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Utilization of Service Set Identifiers (SSID) with ESP-01 in Wireless Networks for Lighting Automation

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ABSTRACT

Wireless networks better known as WiFi (Wireless Fidelity) are often used as a medium for exchanging data, for example: the internet. Each WiFi is equipped with an identity so that users can connect. This identity is known as SSID (Service Set Identifier). In this research, the focus is on assembling the SSID sensor which aims to detect the SSID as well as connect the SSID. So if the connection is successful, the light will be on. This happens because the lamp is connected to an electricity source, and vice versa, the lamp goes out because the lamp is not connected to an electricity source. The description of the system created consists of an input part and a process part, namely the ESP-01 which is capable of providing WiFi, and an output part, namely the relay. From controlling the light conditions, it was found that the average time required to change conditions from on to off was 3.052 seconds and the average time required to change conditions from off to on was 3.036 seconds.

1. INTRODUCTION

Technology makes things easier for humans, such as: implementing remote control known as the Internet of Things (IoT), and remote monitoring known as telemetry. Currently, a lot of research has been carried out on IoT, for example: telemetry to monitor electricity usage loads [1], mobile electrical device control systems via IoT [2, 3], smart home systems [4][5][6][7][8][9][10]. This shows that there are no limits in controlling or managing electronic equipment as long as there is internet. Meanwhile, research related to the ESP module includes its use for Message Queuing Telemetry Transport (MQTT) [11], its use for the Internet of Things [12], its use for dataloggers [13][14]. One of the technologies used to support the implementation of various sensors in a smart house is NodeMCU hardware. NodeMCU is a microcontroller equipped with an ESP8266 module so that it can work wirelessly to support the performance of the internet of things (IoT). In its application, NodeMCU can be connected to the Blynk application, which allows the monitoring of electronic equipment work using iOS and Android-based smartphones.

In a storage room or warehouse, the need for lighting is very important. The need for lighting is sometimes not accompanied by savings, for example, the lights are turned off when they are not needed. This requires an automatic switch. The way this automatic switch works is that some use the light and darkness of the surrounding environment (LDR sensor) , some use human movement (PIR sensor), while this research uses the SSID (Service Set Identifier) which uses the ESP-01 module. The short way it works is that a programmed SSID sensor (to be researched) is installed on each lamp. This SSID can be found on wireless or WiFi networks [15]. To turn on the light, the user must have a WiFi hotspot with the same SSID as the programmed SSID sensor, such as a smartphone or ESP-01 station mode. So that later the user no longer needs to look for the switch button, but just by approaching the SSID sensor the light will turn on. The focus of this research is the effect of distance and the use of electrical power from this SSID sensor.

2. LITERATURE REVIEW

2.1 ESP-01

ESP-01 is a WiFi module that is one of the ESP8266 series families. The ESP01 module can be used by a microcontroller to access a WiFi network. This module is also known as SOC or System On Chip, namely a module that does not require a microcontroller to manage input or output like Arduino. The specialty of the ESP-01 is that it has a WiFi (Wireless Fidelity) chip module in it and has embedded TCP/IP network software. So it can communicate with other devices via a computer network wirelessly using an access point. The size of this module can be seen in Figure 1 [16][17] while the physical image can be seen in Figure 2.

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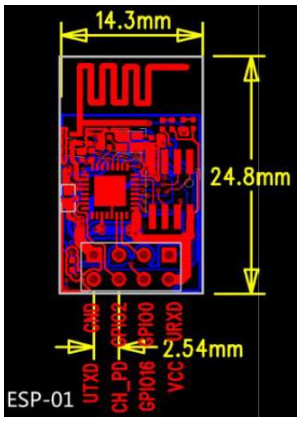

Figure 1. ESP-01 module size

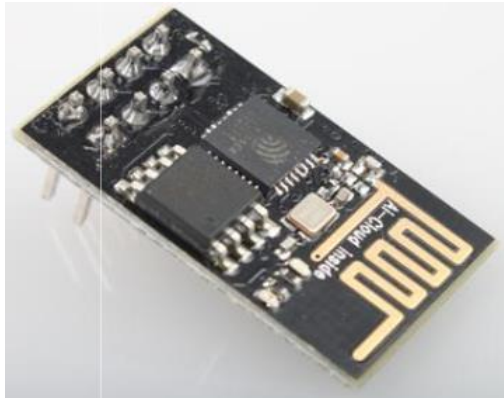

Figure 2. Original form of the ESP-01 module

This ESP01 module has three operating modes, namely:

1. Access Points (APs)
2. Station (STA)
3. Both (AP and STA)

Access Points (AP) mode makes this module work as a WiFi transmitter and allows other devices to connect to this module so that devices can communicate with each other. Station Mode (STA) allows this module to connect to an Access Point, for example, the WiFi network in our home, and allows other devices connected to the network to communicate with this module. Apart from being an AP and STA, this module can also work as both. Meanwhile, this research uses the operating modes as AP and STA.

2.2 Wireless Fidelity (Wi-Fi)

Wi-Fi (or written Wifi or WiFi) is a form of technology for exchanging data wirelessly (using radio waves) over a computer network [10]. The Wi-Fi Alliance defines Wi-Fi as "a wireless local area network (WLAN) product of any form that is based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard". However, because WLANs are generally based on these standards, the term "Wi-Fi" is used in common English as a synonym for "WLAN". A device that can use Wi-Fi (such as a personal computer, video game console, smartphone, tablet, or digital audio player) can connect to a network source such as the Internet via a wireless network access point. Access points (or hotspots) have a range of around 20 meters indoors and even wider outdoors. "Wi-Fi" is a trademark of the Wi-Fi Alliance and the brand name for products using the IEEE 802.11 family of standards. Only Wi-Fi products that complete Wi-Fi Alliance interoperability certification testing may use the "Wi-Fi CERTIFIED" name and trademark. Currently, there are four variations of 802.11, namely: 802.11a, 802.11b, 802.11g, 802.11n. Specification b is the first Wi-Fi product. The g and n variations were one of the products that had the most sales in 2005.

Table 1. Wi-Fi specifications

Specification	Speed	Band Frequency	Compatible
802.11b	11 Mbps	2,4 GHz	b
802.11a	54Mbps	5 GHz	
802.11g	54Mbps	2,4 GHz	b, g
802.11n	100Mbps	2,4 GHz	b, g, n

3. RESEARCH METHODS

This research focuses on a system that can read the SSID found on every Wi-Fi or hotspot. Next, the system design is depicted in a block diagram as in Figure 3. From Figure 3, it can be seen that the system being assembled is within the scope of the SSID sensor system which consists of an SSID Reader/Scanner, Processor, and Connector. Meanwhile, the block that says SSID Transmitter is hardware that is capable of producing wireless networks with WLAN IEEE 802.11 standards, for example, smartphones, computers, and ESP-01 modules. The general setting for transmitting the SSID is known as hotspot mode or station mode.

In summary, the system works by starting by first programming the SSID name as a trigger so that the system can work. The SSID name is given according to agreement with the SSID name that will be broadcast later. What this means is that if later you want to turn on the lights, the user just needs to activate the hotspot feature on their smartphone by setting the hotspot name or SSID name in question and then activating it. Next, the SSID sensor system will detect and check whether the SSID name and security (password) are correct or not. If it matches, then the sensor is connected to the SSID source and the light turns on, if not then the opposite means it is not connected to the SSID source and the light turns off.

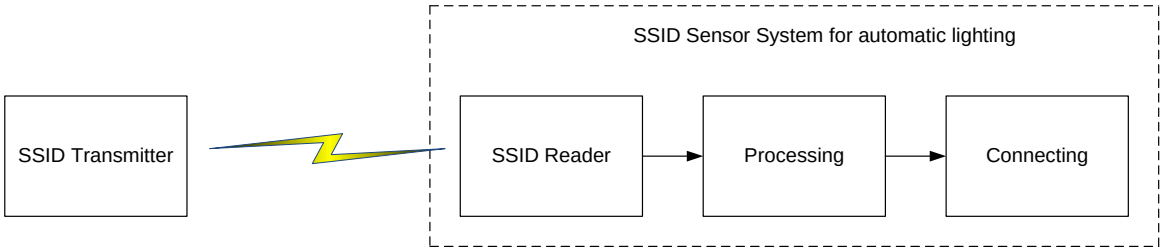

Figure 3. Block diagram of system design

4. HARDWARE AND SOFTWARE

4.1 Hardware

In this research, the hardware used consisted of ESP-01 (figure 2), a Print Circuit Board (PCB), and a Relay. The PCB and Relay are integrated as in Figure 4. The function of this Relay component is to connect or disconnect the electricity from the PLN electricity grid. For the ESP-01 module to be active and working, additional devices are needed in the form of power supply components. The type of power supply used is as in Figure 5. From Figure 5 it can be explained that the compound measures 20.2 mm x 34 mm x 15 mm, with a load output electrical power capacity of 3W. This component is equipped with a pin that is directly connected to the PLN electricity network (marked with the code AC), and then there is an output voltage (marked with the code Vo) of 5 VDC to supply the ESP-01 module. The specifications for the power supply components are as follows:

1. Hi-Link brand.
2. The input voltage range is 100 – 240 VAC with a frequency of 50-60 Hz.
3. The output voltage is 5VDC with a maximum current of 0.6°

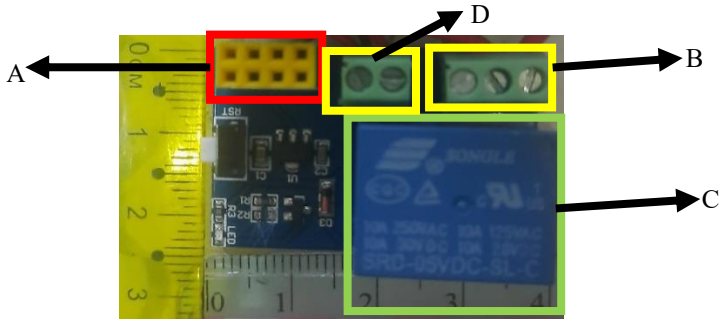

Figure 4. PCB and Relays

In Figure 4, it can be seen that the board in question measures 2.4 cm x 4 cm, has one relay (arrow C), three connectors for the PLN electricity network (marked with arrow B), two connectors for ESP-01 module power supply (arrow D), yellow socket (arrow A) for the ESP-01 module holder and supporting components to activate the relay. The relay specifications are as follows:

1. Active voltage is 5VDC
2. The load capacity is for a voltage of 250VAC, the maximum current is 10A, while for a voltage of 125VAC, the maximum current is 15A.

Next, all the modules listed in figure 2, figure 4, and figure 5 are assembled to produce a result as shown in figure 6, where the lamp to be controlled will be installed in the available socket.

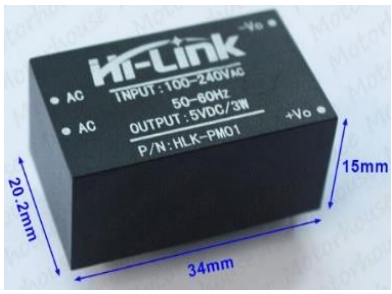

Figure 5. Power supply components

Figure 6. Top view of the assembly with the socke

4.2 Software

In this study, the Balanced Scorecard is limited to the aspects of Customer, Internal Business, and Learning & Growth. Within the Customer aspect, the Key Performance Indicators (KPIs) of Student Satisfaction and Employee Satisfaction will be analyzed with data limited to infrastructure and learning facilities. The software used in this research is the C/C++ language which is applicable in the Arduino IDE environment. Arduino IDE (Integrated Development Environment) is a medium for programming the ESP-01 board. The flow diagram can be seen in Figure 7.

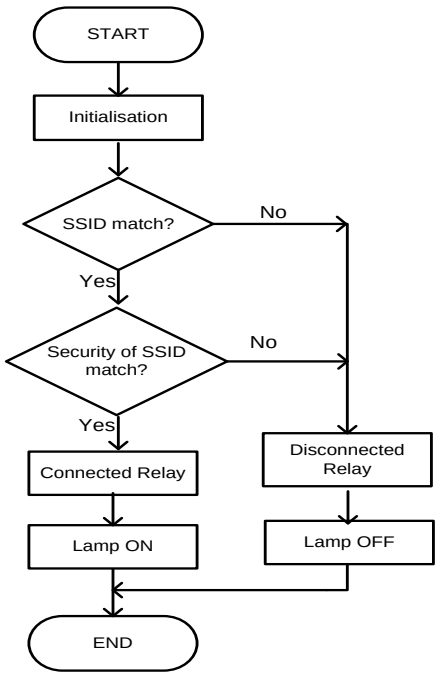

Figure 7. ESP-01 programming flow diagram

The following is an explanation of Figure 7:

1. The program will begin by loading the ESP-01 supporting libraries, in the form of Arduino.h, ESP8266WiFi.h, ESP8266WiFiMulti.h, ESP8266HTTPClient.h, WiFiClient.h.
2. After the library has been successfully loaded, an introduction to the relay module is carried out. Its function is so that the relay can work as a breaker and connector for electricity from the source to the lights.
3. The system's working process begins by detecting the presence of the SSID (Service Set Identifier) in question. SSID is the name of a wireless network that is emitted from an access point or similar device. In this research, SSID is named polmed.
4. Next, the system will connect to the SSID in question if the password from the system to the SSID source matches. Likewise, vice versa, it will be disconnected if the password is not correct.
5. If at point 4 the system is successfully connected to the SSID, the relay will supply electricity from the source to the lamp. Likewise, if the system has not successfully connected to the SSID, the relay will not supply electricity from the source to the lights.
6. Next, the process will repeat itself from detecting the SSID at point 3 to point 5. This will stop if the system power supply is disconnected.

5. DISCUSSION

The software is installed into the hardware and then tested. Testing is intended to determine its capabilities. Starting with ensuring that the system is able to detect SSIDs around it with the help of a computer connected to the ESP-01, the results are as in Figure 8. It can be seen in Figure 8 that point 1 explains that the system has not been connected to the SSID or to the name of the desired wireless access point because it is not yet connected. something is according to what is programmed. Meanwhile, point 2 explains that the system is connected because there is already a programmed SSID name, namely polmed. After that, proceed with getting the sensitivity values which are summarized in Table 2 and Table 3.

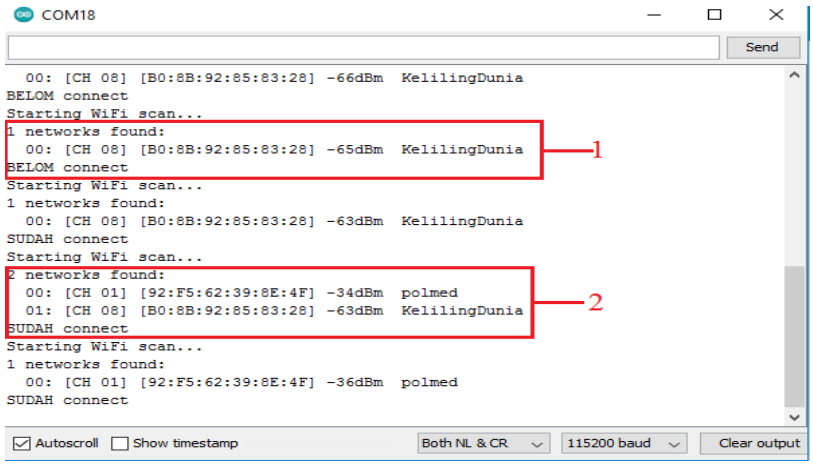

Figure 8. Example of SSID scanning results

Table 2. Sensitivity 1 for places without obstructions

Distance (meters)	Experiment 1		Experiment 2		Experiment 3		Experiment 4		Experiment 5	
	RSL (dBm)	Light condition	RSL (dBm)	Light condition	RSL (dBm)	Light condition	RSL (dBm)	Light condition	RSL (dBm)	Light condition
1	-35	Life	-33	Life	-36	Life	-34	Life	-35	Life
5	-47	Life	-48	Life	-46	Life	-48	Life	-45	Life
10	-63	Life	-70	Life	-64	Life	-65	Life	-64	Life
15	-79	Life	-76	Life	-78	Life	-77	Life	-76	Life
20	-87	Life	-89	Life	-88	Life	-86	Life	-87	Life
25	-98	Dead	-97	Dead	-96	Dead	-95	Dead	-97	Dead

Table 3. Sensitivity 2 for places with obstacles or obstructions

Distance (meters)	Experiment 1		Experiment 2		Experiment 3		Experiment 4		Experiment 5	
	RSL (dBm)	Light condition	RSL (dBm)	Light condition	RSL (dBm)	Light condition	RSL (dBm)	Light condition	RSL (dBm)	Light condition
1	-44	Life	-45	Life	-46	Life	-43	Life	-45	Life
5	-50	Life	-49	Life	-51	Life	-48	Life	-51	Life
10	-72	Life	-70	Life	-71	Life	-73	Life	-71	Life
15	-88	Life	-87	Life	-88	Life	-86	Life	-89	Life
20	-96	Dead	-98	Dead	-99	Dead	-97	Dead	-96	Dead
25	Can not be read	Dead	Can not be read	Dead	Can not be read	Dead	Can not be read	Dead	Can not be read	Dead

Next, look for the RSL value for each distance in Table 2, which is as follows:

1. For a distance of 1 meter, the average RSL value is [(-35)+(-33)+(-36)+(-34)+(-35)]/5 = -173/5 = -34.6 dBm
2. For a distance of 5 meters, the average RSL value is [(-47)+(-48)+(-46)+(-48)+(-45)]/5 = -234/5 = -46.8 dBm
3. For a distance of 10 meters, the average RSL value is [(-63)+(-70)+(-64)+(-65)+(-64)]/5 = -326/5 = -65.2 dBm
4. For a distance of 15 meters, the average RSL value is [(-79)+(-76)+(-78)+(-77)+(-76)]/5 = -386/5 = -77.2 dBm
5. For a distance of 20 meters, the average RSL value is [(-87)+(-89)+(-88)+(-86)+(-87)]/5 = -437/5 = -87.4 dBm
6. For a distance of 25 meters, the average RSL value is [(-98)+(-97)+(-96)+(-95)+(-97)]/5 = -483/5 = -96.6 dBm

Next, look for the RSL value for each distance in Table 3, which is as follows:

1. For a distance of 1 meter, the average RSL value is [(-44)+(-45)+(-46)+(-43)+(-45)]/5 = -223/5 = -44.6 dBm
2. For a distance of 5 meters, the average RSL value is [(-50)+(-49)+(-51)+(-48)+(-51)]/5 = -249/5 = -49.8 dBm
3. For a distance of 10 meters, the average RSL value is [(-72)+(-70)+(-71)+(-73)+(-71)]/5 = -357/5 = -71.4 dBm
4. For a distance of 15 meters, the average RSL value is [(-88)+(-87)+(-88)+(-86)+(-89)]/5 = -438/5 = -87.6 dBm
5. For a distance of 20 meters, the average RSL value is [(-96)+(-98)+(-99)+(-97)+(-96)]/5 = -486/5 = -97.2 dBm

From Table 2 and Table 3 it is known that the RSL value depends on the distance between the system and the WiFi SSID source, where the smaller the distance, the greater the RSL value, and the smaller the RSL value, the greater the distance. Next, the test is to determine the time required when the condition changes from initially off to on and initially on to off, the results of which can be seen in Table 4. From Table 4 it is found that the average time required for the condition to change from on to off is 3.052 seconds and that the average time required for a state change from off to on is 3.036 seconds.

Table 4. Time of condition change

Try to	On to off state (seconds)	Off to on condition (seconds)
1	2,94	3,01
2	2,83	2,92
3	3,20	2,89
4	2,90	2,98
5	3,12	2,93
6	3,33	3,11
7	2,97	3,23
8	3,06	2,94
9	2,98	3,12
10	3,19	3,23

6. CONCLUSSION

SSID (Service Set Identifier) as a trigger for turning on and off the lights controlled by the system can work with an average response from off to on and from on to off is 3.044 seconds and the distance affects the RSL value of the SSD. Apart from that, the system uses standard wireless security such as WEP (Wired Equivalent Privacy), WPA, or WiFi Protected Access, WPA2) to secure the connection and its use.

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