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EXTENDING THE CAPACITY OF AN RFID TECHNOLOGY AND REAL TIME CLOCK IN CONTROLLING THE POWER DISTRIBUTION OF MCNP-ISAP

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Abstract

This research paper addresses the issues of energy waste and inefficiency in the context of increasing energy consumption and environmental concerns. It focuses on the implementation of an efficient energy management system in schools, with a specific case study of MCNP-ISAP. The system utilizes RFID technology, a real-time clock (RTC), and energy consumption monitoring to control the power distribution of air conditioners according to the school's 10AM-3PM Policy. The research methodology employed in this study follows a developmental descriptive approach, with the Agile Development Methodology utilized for system development. The study involves several phases, including problem definition, background research, specifying hardware requirements, system development, testing, result communication, and data analysis. The proposed system utilizes components such as Arduino Uno, ESP8266 NODEMCU, 5V-Relay, ACS-712 Current Sensor, RFID Scanner, RFID Tag, and the Blynk Application. The integration of these components allows for real-time monitoring and control of air conditioner usage, ensuring adherence to the 10AM-3PM Policy. The ACS-712 Current Sensor is used to measure energy consumption accurately. The research findings indicate that the system successfully controls air conditioner usage based on scheduled times, reducing energy consumption by approximately 55%. Actual energy consumption measurements were compared to theoretical calculations, showing a small gap due to residual power draw even when the air conditioner is not in use. In conclusion, the Mobile Application Based RFID and RTC Switch with Energy Consumption Monitoring system proves to be an effective and efficient solution for implementing energy management policies in schools. It offers significant energy savings and can be recommended for full implementation. Future recommendations include expanding the system to cover all offices with air conditioners, exploring additional features such as temperature control and voice commands, and further research and innovation in the field of energy efficiency.

Key words: Energy, Sustainable, Sustainable Energy

INTRODUCTION

The global population growth and the increasing importance of energy consumption in the context of climate change have highlighted the issue of energy waste and its negative environmental impact. In the Philippines, hydroelectric power plants, which generate 90% of the country's electricity, face challenges during the dry season when water levels drop to critical

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levels, leading to water shortages and rotating power outages in different areas (Mincher, 2013). This situation is exacerbated by mountain deforestation, which has hampered the ability of these dams to meet the energy demands of the country. Additionally, energy consumers in the Philippines are not utilizing electricity efficiently, contributing to waste and environmental harm (Department of Energy, 2018).

To address these issues, an efficient energy billing system with real-time consumer load tracking is required to ensure proper billing, track maximum demand, and establish threshold values. Manual billing and traditional human-operated metering systems are slow and imprecise (Mohamed Mufassirin & Hanees, 2018; Mohamed Mufassirin & Hanees, 2014). Integration of technology becomes crucial in such scenarios. Various technological solutions have been proposed to reduce energy consumption, such as the use of RFID-based systems for home or office automation, which enable active light switching based on simplified position monitoring (Clark, 2011). Another example is the development of automatic street light control systems based on real-time clock and light-dependent resistors (Rampelli, 2013). RFID-based line switching using solid-state relays has also been explored to power appliances based on RFID tags (Michael E. et al., 2017). Additionally, GSM-based automated power meter reading systems have been proposed to improve energy usage monitoring and billing (Tan et al., 2007). Prepaid digital energy meters have been suggested as a replacement for electromechanical ones to reduce revenue losses and inaccuracies in meter reading (Jain et al., 2011). In the context of schools, which hold a significant social responsibility, energy efficiency is crucial. However, a study conducted in December 2019 found that a policy requiring office air conditioners to be turned on at 10 a.m. and off at 3 p.m. was not consistently followed by respondents, with only 15% adhering to the policy (Darshan & Radhakrishna, 2015). To address this issue and improve energy management, the researchers propose a power distribution system controlled by RFID, a real-time clock, and energy consumption monitoring. The system includes a mobile app that allows users to monitor office energy consumption in real time, thus facilitating adherence to the air conditioner policy (Darshan & Radhakrishna, 2015).

In summary, addressing energy waste and promoting energy efficiency is crucial in the face of global population growth and climate change. Various technological solutions, such as RFID-based systems, Automatic Street light controls, prepaid digital energy meters, and real-time energy consumption monitoring, have been proposed to improve energy management and reduce waste. Schools, as educational institutions with significant social responsibility, can play a vital role in promoting energy efficiency through the implementation of effective energy management systems.

RESEARCH METHODOLOGY

This area presents and discusses the overall operation, graphical representation, diagram of the sequence of operation and the components of the whole system.

This study used developmental-descriptive research for the development of the system. Developmental research was used for the designing and developing the functionality of the system while Descriptive Research was used to assess the effectiveness and efficiency of the

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system. The researchers opted to implement the system to show the functionality on how it will address the full implementation of the 10AM-3PM Policy in air conditioners. Also, in this study, the researchers will use the Agile Development Methodology to achieve the objectives of the study. It was supported through in the study of Andrei Gat et.al (2018) that using Agile Development Methodology can achieve better outcomes faster through the use of a dynamic, systematic and collaborative framework.

A written permission will be secured from the school administration through channels in order to obtain full cooperation from employees to test the system in the Accountancy Simulation Room. When the permission will be granted, the researchers will arrange appointments to use the Accountancy Simulation room for initial implementation to measure the effectiveness and efficiency of the system.

Lastly, Surfing the internet was used to search for literature regarding our study. As a result, the researchers used those documents as our related literature. The researchers recorded and analyzed the energy consumption of the accountancy laboratory in to two different time, 8:00AM-5:00PM and 10:00 AM-3:00 PM.

After all the data had been collected, an analysis of it has been carried out to conclude all the findings and assemblage the data into their percentage and average. This is done to come out with a list of figures and tables discussing each question. The data collected is first recounted to make sure that the system was conducted in a proper manner. After that, an analysis of the data collected was and totaling them up in a form of percentage/mean. Then, the percentage and mean of each data is transmitted into the different charts provided by the computer.

PROJECT DEVELOPMENT PHASE

First Phase: Define the Problem. In this phase, the first is making research in finding the best project to propose. After we get the information about the project, proposal is submitted and defended. The proposal consists project background, problem area, objectives and project requirement. This is the most important thing to do in phase planning.

Second Phase: Do Background Research. The researchers gather their data through a questionnaire/checklist used to determine the extent of implementation of the 10AM-3PM Policy of the School. Manual monitoring by the General Services Offices in turning on and turning off the air-condition of MCNP-ISAP Admin offices.

Third Phase: Specify Requirements. Hardware requirements in developing the proposed system:

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Components	Description
Arduino Uno	This will serve as the central processor of the work. It is the component that receives and process data for further control actions.
ESP8266 NODEMCU	It is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.
5V-Relay	Relays are switching that open and close circuits electromagnetically and electronically.
ACS-712 Current Sensor	It is a sensor that is used to measure the energy consumption.
RFID Scanner	It is a data capture device responsible for communicating with tags, applications and computer networks.
RFID Tag	An RFID tag include a microprocessor, transmitter and a radio antenna that allows data from the tag to be read and written contact less between the reader and the tag.
Blynk Application	It is a Platform with IOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets

Fourth Phase: Develop and Prototype Solution. The researchers develop a System Architecture that shall be adopted for the development of the project. The system architecture shows how the system flows, how the system works and the connection of the different components used of the developers to create the project.

Fifth Phase: Test and Redesign. In this phase, all functionality of the system are tested and confirm if there are no error and record the entire not function requirement and correct it.

Sixth Phase: Communicate Results. After the development of the system, the systen will be presented to CpE Instructors and other faculty of ISAP. Suggestions and Recommendations will be made as a basis to remodel/redesign the project.

RESULT AND DISCUSSION

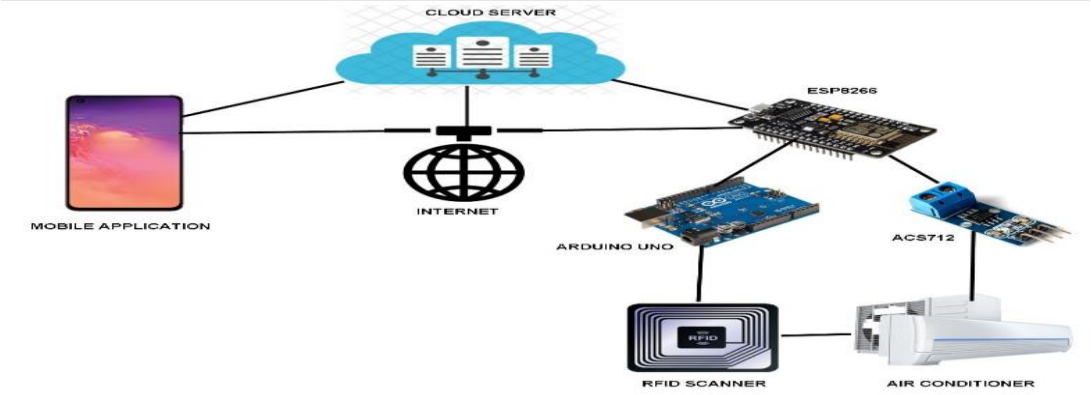

Figure 1: Architectural Design of the Project

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The Figure 1 shows all the required components used for the development of this project. An e-mail address of the user will be used in order to have an access the Mobile Application Platform of the system. The Real Time Clock of the Mobile Application was used to check the real time and check if it is ON time and OFF time. If the time is Turn-On Time, the relay will turn on the Arduino Uno where the RFID was connected to it. The RFID Scanner will now turn on. The tag is activated when it passes through a radio frequency field (125 kHz in this case), which is generated by the antenna embedded within the reader box. The program checks whether the tag is valid or not. If the tag is valid, it will turn on the air conditioner. If the tag is valid, the air conditioner will turn on. When the turn-off time comes (3 o'clock), the air conditioner and the RFID Scanner will automatically off.

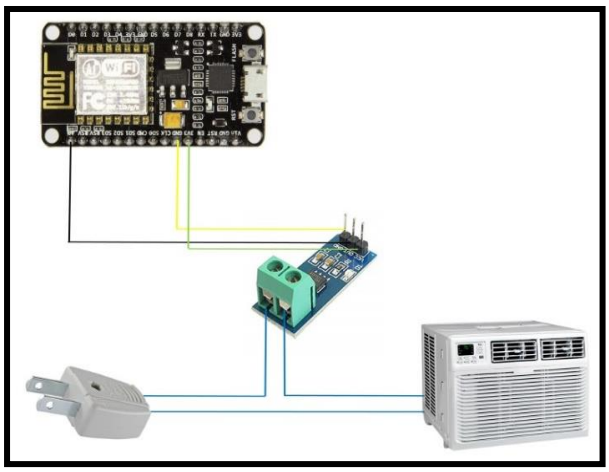

Figure 2: Energy Consumption Meter

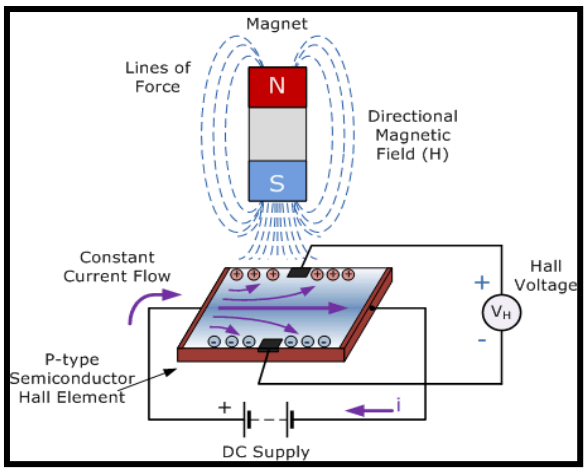

Figure 3: Hall Effect in Current Sensor

In this study, the researchers used ACS712-30A current sensor to determine the electric consumption of air conditioner. The ACS712-30A is a module works on the principle of Hall-effect, which was discovered by Dr. Edwin Hall. According in his principle, when a current carrying conductor is placed into a magnetic field, a voltage is generated across its edges perpendicular to the directions of both the current and the magnetic field. The current sensor uses an indirect sensing where the current is measured by calculating this magnetic field by applying either Faraday's law or Ampere law. To sense current a liner, low-offset Hall sensor circuit is used in the Integrated Circuit (IC). This sensor is located at the surface of the IC on a copper conduction path. When current flows through this copper conduction path it generates a magnetic field which is sensed by the Hall effect sensor. A voltage proportional to the sensed magnetic field is generated by the Hall sensor, which is used to measure current.

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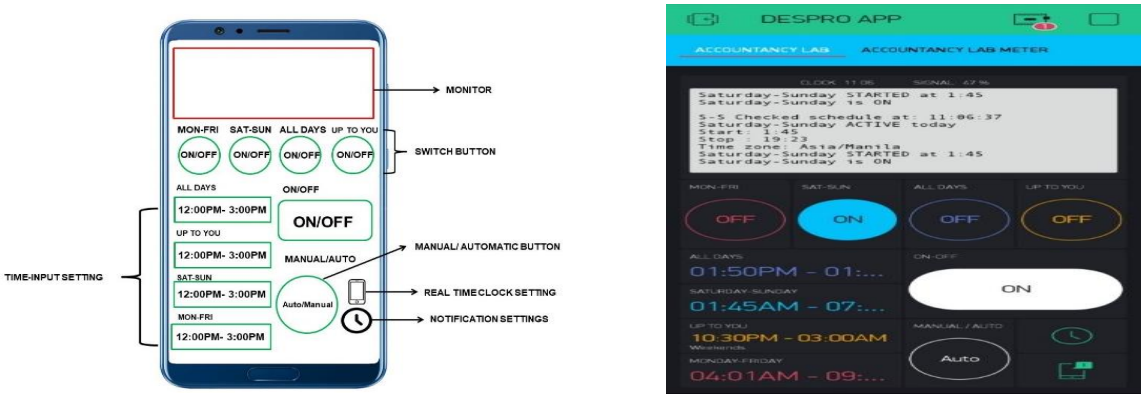

Figure 4: The Mobile Application Layout in Scheduling Turn-On and Turn-Off

Mobile Application Based RFID and RTC Switch with Energy Consumption Monitoring

Based on the findings of the researchers in the extent of implementation of the 10AM-3PM on turning on and turning off of air conditioner, the researchers design a system named Mobile Application Based RFID and RTC Switch with Energy Consumption Monitoring wherein it is design to control the turning on/off of air conditioners based on its scheduled time through a mobile application anytime and anywhere. Once the scheduled time in turning on is reached, the RFID Scanner will now turn on. Thus, the RFID Tag and RFID Scanner will serve as the switch where the users can now turn-on the air conditioner and allow the user to monitor its electric consumption through the use of internet anytime and anywhere. Through this project, it offers an alternative way of reducing energy consumption and effectively and efficiently handles the extent of implementation of the 10AM-3PM Policy of the MCNP-ISAP using Radio Frequency Identification (RFID) technology, Real time Clock and a Mobile Application. The system worked using a Mobile Application through its Real Time Clock.

OBSERVATION RESULTS

Table 1: Comparison of Energy Consumption of Air conditioners at 16 degrees Celsius

Time	Temperature	Energy Consumption		Percentage Error
		Actual	Theoretical	
10 AM- 3PM	16°C	7.673 kWH	7.457 kWH	2.90%
		7.685 kWH	7.457 kWH	3.06%
		7.681 kWH	7.457 kWH	3.00%
8AM-5PM	16°C	13.969 kWH	13.422 kWH	4.08%
		13.973 kWH	13.422 kWH	4.11%
		13.983 Kwh	13.422 kWH	4.18%

Based on the findings, in terms actual measurement, 7.673 kWH,7.685 kWH and 7.681 kWH was consumed of electric consumption from 10AM-3PM while 13.969 kWH, 13.973 kWH,and 13.983 Kwh from 8AM-5PM at 16 degree Celsius of temperature. On the other hand, in theoretical approach,7.457kWH will be used from 10AM-3PM and 13.422kWH will be consumed from 8AM-5PM at 16 degrees Celsius of temperature. The small gap between the

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actual and theoretical approach was caused by the system on how long the system was plugged in. Even the air conditioner was not started to turn-on, once the plug is connected to the source it will generate electrical energy. It was supported by Josh Crank (2018) that appliances and electronics that was plugged in draw small amount of electronic power even when we're not using them.

Table 2: Comparison of Energy Consumption in terms of Temperature and Time

	Temperature	Time		Energy Saved
		10AM-3PM	8AM-5PM	
Energy Consumption	16^{O}C	7.673 kWH	13.969 kWH	54.93%
		7.685 kWH	13.973 kWH	54.99%
		7.681 kWH	13.983 Kwh	54.93%
	25 ^{O}C	5.493 kWH	9.987 kWH	55.00%
		5.502 kWH	9.994 kWH	55.05%
		5.495 kWH	**9.989** kWH	55.01%

Based on the table, the system can reduce approximately 55% of electric consumption of each air conditioner. This implies that it is recommended that this should be implemented fully in order to attain the best results.

CONCLUSION

Based on the results on the finding, the researchers concluded the following: through the use of microcontroller and sensors we can developed a system that control the power distribution of air conditioners in each office. The project cost proves this system as acceptably low-cost as well as cost effective to its operation; the Mobile Application Based RFID and RTC Switch was efficiently and effectively in implementing the 10AM-3PM Policy of the School; through the use of ACS-712 current sensor, we can measure the accurate electric consumption of each air conditioners in each office, lastly, by using the system, we can save 55 percent of electric consumption.

RECOMMENDATIONS

This project was effectively made and designed and so the designers would like to recommend the following:

1. It is recommended for the parties' interest to implement the Mobile Application Based RFID and RTC Switch with Energy Consumption Monitoring to ensure that the 10AM-3PM Policy was implemented properly.
2. It is also recommended to include all offices inside the school that have air conditioners.
3. It is recommended that this should be implemented fully in order to attain the best results.
4. It is recommended that they can open the air conditioner early than 10 AM as long as they set it from 25 degrees Celsius.

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5. It is recommended that the future researchers will conduct an innovation to this project like adding a temperature control in mobile application and voice command features.

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