PROTOTYPE OF LIVE THEFT DETECTION SYSTEM USING MICROCONTROLLER BASED SMS *GATEWAY*

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Abstract
Electricity theft is a common problem in many countries, including Indonesia. Electricity theft can be carried out in various places, such as homes, office buildings, industrial facilities, and so on. Theft of electricity can have a negative impact on owners of electrical installations and can result in significant financial losses. There is a system to prevent or even reduce electricity theft by using a monitoring system via short messages/SMS gateways. This system will send a notification to the technician containing the location of the electricity theft and the amount of current stolen. In this study using a current sensor as a current reader, if the incoming current exceeds the current limit that has been programmed on the NodeMCU ESP32 microcontroller, it will automatically give an order to the SIM module to send a notification to the smartphone technician in the form of an SMS Gateway containing the amount of the stolen current and the location where the electricity theft occurred and there is also a buzzer module as an indicator on the tool. With that, it is hoped that technicians can be helped by this system.

Keywords: *Electricity Theft, SMS gateway, NodeMCU ESP32, SIM Module*

1. INTRODUCTION

Electricity theft is a common problem in many countries, including Indonesia. Electricity theft can occur in various places, such as homes, office buildings, industrial facilities, and so on. Electricity theft can have a negative impact on the owner of the electrical installation and can result in significant financial losses.

Electricity theft is common in Indonesia for several reasons, such as the lack of public awareness of the importance of paying electricity bills, the lack of strict supervision and law enforcement, and the existence of an electricity network that is not yet fully connected and well monitored. Electricity theft is also a major problem for electricity companies in Indonesia, as it can cause significant financial losses. In addition, electricity theft can also cause damage to the electricity network, fire, and danger to public safety.

According to data from PT PLN (Persero), in 2020 there were around 73,774 cases of electricity theft throughout Indonesia, with a total loss of around Rp 2.8 trillion. Of these, around 56% of electricity theft cases were committed by household consumers, while the rest were committed by industrial and business customers. The Indonesian government and PT PLN have made various efforts to reduce the number of electricity theft cases, such as the installation of prepaid meters, replacement of power lines that are more resistant to manipulation, and increased surveillance. However, electricity theft remains a serious problem in Indonesia and requires greater efforts from all parties to address the issue.

In Indonesia, there are 4 types of theft modes that are often encountered, namely, changing the electricity meter, outsmarting the kWh meter, a

combination of the first and second modes, and by direct connection. In this study will make a tool to detect electricity theft directly, electricity theft by direct connection is theft by jumping the power cable before entering the kWh meter so that consumers can get more power without having to pay electricity bills.To prevent electricity theft, it is necessary to detect electricity theft that can identify electricity theft in electrical installations. The approach often used by PLN technicians is to use *Amperestick*. However, this method is not always effective, because the electricity meter can be changed by the perpetrator of electricity theft.

Therefore, there is a need for a more sophisticated approach to detecting electricity theft. From these problems, this research was made with the title "Prototype of an Electricity Theft detection system using an SMS *Gateway-based* Microcontroller. The benefits of this research can provide a quick response to technicians in the event of theft of electricity and can facilitate the work of technicians because they do not have to check manually to the field.

From previous research with the title Electricity Theft Detection and Information System Based on SMS Gateway and by Stephy Walukow (2020) has differences in the content of SMS sent to technicians. From the tool designed in previous studies only provides information if there has been electricity theft without knowing its location. Whereas in this research, the contents of the SMS sent by the tool contain a link to the location of the theft of electricity that can be accessed through the *google maps* application.

2. METHODS

2.1 Tool Design

This tool will be placed on the *output* cable of the 20 kv distribution transformer before entering the KWh meter, so the SCT sensor in this tool is installed on several power cables that will enter the KWh meter where the power cable has been divided according to the location of the adjacent KWh and the load does not exceed 100A. This tool uses NodeMCU ESP32 as a regulator of the current passing through the SCT sensor must be in accordance with the amount of current subscribed to consumers, for example in the picture above 3 houses subscribe to each 6A, 4A, 10A (total 20A) and installed SCT sensors that have been integrated with ESP32 which have been programmed to limit the total current of 20A, the total maximum current read by the SCT sensor must be below 20A if it exceeds the buzzer will turn ON and the SIM module will send SMS to the technician.

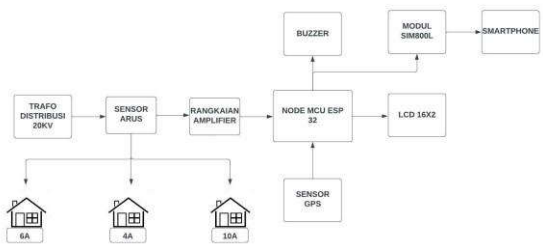

Image 1 Tool Design

Due to the limited tools and time to facilitate the testing of the tool, a *mock-up* is made, so a load is needed in the form of three 60 Watt incandescent lamps. The SCT 013-000 current sensor is used to read the current on the load input. Since the output of the SCT 013-000 sensor is current, the author uses a supporting circuit to convert the current into voltage, namely by using two 100k ohm resistors and a 10uf capacitor.

This tool uses the NodeMCU ESP32 microcontroller as the control center, the SIM800L module is used as a notification sender to the technician's *smartphone* according to the program on the microcontroller, in addition to the SIM800L module there is also a neo-6m GPS sensor to determine the location and *Buzzer* as an indicator when electricity theft occurs. 16x2 LCD as current *monitoring*. The adapter here functions to supply voltage to the microcontroller, SIM module and GPS sensor, which had previously been reduced in voltage by a *Buck converter*.

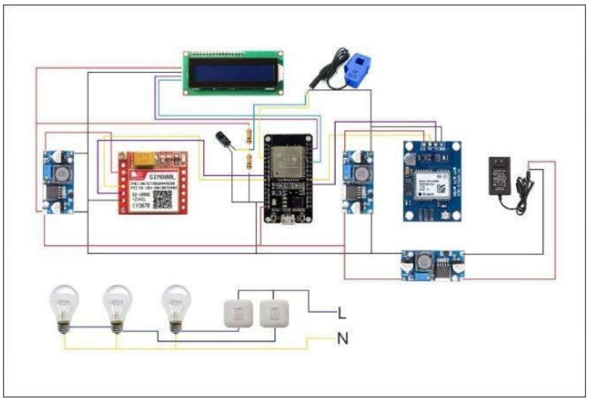

Image 2 Tool Mockup Design

2.2 How the tool works

The way this tool works is by measuring the current entering the load using the SCT 013-000 current sensor, the measurement results from the current sensor then enter the NodeMCU ESP32 microcontroller for processing and classification, if the current read exceeds the current threshold that has been programmed on the NodeMCU ESP32, then the SIM800L module to send a notification to the technician's *smartphone in the* form of an SMS containing the location of the theft of electricity. In addition via SMS on this tool there is also an indicator in the form of a *buzzer* that will turn ON if electricity theft is detected, technicians can also monitor the LCD installed on the tool, if there is a notification "theft detected" indicating that electricity theft has occurred.

3. RESULTS AND DISCUSSION

The results of testing this tool aim to determine whether the components in the tool can work properly so that the tool can work properly.

Image 3 Research Results

3.1 Tool Component Testing

a. Microcontroller Testing Results

Table 1 Microcontroller Testing Results

Experiment	Conditions
Compiling Arduino Coding	Normal

Upload Arduino Coding	Normal
Voltage at 5V pin	Normal
Voltage at pin 3.3V	Normal
Program alignment with Arduino work	Normal
Reset Button	Normal
Digital input value reading on digital input	Normal
ADC value reading on analog input	Normal

This test aims to find out whether ESP32 can function and can process data that has been coded in the Arduino IDE application or not. In the table above, it can be seen if the digital *ports* on the microcontroller are in normal condition, the voltage on the pin is also normal. *Compiling* and *uploading* results from the application are also normal.

b. SIM Module Testing Results

Table 2 SIM Module Testing Results

Delivery Time (WIB)	Receiving time (WIB)
19.05.27	19.05.58
19.10.03	19.10.35
19.15.14	19.15.41

This test aims to determine whether the SIM800L Module can send SMS to the technician's smartphone appropriately. From the table above, it can be seen that the SIM800L Module can function properly, because it can send SMS to the technician's Smartphone with a fairly short period of time. SMS notification received by the technician containing the amount of current stolen along with the web address of the location of the theft that can be accessed via the *google maps* application.

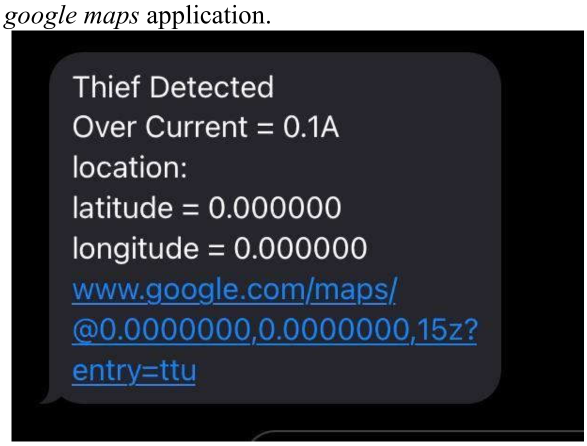

Image 4 SMS received by the technician

c. GPS Sensor Testing Results

This neo-6M GPS sensor test aims to determine the accuracy of the location processed by this sensor, using the *Google Maps* application*. It* can be seen in the picture below that the sensor can send a *link* that can be accessed using *Google Maps* correctly.

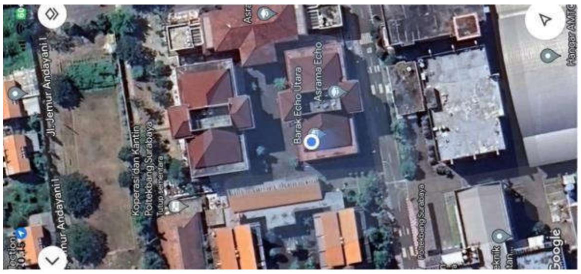

Image 5 GPS sensor test results through the *google maps* application

d. *Buzzer* Testing Results

Table 3 *Buzzer* Testing Results

Testing Time (WIB)	Input (V DC)
14.00	3,97
14.05	3,92
14.10	3,90

Testing the buzzer aims to find out whether the buzzer can function normally as an indicator if there is electricity theft in this tool. To find out the buzzer is functioning normally or not is to see the input voltage which is between 3-5 V DC.

e. *Buck converter* test results

Table 4 *Buck Converter* Testing Results

Testing Time (WIB)	Input (V DC)	Output (V DC)	Voltage Difference (V DC)
19.40	12,21	4,97	7,24
19.45	12,18	4,91	7,27
19.50	12,16	4,90	7,26

This test aims to determine whether the *Buck Converter* can reduce the *DC to DC* voltage well to provide the *input* voltage of the components in this tool. It can be seen in the table above that the *output* voltage from the *Buck converter* is in accordance with the *input* voltage required by the components in this tool.

f. LCD test results

This test aims to determine whether the LCD can display the current measured by the current sensor and whether there is electricity theft or not.

Image 6 LCD display if no power theft is detected

Thief Detected" on the LCD indicates the theft of electricity on the cable monitored by this device.

Image 7 LCD display if theft of electricity is detected

g. Adapter Testing Results

Table 4. Adapter Testing Results

Testing Time (WIB)	*Input* Voltage (V AC)	*Output* Voltage (V DC)
19.25	223,4	12,21
19.30	218,4	12,01
19.35	223,0	12,18

Adapter testing aims to determine the output voltage of the adapter whether it is in accordance or not with what is needed by this tool. From the table above, it shows that the adapter can convert AC current to DC well because it produces an average *output* voltage of 12V DC.

3.2 Overall Tool Testing Results

Table 5 Overall tool testing results

Testing Time (WIB)	Current Limit (V AC)	Total Load (V AC)	LCD Display	Indications of Electricity Theft	Buzzer
20.10	0,6	0,25	0,28	Not Detected	OFF
20.15	0,6	0,52	0,55	Not Detected	OFF
20.20	0,6	0,78	0,22	Detected	ON

In this test using a halogen lamp with a power of 60 watts as a load to be detected, here using two lamps as a legal load and a lamp as an illegal load. In this test the microcontroller is set for a legal current limit of 0.6 A if the current read is more than that then the buzzer is ON and electricity theft is detected, the LCD will display the words "*Thief Detected"* and the amount of current stolen, then the device will send an SMS to the technician. From the table above, it can be seen that the device functions properly, that is, if there is a current that exceeds the specified current limit, the device will detect it as electricity theft so that the device sends an SMS to the technician and the buzzer will sound.

4. CLOSING

4.1 Conclusion

From the overall test of the research entitled "Prototype Electricity Thief Detection System Using SMS *Gateway-Based* Microcontroller" and based on the discussion in the previous chapter, the following conclusions can be drawn:

1. This electricity theft detection system can determine the location and amount of stolen electricity.
2. This electricity theft detection system can help P2TL technicians in checking and taking action in overcoming electricity theft.

4.2 Advice

In perfecting and improving the function and performance of a tool, modification and development are needed. The suggestions for improving and developing this tool include:

1. Improve the specifications of the current sensor in overcurrent reading, so that it can read the current with a higher level of accuracy.
2. Improve the data transmission system to technicians using IoT or Radio link.
3. Using a control system that can automatically disconnect illegal loads.

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