Designing of Monitoring System for Electricity Power Consumption using Microcontroller and IoT

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Abstract*— Modernization has indeed had a huge impact on the lives of today's societies, and the modern age has all sorts of technological implications. Household and electricity tools have followed closely, as is evident by the development in prepaid and digitized meter. However, in doing so, society will not be able to control and monitor this specific use of power. In the above view of the problem, the author came up with the idea of creating a prototype electrical power monitoring device that could operate automatically. They use microcontroller arduino uno with ACS712 current sensors, and air-conditioned module sensors 1 phase (ZMPT101B) along with LCD. The way this works is to detect electrical currents entering the load of electrical equipment on ACS712 sensors, and the voltage coming in on sensors (ZMPT101B), the sensor system receives current and the voltage at the entrance as it directs the microcontroller module arduino uno to be systematicaly combined with a power equation (Wh) Wh = Ixt (stream x time) So we get the electrical power that's used during use. And for record-keeping. We added some tweaked hardware IOT Which is the ESP8266 wireless module as a data bridge from device to cloud using Internet media.*

Keywords*— monitoring, electricity, IoT, microcontroller*

I. INTRODUCTION

The growth of the tech industry today is dramatic, not to mention the products of household electrical appliances is also increasing in variety. All of this equipment craves electrical energy to operate it. Sometimes in one household electrical appliances are so many without regard to how many electricity customers are attached.

Often in a single household the electricity goes out because of trips MCB, because it happens to be the same household electrical appliances that are used at the same time without ever taking into account how much electricity the household USES by operating those household electrical appliances. If the event was frequent, eating would be done quickly with household electrical appliances.

The country's electricity company (PLN) did a TDL's basic rates so that costs To be expelled would be enormous

For electricity consumption, this design is expected to provide learning to care more about energy that will eventually lead to savings in regular spending.

In the above-ground conditions, monitoring and controlling your use of power consumption, output from control will be used to keep the MCB off course as soon as it exceeds the denomination current. The design will also show the value of actual power consumption as information to its user about the use of electricity. It would be easier to

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monitor his electrical usage, and would be put on a buzzer asa warning that the power used had already reached the nominal current of a MCB subscription to his power.

Above the buzzer, the future development plan for the device will be complete a report of the use of power flow to household electrical appliances run, which will be stored to cloud through the Internet asa reporting storage medium, and for report results will be digitized anywhere and processed into a variety of more detailed information. The benefits of design are expected to be of immediate benefit to society in order to provide the study of energy savings and to provide the expertise of household electrical appliances.

I. The Usage of Microcontroller and IoT

Internet of Things (IoT) is a concept where internet connectivity can exchange information with each other with the objects around it. Many predict that the Internet of Things (IoT) is "the next big thing" in the world of information technology. This is because a lot of potential can be developed with the Internet of Things (IoT) technology. For those of you who don't understand further, Internet of Things (IoT) Technology is likened to where physical devices can be connected to the internet. For example, refrigerators, TVs, washing machines and others can be controlled using a smartphone to turn off, turn on and other activities.

The system uses the instantaneous power calculation method to calculate the total power, voltage, current and power factor consumption of the house using arduino microcontroller. It displays the results and through the actions of the relays that supply the house, the loads will be reduced based on the priority to ensure that the total KW consumption of the house is not more than the threshold value. The work also provides the analysis on the voltage sensor using Polynomial Curve Fitting. Experimental analysis on the system shows that it is capable of maintaining the house loads below 2KW (the set threshold value), automatic reconnection of the loads and a special alarm if all the relays cut out. It also displays the real time power consumption, Voltage, Current and power factor of the loads. The system has a maximum error of 2.47% in voltage measurement (above 10V AC) and a maximum error of 1.89% in current measurement when compared with a standard FLUKE meter [1]. This work described the development and implementation of energy consumption management of a smart house. Through the effort of developing the system a reliable analysis is done on the ZMPT101B voltage sensor module, and its accurate response is found using polynomial regression. The prototype built is capable of managing the system loads effectively by not allowing more than the threshold value of the power (2000W) to operate in the system and it is equipped with automatic reconnection capability. It also correctly measure and display Voltage, Current, Power consumption and power factor of the system. The power measurement recorded higher error when compared to the value obtained using the standard FLUKE meter [1].

With IoT objects can be moved remotely through network infrastructure, development can also be carried out in accordance with the development of updated technologies such as using sensors and other hardware to implement collecting applications that increase efficiency and also improve the economy. Arduino as the heart of this project has a lot of functions and uses, in addition to economics, programming that is very easy and easy for us to develop on various application-specific applications on IoT-based implementations [2].

The project consists of a Hall effect current sensor that detects an electric current and produces a signal according to it, a microcontroller programmed to calculate Wattage and units, an LCD screen that shows the instant value of the desired output. The proposed project is to develop a prototype of the energy meter without actually using a conventional energy meter using a PIC microcontroller and Hall Effect current sensor, so the product cost will be much cheaper than the model discussed above. In addition, the Hall effect sensor senses a magnetic field caused by current, and can therefore measure absolute current. The data collected is stored in the EEPROM of the microcontroller so that when the power goes out, it will store the value of the energy consumed and will return.

reproduce it again when the power is on. Also this system will measure rates based on the burden and energy consumption [3]. By successfully implementing real-time hardware projects like this and providing end users with the information they need about energy consumption by household appliances, electricity bills can be reduced to a very large extent. The use of open software and open hardware technology will help future developers to modify circuits with future technology and develop better devices.

Arduino Uno is a microcontroller board based on ATmega328 (datasheet). Uno Arduino can be activated via a USB connection or with an external (automatic) power supply. External (non-USB) power can come from either the AC-to-DC adapter or the battery. This adapter can be connected by plugging a center-positive plug jack of a 2.1mm size POWER connector. The tip of the head of the battery can be inserted into the Gnd and Vin pin header of the POWER connector. The recommended range of power requirements for Uno boards is 7 to 12 volts, if powered by less than 7 volts the Uno pin may be 5 but can operate but is not stable then if the power is more than 12V, the voltage regulator can overheat and can damage the Uno board.

Previous research in [4] microcontrollers are unable to have large ac tension as an analog input. To compensate for high-voltage ac delivery, differential boosters are designed using lm358 operational boosters. A differential amplifier will increase the power of 230 VRMS ac voltage to lower ac voltage. PMAS (power monitoring and switching devices) generally adapter, the concept for a PMAS adapter is designed based on the voltage sensor components and current and because that would allow microcontrollers to measure electrical parameters such as voltage and current. As well as in research in [5] the results are we expected to be able to reduce the burden on customers and not make worry about the consumption and use of electricity that is too excessive so that it does not damage the equipment at home, with this system can also see the power capacity in the device used, easy to use, and reliable. Data is always stored in a large cloud. In this observation it is expected

II. SYSTEM BUILDING BLOCK

A. The Components and its building block

The system we will build consist of several components. Each component will have certain functions and its connected in certain configuration so it can deliver the functionality as we expected.

The components of the system consist of input, process, output and power supply.

a. Input section

This section is a collection of several sensors which have been arranged according to the circuit design which was previously designed in advance.

b. Process section unit

This section uses the arduino uno that works as a data processing center or can be said which CPU (Central Processing Unit) its job is to process all incoming data and data coming out. This section will examine input from ACS712 sensor and ZMPT101B Sensor

c. Output section

This section is the part that is controlled by Arduino Uno to one part, namely LCD and Wifi Module ESP 8266-01.

d. Voltage *supply* section

This section provides the voltage needed to all components like arduino uno, sensors, Wifi Module and LCD.

Each component above we set together so its form the configuration of system building block as shown in figure 1. Each component needs several detail configurations that we will discussed later. Table I show the functions of each component.

B. Circuit Design

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Design a circuit here in other words analyze and make a circuit design pattern which is the first step before it is used to support performance system. In this series there are several designs from hardware include:

- Arduino Uno circuit design
- AC to DC Power Supply Design
- ACS712 Sensor Module circuit design
- ZMPT101B Sensor Module circuit design
- ESP 8266-01 Wifi Module Design
- LCD circuit design

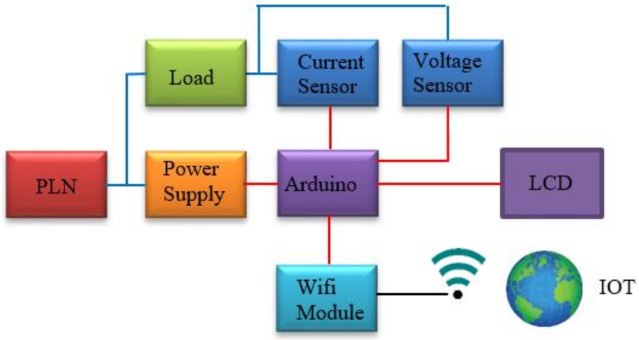


Figure 1. Building Block of Microcontroller system for monitoring electricity power usage.

Table I. The Components and its function

No	System Block	Function
1	Arduino uno	As a data processing center
2	ACS712 sensor	As a connecting Arduino and Electric Current Load
3	ZMPT101B sensor	As a connecting Arduino and Electric Voltage
4	LCD	As displaying results Arduino processed electric power
5	DC Voltage of 5V and AC 220V	As a source of voltage on Arduino and Load
6	Wifi Module ESP 8266-01	As a bridge sending data to the internet via wifi
7	Push button	As a sitch On / Off device

a. Component Installation

The activity of assembling or installing each component is basically installing it into Arduino Uno. This matter because Arduino Uno is the brain where everything is other components or sensors to this main component (arduino uno).

b. Testing each series

Overall testing is the thing important because from here hopefully later get definitive conclusions about systems that are already made.

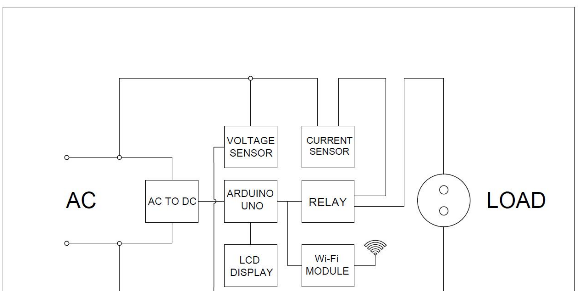


Figure 2. The Series

III. RESULT AND DISCUSSION

A. System requirements:

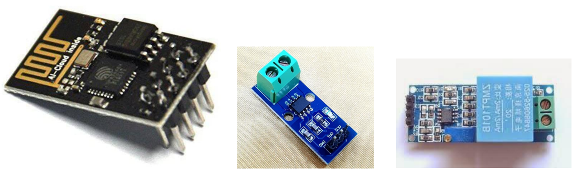
The requirements of the monitoring system that would be provided are:

1. To be able to read electricity usage data, a voltage sensor and current sensor are used, the output of which will be converted through the Arduino Uno microcontroller so that it can be displayed by display displays

2. Information data obtained at the microcontroller output can be sent to the internet via a wifi module integrated with the microcontroller
3. The data sent is connected to the IoT provider web server and can be read by the user by accessing the page on the web using a PC computer or cellphone
4. Home users / owners will get notifications via piezoelectric buzzer installed on the device as an alert if usage exceeds the set limit

B. Prototype Sensor

We build the prototype of the sensor as shown below.



Wi-Fi module esp8266	Voltage sensor ZMPT	Current sensor ACS 712 101B

Figure 3. The Prototype Components

C. System Workflow

The outline of making a system workflow is to make it easier to write program code and create a system flowchart later. The system will work if Arduino Uno has obtained a voltage and current supply of 5 Volt DC generated from the AC to DC module as well as other components. Here's how the system works:

The first step is to create a schematic and prototype model or sample tool that will be produced

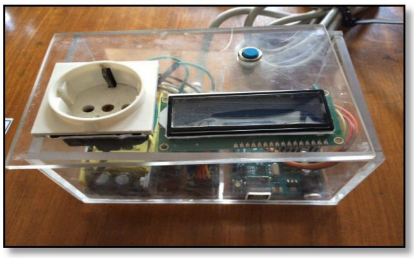


Figure 4. The Prototype Sensor Tools

The second step After completing the tool design stage, the next step is to arrange and stick pins in each position that has been determined and in accordance with the procedure

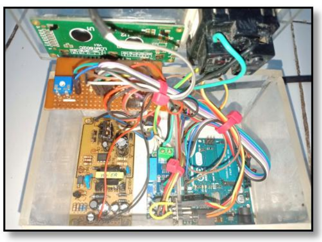


Figure 5. Complete Circuit

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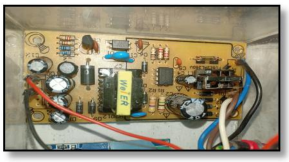


Figure 6. AC to DC Module , Input 220 VAC – Output 5VDC

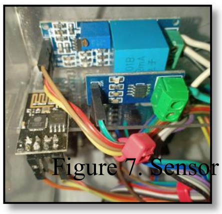


Figure 7. Sensor Block, Voltage Sensor, Current Sensor, Wi-Fi Module

Figure 8. Display LCD Modul

3. Conducting testing each module includes modules:

Arduino Uno Testing

Tool testing is carried out to find out whether the planned tool is working properly or not. System testing conducted by the author is the Arduino uno microcontroller module, LCD 16x2, RTC DS1307. For arduino uno communication modules can be done with one computer or laptop unit. For testing RTC DS1307 can be done by making a Text banner.

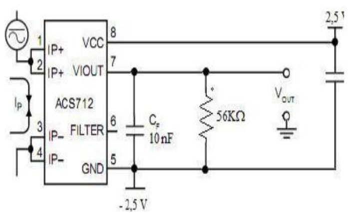
Figure 9. Arduino testing with LEDs

In figure 9,it can be seen that the Arduino uno microcontroller can work as desired, both with power supply and with power that comes from the USB module (Universal Serial Bus).

Testing the ACS712 Sensor and ZMPT101B Sensor

The steps to carry out this test are:

1. Connect the Arduino uno to the USB (Universal Serial Bus) port on the computer. In this way the module will be active, because it directly gets power supply from the USB port (Universal Serial Bus).
2. Open Arduino IDE, select Tools> Serial Port> select the serial port as detected in the device manager.
3. Connect the ACS712 Sensor and ZMPT101B Sensor on VCC pin to Arduino 5v, GND pin on Arduino groud GND and Out pin to Analog A0 (Current Sensor) and A1 (voltage sensor)
4. Enter the current sourced from the adapter on Arduino while on ACS712 and ZMPT101B at the input load from the AC current using the incandescent lamp load.



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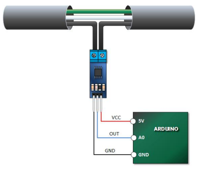


Figure 10. ACS712 sensor circuit schemeZMPT101B Voltage Sensor

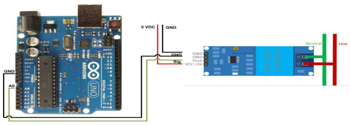
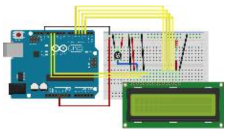


Figure 11. ZMPT101B sensor circuit scheme

Testing the LCD Module

The steps to carry out this test are by reference to the 16x2 LCD mounting schematic:



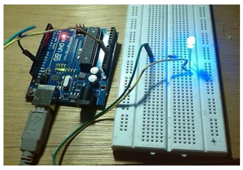
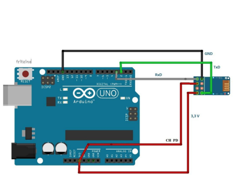


Figure 12. Schematic of the LCD installation

Testing ESP 8266 Wifi Module



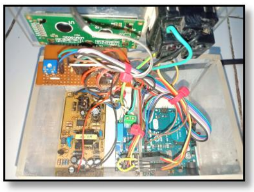


Figure 13. Wiring Arduino to WiFi module ESP 8266-01

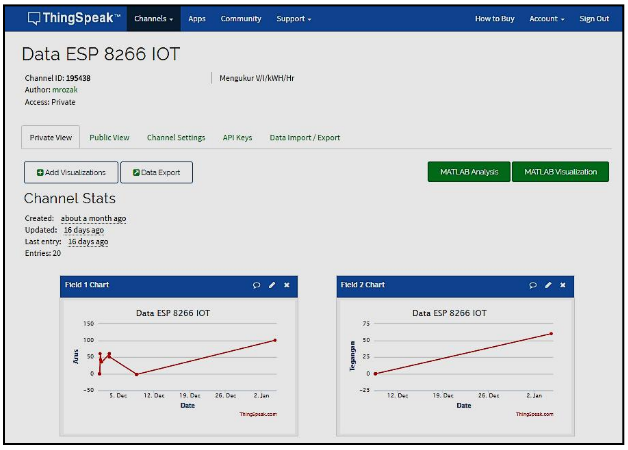
ESP8266 is a WIFI module to connect microcontroller equipment to the Internet. The ESP8266 module is very small, and uses a voltage of 3.3V. There are many variants of the ESP8266 module available on the market. The author uses the ESP 01 module.

Communication testing

Communication with this module uses a serial port with commands in the form of AT Command, as in the GPRS module. Arduino is used as a 3.3V power supply for ESP8266 and as a liaison between the computer and ESP8266.

The author uses Arduino only as a liaison between ESP8266 with a computer, so it does not require any sketch to just fill in the blank sketch into Arduino.

```
void setup() {
// put your setup code here, to run once:
}
void loop() {
// put your main code here, to run repeatedly:
}
```



After an empty sketch was uploaded to Arduino, I dabbled at the AT command via Serial Monitor.

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AT Command

The AT command is used to assure us that the AT Command can be well received by ESP8266.

```
AT
OK
```

Join the WIFI network

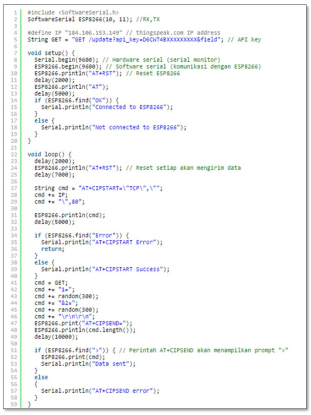
```
AT + CWJAP =
"myWifi",
"password"
```

When your device is turned off, the WIFI connection settings will still be saved, so the next time you turn on the device, ESP8266 will automatically connect.

Arduino + ESP8266 connection to ThingSpeak

ThingSpeak is an Internet of Things platform that can be used free of charge to display charts of IoT equipment. In this experiment the author does not use sensors. I only send data randomly to the ThingSpeak server.

ESP8266 is connected to pins 10 and 11 on Arduino, and communicates using the Software Serial library. The Serial Port on Arduino is used to communicate with Serial Monitor, to facilitate debugging.



```
#include <SoftwareSerial.h>
SoftwareSerial ESP8266(10, 11); //RX,TX

#define IP "184.106.153.149" // thingspeak.com IP address
String GET = "GET /update?api_key=D6CWT4BXXXXXXXXX&field"; // API key

void setup() {
  Serial.begin(9600); // Hardware serial (serial monitor)
  ESP8266.begin(9600); // Software serial (komunikasi dengan ESP8266)
  ESP8266.println("AT+RST"); // Reset ESP8266
  delay(2000);
  ESP8266.println("AT");
  delay(5000);
  if (ESP8266.find("OK")) {
    Serial.println("Connected to ESP8266");
  }
  else {
    Serial.println("Not connected to ESP8266");
  }
}

void loop() {
  delay(2000);
  ESP8266.println("AT+RST"); // Reset setiap akan mengirim data
  delay(7000);

  String cmd = "AT+CIPSTART=\"TCP\",\"";
  cmd += IP;
  cmd += "\",80";

  ESP8266.println(cmd);
  delay(5000);

  if (ESP8266.find("Error")) {
    Serial.println("AT+CIPSTART Error");
    return;
  }
  else {
    Serial.println("AT+CIPSTART Success");
  }
  cmd = GET;
  cmd += "1=";
  cmd += random(300);
  cmd += "&2=";
  cmd += random(300);
  cmd += "\r\n\r\n";
  ESP8266.print("AT+CIPSEND=");
  ESP8266.println(cmd.length());
  delay(10000);

  if (ESP8266.find(">")) { // Perintah AT+CIPSEND akan menampilkan prompt ">"
    ESP8266.print(cmd);
    Serial.println("Data sent");
  }
  else
  {
    Serial.println("AT+CIPSEND error");
  }
}
```

Figure 14. Script Program

Following are the results of data acquisition on the ThingSpeak server.

Figure 15. ACS712 sensor circuit schemeZMPT101B Voltage Sensor

IV. Conclusion

It can be concluded from the results of the design of Monitoring of Electric Power Usage Monitoring Using IOT-Based Microcontroller which was built from an effort that has been made to make a practical model of IoT based on Smart Energy Meters. 'The propagated model is used to measure the use of household electrical energy, and even makes the energy unit work for the use of electric current by using an IoT and arduino-based device. Therefore, with this system, we can reduce energy waste and produce information from an electric power usage that is used and informs all of us, especially our users. In fact it will reduce manual intervention in the use of existing electricity.

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```
AT + CWJAP = "myWifi",
"password"
WIFI CONNECTED
WIFI GOT IP
OK

OK
```

```
AT + CWJAP = "myWifi",
"password"
WIFI CONNECTED
WIFI GOT IP
OK

OK
```

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