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Control and Monitoring Air Conditioner: Perspective of Internet of Things

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Abstract

Air conditioner is mainly used for human to comfort themselves. In the tropical country, air conditioning is important for the purpose of cooling the environment to overcome the heat in Malaysia. However, the usage of air conditioning is uncontrollable and it brings the increasing of energy usage, electricity bills and carbon emission toward the atmosphere. This aim of this study is to develop an Internet of Things (IoT) meter as a data extraction tool. This IoT meter consists of NodeMCU board, which is an open source Internet of Things embedded with ESP8266, Wi-Fi system on chip. Sensors used to monitor the energy management of the selected room, able to detect voltage, current, power, energy, temperature and humidity. The microcontroller is responsible to transfer all the collected values to an open cloud server in the presence of internet. These outcomes have been transferred to the database known as phpMyAdmin and act as storage through ESP8266 microcontroller in the presence of internet for users' monitoring purposes. User able to turn on/off the electrical appliances using the application installed in the mobile phone at any moment.

Keywords; *Internet of Things, Energy Management system, IoT Meter, Hypertext Preprocessor, Cloud Storage*

I. INTRODUCTION

The Internet of Thing has become more popular due to most people are using smartphone in this aged. The IoT network technology was created in 1999 by a member of Radio Frequency Identification, called as RFID [1]. IoT is a technology that uses the internet to connect the entire device to communicate each other as a medium. The IoT is wireless and widely used because the IoT can monitor and control almost all electrical and electronic appliances by using internet. The IoT utilize the internet for accessing the cloud to communicate with each other, thus this technology can control the device from any range and anytime[1].

This study is aiming to control and monitor the air conditioner using the Internet of thing (IoT). The proposed design helps the individuals to monitor the information and control the system remotely using the mobile application via the internet connection. By applying the IoT technology, the system can be more efficient and reliable due to the ability to assess the intended data for all the time.

Element of smart control mechanism for air conditioner in the modelling needed to avoid the waste of energy produced by air conditional. This study can monitor and control electrical equipment from anywhere and anytime. People tends to forget turning off the electrical appliances before leaving their home or office [2]. Technique of controlling the system has been considered for sensing circuits, that turn on and off the air conditioner whenever no one is at home or at work. Therefore, the air conditioner controlling system has been modified to make the room temperature control system more

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efficient by adding a system where it can control and monitor room temperature from anywhere.

II. LITERATURE REVIEW

There are many types of wireless connection that are using in Wireless Automation System (WAS) such as Bluetooth, Global System for Mobile Communication (GSM), Zigbee and Internet of Things (IoT). The previous studies have been made for all types of wireless connection technology in wireless automation system (WAS). Firstly, Bluetooth based on remote monitoring and control system. The system uses Bluetooth as medium of wireless communication between a mobile phone and the central controller [3]. Secondly, Temperature and Humidity Monitoring System Based on GSM Module[4]. They use GSM to enable the users located globally to work together using mobile phone cellular network and allow the users to get real-time data of temperature and humidity [5]. Thirdly, is the Wireless Home Automation System using Zigbee. In that study, it explained the Zigbee is a low-power, robust, mesh network and interoperability of wireless communication technology design for remote controlling and monitoring of devices [6]. The ZigBee has a limited physical range of between 10 and 20 meters only, and the ZigBee be able to increase its distance up to 150 meters using direct sequence spread spectrum (DSSS) method [7]. Lastly, is Smart server IoT based temperature Monitoring System and it uses the Internet of Things to monitor the temperature for the server room. An application can publish the current temperature of the server room for 2 second [8].

III. METHODOLOGY

A. Data Generation to Storage

Figure 1 shows how the study will operate and firstly the user needs to connect the smart device to the Wi-Fi router. Then, the DHT22 and PZEM-004T sensor will sense voltage, current, power, energy temperature and humidity for one minute interval.

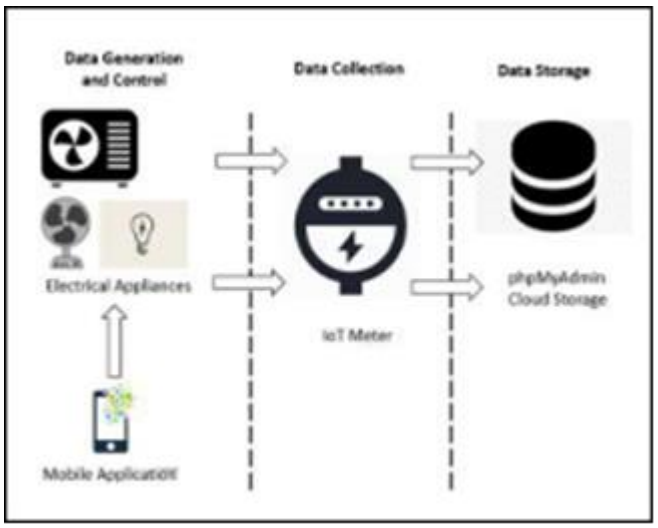

Figure1: Block Diagram

The IoT meter will transmit all the data that have been collected from the sensor to the 000webhost as a cloud. The cloud will sort and arrange all the respective data from the IoT meter into the database. The users can control the appliances via the mobile application and they can choose either want to turn on/off the appliances at anytime and anywhere as long the users and IoT meter connected to the internet.

B. Overview on HVAC system of the existing EMS

Viewing on the existing HVAC data create a form of discrete function as below.

25% 26°

equation (1)

, (%) = (35% 21°)

equation (2)

45% 16 °

$$, (\quad h) = \sum \ . \quad (\quad h)$$

The data shows the differences of five degrees Celsius of temperature in the HVAC system, and it increase the energy consumed by 10%. Therefore, it is important and crucial to control and monitor the system as the effect is very significant.

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C. Smart Device Flowchart

Figure 2 shows the detail flowchart for this study. First, setup the smart device to Wi-Fi, where the user needs to set up the Wi-Fi network with the smart device in order to make the system to be enable. When the setup of Wi-Fi is successful, then the initialization of related devices will take place. The system starts to extract all data from the sensor in the interval of one minute. All the data will go through the NodeMCU for the next process. The microcontroller will then transmit all the data to be sent to the cloud via the internet. The cloud will start to connect the database for storing process and it uses the Application Programming integration (API) to access the database. When the cloud has the access to the database, the cloud will arrange all the data to into the table in the database. The process of updating the data and storing the data operate in the interval of one minute.

Figure 2: Smart Device flowcharts

D. Android Apps Smartphone Flowchart

By referring to Figure 3, it shows the flowchart for the Smartphone apps that have link with the smart device. This application is used to control and monitor the temperature and humidity of the room. The smart device will send the data of temperature and humidity in the room through the apps, so the user able to monitor the environment of the room through the application.

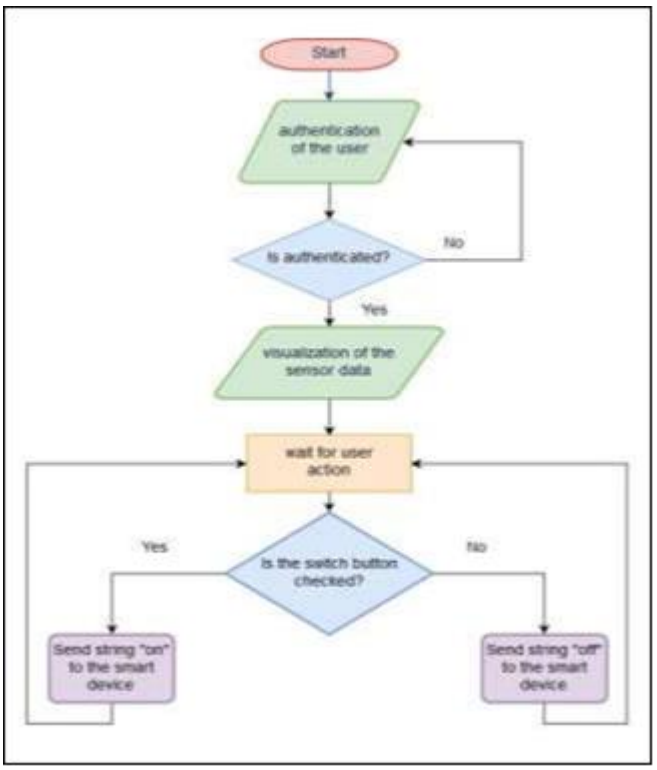

Figure 3: Android Apps Smartphone Flowcharts

The application starts with authentication of the user, where the user needs to login the id and password for safety purpose. Then after the authentication of user done, the application will display the visualization of the sensor data that has been received from the smart device on the temperature and humidity of the room. Then, the user able to make a choice to control the electrical appliance by switching on or off in the smartphone application. Whenever the user chooses to turn on/off the electrical appliances, the application will send the instruction to the smart device to turn on/off the electrical appliances.

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IV. COMPONENT USED

There are several components and software will be used in order to complete this study such as NodeMCU, relay, rectifier, PZEM-004T and DHT22 sensor, smartphone and electrical socket. the software that will be used is Arduino IDE.

V. RESULT AND CONCLUSION

A. 0020Overview on Existing Energy Management System (EMS)

A review on existing EMS specifically on the theatre area where the usage of HVAC system is high. Researchers emphasized more on the correlation of temperature and the power consumed by the tenant. This overview is important as before moving further onto developing as meter, it is crucial to know the impact of the mentioned elements.

B. Highlights on Heating Ventilation Air Conditioner

Since the study is based on developing a smart device for air conditioner, HVAC system is perfect example for the researcher to look into. Thus, a data on related elements has been taken from the existing EMS such as temperature was taken manually, the maximum demand and power consumption are extracted directly in CSV file form from the data storage of EMS developer. Figure 4 shows on display of the dashboard of the propose system.

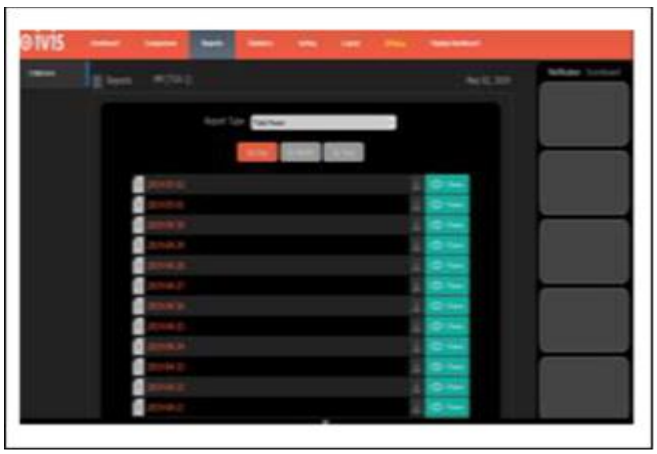

Figure 4: Dashboard of existing EMS

C. Correlation Between Temperature and Power Consumption

As seen below, the actual power consumption as series 1, series 2, 3 and 4 are 25%, 35% and 45% consecutively. The calculations are made through a CSV file listing extracted from the existing EMS. After a detail observation made by the company's audit team it is decided the composition difference as above.

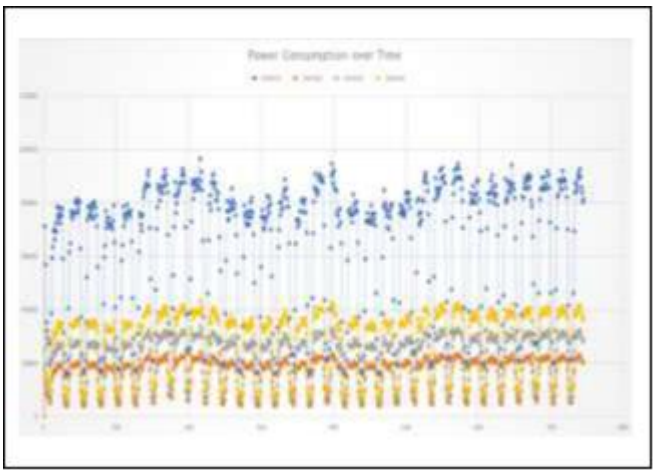

Figure 5: Power Consumption Over Time for a total of 4 elements

By referring to formula 3.1 an and 3.2, the visualization performed in excel. The blue line indicates the energy consumed by the whole system. Meanwhile, the yellow as 45% energy consumed if the HVAC system measured to be 16 ℃. The grey line as 35% energy consumed if the temperature denotes as 21 ℃ and lastly, orange line as 25% energy consumed if maintained at 26 ℃. In summary, the visualization showed the significance effect of the importance to monitor and control the HVAC system.

D. Implementation of Data Extraction

Before the data extraction process could be established, a thorough review has been done from a previous case study in the industry of EMS. Whereby, a complex IoT meter was developed by the industry key person. In order to mimic the IoT meter to be implemented in this study of university

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building, the mechanism of the meter was studied and Internet of Thing meters was built from scratch as mentioned in previous chapter.

E. Installation of Data Extraction Tools

Initially, the study needs to build the IoT meter to make the system operate. The DHT22 and PZEM-004T sensor was implemented to the system in order to read the voltage, current, power, energy, temperature and humidity on the environment. The system has been setup to collect the data in the interval of one minute.

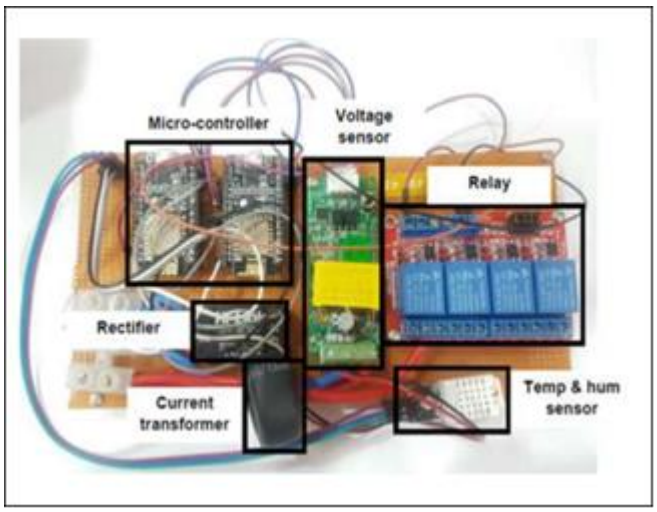

Figure 6: The bare section of IoT meter

The data that has been extracted from IoT meter will be uploaded to the open cloud database as a storage medium. Before the IoT meter start extracting the data, there are few stages where the meter needs to be go thru.

VI. CONCLUSION

In this study, a smart device has been designed in order to control and monitor the room temperature of electrical appliances concern on air conditioner. Smart device which was proposed in this study consists of NodeMCUboard, an open source Internet of Things (IoT) embedded with ESP8266 Wi-Fi system on chip (SoC) that act as a microcontroller for controlling purposes. NodeMCU ESP8266 runs Arduino coding that has been design using an integrated development environment (IDE) software application. Sensors used to monitor the energy management that able to detect voltage, current, power, energy, temperature and humidity. All the values that have been extracted will be transferred to the NodeMCU microcontroller with the help of a basic chip that able to convert the collected values in the form of programming language that can be read by the microcontroller. The microcontroller is responsible to transfer all the collected values to an open cloud server in the presence of internet. Smart device also consists of one channel 5V relay that is connected to the air conditioner at the room in order to receive information from microcontroller and send commands to the appliances due to the capability of the relay in controlling the electrical flow.

Application software also has been designed to complete the purpose of this study to control the on/off air conditioner. This application has been written in MIT programming using MIT App Inventor and has been installed in the mobile phone that can be access by users by giving and Identity Document (ID) number and password. Smart device will send all the information of voltage, current, power, energy, temperature and humidity collected in a room with the help of PZEM-004T and DHT22 sensor. These outcomes have been transferred to the database known as phpMyAdmin and act as storage through ESP8266 microcontroller in the presence of internet for users' monitoring purposes. User able to turn on/off the electrical appliances using the application installed in the mobile phone at any moment. Smart device will receive this command via microcontroller and automatically send the information towards relay for on/off switching purposes of the electrical appliances. This study can be improved in the future and the recommendations required are, firstly include Liquid crystal display (LCD) together with the Internet of Things (IoT) meter to bring convenience towards user for monitoring the extracted values directly. Secondly,

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application software at the mobile phone need to be modified and improved for monitoring purposes without accessing to web browser. And lastly, prediction on extracted data consists of voltage, current, power, energy, temperature and humidity can be done by using Big Data Analytic and Artificial Intelligence (AI) for energy saving.

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