1.	Alun-Alun Cilacap	109.00949	109.00942	109.00942
		-7.72729	-7.7275328	-7.7275328
2.	SPBU Damalang	109.01361	109.01370	109.01370
		-7.71966	-7.7197146	-7.7197146
3.	Terminal	109.0251	109.02491	109.02491
		-7.69637	-7.7018532	-7.7018532
4.	Blumoon	109.02969	109.02929	109.02929
		-7.69637	-7.6966300	-7.6966300
5.	SPBU Gumilir	109.03523	109.03512	109.03512
		-7.6914	-7.6914834	-7.6914834

Base on experiments have been carried out in 5 different places that is shown in Table 1, it is known that there is error measurement between latitude and longitude of the location on google maps and data which is given from the GPS sensor. The average error from those two measurements is 0.00015% for latitude and 0.00209 % for longitude.

3.2 Testing of Pressure Sensor

This pressure sensor test is carried out by displaying the value detected by the sensor and comparing it with an air pressure gauge for motorcycle tires. This test is to determine the performance of the tool in monitoring tire pressure on the motor. After the tool is installed, the atmega8 will send data with NRF24l01 obtained from the pressure sensor to esp-12e which is then sent to the firebase database and on smartphone displays the results in the form of pressure values in psi units.

Testing air pressure on motorcycle tires by displaying results on sensors and measuring instruments can be seen in Table 2.

Table 2: Pressure Sensor test result.

No.	Pressure value from sensor				Pressure value from measurement tools	% error
	Before test (psi)	difference (psi)	Air loss (psi)	After test (Psi)		
1.	15.49		0.11	15.38	15.40	0.26
2.	19.43	19.38	0.11	19.32	19.40	0.10
3.	23.28	23.23	0.11	23.17	23.20	0.13
4.	26.12	26.01	0.22	25.90	25.10	0.35
5.	30.28	30.23	0.11	30.17	30.20	0.10
6.	31.33	31.33	0.11	31.22	31.40	0.22
7.	32.36	31.20	0.11	32.15	32.30	0.32
8.	35.64	35.59	0.11	35.53	35.60	0.03
% Average of			0.124			0.189

When taking measurements with measuring instruments, the wind will be wasted several psi, so look for the value of the difference which is the value between sensor values after and before testing using measuring instruments. After doing 8 experiments, it is known that the average % *error* is 0.189%.

The calculation of the difference value is obtained by the following formula:

- Wind wasted = sensor value before - sensor value after
- Tool difference value = sensor value after + (difference / 2)

3.3 Testing of the Oil Change Schedule Remainder Systems

Testing the engine oil change reminder system is done by comparing the distance travelled on the tool with the mileage on speedometer. The Proximity Sensor is installed as a tire rotation detector which is used to determine the distance travelled by calculating the wheel circumference plus the calculated mileage.

Testing the engine oil change reminder system can be seen in Table 3.

Table 3: Proximity Sensor test result.

No.	Travelled	Distance		ΔS (km)	% Error
		SB (km)	SS (km)		
		Sensor			
		Opdometer			
1.	Jl. Kluwih – Alun-alun Cilacap	2.485	3.502	1.017	1.67
		85940.9	85941.9	1	
2.	Alun-alun Cilacap – SPBU Damalang	3.502	4.891	1.389	0.79
		85941.9	85943.3	1.4	
3.	SPBU Damalang – Terminal	4.891	7.390	2.499	3.96
		85943.3	85945.7	2.4	
4.	Terminal – Pertigaan Blumoon	7.390	8.220	0.83	3.61
		85945.7	85946.5	0.8	
5.	Pertigaan Blumoon – SPBU Gumilir	8.220	9.094	0.874	8.47
		85946.5	85947.3	0.8	
Average of Error					3.7

Proximity sensor detects one rotation of a motorcycle wheel, the distance travelled will increase according to the circumference of the wheel used. From these tests, it is known that the average % error of the tool and speedometer is 3.7%. The following mileage formula is used:

Mileage = Previous mileage + (3.14 x wheel diameter)

3.4 Testing of Temperature Sensor

This test is carried out by displaying the value detected by the temperature sensor. This test is carried out to check and ensure the sensor functions with a difference that is not too high, then it will be displayed on smartphone android

The comparison test for temperature display readings with sensors and temperature display with measuring instruments can be seen in Table 4.

Table 4: Temperature Sensor test result.

No.	Data from Sensor	Data from measurement	%error
1.	34.87	35.1	0.66
2.	40.56	40.8	0.59
3.	60.27	60.8	0.87
4.	70.55	70.9	0.49
5.	80.10	80.2	0.12
6.	90.61	90.4	0.23
7.	95.20	94.6	0.63
8.	100.18	99.5	0.68
Average of Error			0.53

From the results of the tests that have been carried out according to Table 4, it can be stated that the sensor readings are accurate and have an average the average value of % *error* sensor readings with the temperature on the measuring instrument is about 0.53 %.

3.5 Testing of Application Smartphone

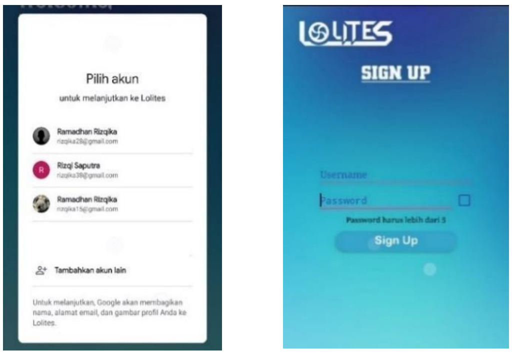
3.5.1 Testing of Login Page

The login page *display* can be seen in Figure 13.

Figure 14: Testing *Login* Page.

Page The *login* is tested on the "*Login*" button, "*Sign Up*" button and the *"Google" button.* This test is done to find out the function of the button works well or not. The first test carried out is the function of the *"Sign Up" button.* On the test page, when the *"Sign Up"* pressed it will go to the list page. The registration page is a page for registering an application account. If you do not want to register, users can choose the *google* as another option to *login.*

The display of the login page *with* account *googles* and the registration page can be seen in Figure 14.



(a) (b)

Figure 15: Application Display (a) Page *Login* (b) Account *Google.*

List page is expected to be able to enter the *username* and *password* on the registration page first, *the password* must be filled with more than 5 digits. Tests carried out on the list page are the function of the "*Sign Up*" button to save *username* and *password* to *firebase*. Tests carried out on the *login* are the functions of the *textbox* and the "*Login*. The test on the page works well, if the user enters *username* and *password* correctly, the *login* successful and will go to the *home page.* If you do not have an account and will *log* using a *google*.

3.5.2 Testing of Home Page

The tests carried out on the home page, namely the function of reading data and the "Profile". If the "Profile" is pressed, it will go to the info page which will display user profile information and creator profile information. The info page can be seen in Figure 17.

Figure 16: Home Page display.

3.6 Testing of Realtime Database on Firebase

This is done by sending string data from ESP-12E to firebase with the "test" field, if the data has been sent, the field of the data sent will be orange which indicates there is a change in the data in the database. Data sent to the database can be seen in Figure 16.

Figure 17: Data Sent to the Database.

4 CONCLUSIONS

From the experiments that have been carried out, it can be concluded that:

1. sensor GPS can detect the location of the motorcycle with an average value of % error data latitude 0.00015 % and an average % error data longitude 0.00209 % after 5 different places have been carried out.
2. The pressure sensor can function to monitor tire pressure with an average value of % error 0.124%, after 8 experiments.
3. The proximity sensor can detect vehicle wheel rotation to detect vehicle mileage which is used as a reference for oil change warnings, with an average % error tool and odometer is 3.7%.
4. The DS18b20 temperature sensor can detect the vehicle engine temperature with an average value of % error sensor readings with the temperature on the measuring instrument around 0.53 %.

REFERENCES

Fatimah, Oneng. (2016). Rancang Bangun Sistem Keamanan Kendaraan Bermotor Berbasis GPS. Universitas Airlangga.

Aris, Riki; and Marisa, Dwi. (2018). Rancang Bangun Alat Monitoring Tekanan Ban Secara Real Time Menggunakan Metode Tsukamoto Pada Kendaraan Roda Empat. Jurnal Coding, Sistem Komputer Untan, Vol.06, No.3.

Aditiya. (2019). Ganti Oli Motor, Sebaiknya Perhatikan 'Engine Hour'. https://kumparan.com. Accessed on February 23, 2020.

Nova, Adi; Djuniadi. (2011). Pengembangan Sistem Peringatan Ganti Oli Pada Sepeda Motor. Jurnal Teknik Elektro, Vol.3, No.1.

Bagus Rachmanto. (2018). Penyebab Mesin Sepeda Motor Overheat. https://medcom.id. Accessed on February 23, 2020.

Tjhin, Santo; Amami, Mohammad; Tahir, Mirza; dan Faqih, Ahmad. (2014). Sistem Keamanan Sepeda Motor Melalui Short Message Service Menggunakan AVR Mikrokontroler Atmega8. Seminar Nasional Teknologi Informatika dan Komunikasi. Yogyakarta.

Dwi, Edwin; Ernawati; Farady, Funny. (2016). Penerapan Open Street Map untuk Mencari Lokasi ATM Terdekat dengan Algoritma Kruskal Berbasis Smartphone Android. Universitas Bengkulu, Vol.4, No.2.

Aji Noor. (2013). Cara Kerja GPS. https://blog.ub.ac.id. Accessed on February 9, 2020.

Arafat. (2016). Sistem Pengaman Pintu Rumah Berbasis Internet of Things (IoT) dengan ESP8266. Jurnal Ilmiah Fakultas Teknik Technologia, Vol.7, No.4.

Setiawan, Santoso. (2017). Aplikasi Pengaman Kendaraan Berbasis Mikrokontroller Atmega8 dan Attiny 2313. Jurnal Techno Nusa Mandiri, Vol.14, No.1.

Shobrina, Upik; Primananda, Rakhmadhany; dan Maulana Rizal. (2018). Analisis Kinerja Pengiriman Data Modul Transceiver NRF24L01, Xbee dan Wifi ESP8266 Pada Wireless Sensor Network. Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer, Vol.2, No.4.

Datasheet MPX 5700 Series. (2012). Freescale Semiconductor. Freescale.

Susilawati, Elfi; Yulkifli; Kamus, Zulhendri. (2017). Jurnal Pillar of Physics, Vol.10.

Zaky, EL; Hasan, Hafidh; dan Syukriyadin. (2017). Perancangan Mesin Pengering Hasil Pertanian Secara Konveksi Dengan Elemen Pemanas Infrared Berbasis Mikrokontroler Arduino Uno Dengan Sensor Ds18b20. Jurnal Online Teknik Elektro, Vol.2, No.3.

Firebase, "Firebase Product". (2020). downloaded on November 4, 2020 via https://firebase.google.com/products/.

Rawal, Dinesh. (2017) Traditional Infrastructure vs Firebase Infrastructure. International Journal for Scientific Research & Development| (IJSRD), Vol.5, Issue 4.