Development of Electricity Consumption and Monitoring System Using Internet of Things and Raspberry

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ABSTRACT

In this study, the scientists collected the features of Internet of Things (IoT), Android smart phones and Raspberry Pi for surveillance and control. The electrical power usage of user's devices was monitored by an android smart phone. An app to monitor and control the user's energy use of the Android smart phone was installed. In addition, a database for storing information from android applications and sensors has been created. The system has been tested using various electrical equipment and the outcomes have been shown. Based on the outcomes, the scheme was highly accurate (99.5%) for certain systems, while the accuracy (18.5%) for some other systems was very small.

Keywords: electricity consumption; monitoring, control, IoT, Android, Raspberry Pi.

CISDI Journal Reference Format
Olawuni, A., Ola, B.O. & Ogunwuyi, O.J. (2019): Development of Electricity Consumption and Monitoring System Using Internet of Things and Raspberry. Computing, Information Systems, Development Informatics & Allied Research Journal. Vol 10 No 4, Pp 65-75. Available online at www.cisdijournal.org. DOI Affix - https://doi.org/ 10.22624/AIMS/CISDI/V10N4P6

1. INTRODUCTION

Technology improves day by day right now, it is increasingly necessary to own a smart phone. A smart phone can do multiple stuff that makes it easy for smart phone owners to have one rather than none. The Internet is also available on smart phones, which is crucial for smart phone owners. The use of the Internet–the world's largest computer communication is now influencing the present technology strongly. For businesses, scholars, personal communications to public networks the Internet can be used everywhere. As of now, the Internet is being used on a number of devices to control such devices, which are known as the Internet of Things (IoT), wirelessly and automatically operated.

In addition Microcontroller are often used in addition to the programmed languages like python and C++, (Bonganay *et al*, 2014; Srikanth, 2015; Kurde and Kulkarni, 2016). Hence, the promoters of the project decided to use Raspberry Pi and Arduino for this project. Many automated IoT application products currently use microcontrollers like Arduino and Raspberry Pi (Kunal, 2016 and Mnati, 2017). The advocates decided to use Raspberry Pi. The Raspberry Pi was the system's primary controller and Arduino was used to link sensor inputs (Kurde and Kulkarni, 2016). The Raspberry Pi can be connected to a Wi-Fi attachment to the Android smart phone. For the acquisition of present readings a present sensor AC / DC 50 ampere and module ACS758 were used and linked to Arduino Uno. Analog inputs that raspberry pi cannot obtain were used to Arduino Uno. The Arduino Uno has been reading the information collected by the current sensor so that the raspberry pi can understand and read it via the python sent to the cloud server.

The Android app was able to get information from the cloud server and to show a line graph in the Android application. The diagram was daily updated and the present readings energy use were checked using a refreshing trigger button. The android application could enable several relays linked to raspberry pi to be switched on or off. The Android application used also an energy consumption scheme where the user was able to insert a certain quantity of energy deemed to be the monthly limit. When the usage threshold was reached, the application informed the user. The aim of this research was for Raspberry Pi and Android Application to create a prototype of the monitoring and control of energy consumption. The research is specifically directed at developing a system that enables users to monitor power consumption, develop a database to store previous electricity consumption readings and develop an Android system to monitor and regulate the system.

The implementation of android can be regarded to be a way of adaption to present technological trends on domestic energy consumption surveillance. The energy consumed by the consumer can be wirelessly tracked and regulated via the Android application and with the aid of the Internet. The electrical line was controlled by switching off or on using Android devices, among many other characteristics. In addition, information on energy consumed in the cloud can also be collected and viewed by the customer. The energy consumed was tracked by Android application design and viewed in a line graph.

The advocates will profit significantly from this investigation because several things have to be studied in order to finish this research. This study requires the understanding and abilities needed for the future of the advocates in relation to electrical engineering. In the bill notification and surveillance process, the tracking of the other home electricity meter utilizes GSM. These include not the use of android to monitor and control the energy the user consumes.

2. REVIEW OF RELATED LITERATURE

As innovation progresses, mobile telephones have proven to be more than just calling. Small, intelligent and adaptable mobile phones today have appeared to be intensive apps joining cameras, media players, GPS frameworks and touch-screens (Esmaee, 2015). The number of Android users is rising and many android apps are being created both for entertainment and industrial purposes (Esmaee, 2015). In the context of this investigation, advocates use smart phones to remotely access the data logger (Sivasubramanian, and Sivasankaran, 2014). Controlling of home appliances is a part of home automation, and through the increasing numbers of internet users and smart phone users, it was developed. Android intelligent devices may serve as web servers that store information and regulate the devices (Sankaranarayanan, 2014). The surveillance system can view computers or Smart phones (Kale, 2015). The programming of Java uses Android application and Android Studio to produce applications (Bonganay *et al*, 2014). Many methods to monitor the information collected are by using the internet and Laravel in databases (Srikanth, 2015 and Kunal, 2016).

A survey that also uses Android application is used in a linked way. Zigbee was used wirelessly to transfer information by GSM and other research (Mnati, 2017 and Vatsa, 2016). There are still numerous studies which have used distinct designs and implementations of hardware, such as integrated circuit ADE7757, which have been widely used for power (Vatsa, 2016). Many Electric Meter automatic readings and monitoring systems use relays to monitor load. The MQTT Protocol is used by others (Esmaee, 2015; Sivasubramanian, and Sivasankaran, 2014). Every research also considers low-cost, and should be attempted with a view to reducing costs (Vatsa, 2016 and Sankaranarayanan, 2014). It may be extremely important to use Raspberry Pi for IoT research, given that there are numerous sensors available in a varied industrial sector alongside Raspberry Pi (Srikanth, 2015). According to the literature review, the design and implementation of the scheme are subject to distinct methods and techniques. In order to monitor the various parameters, the study was largely conducted and implemented using the sensors, GSMs, and smart phones.

The sensing data were analyzed and sent via various methods such as SMS text message and the internet. Moreover, most of the research use the web to view and access data via the web. The advocates were also aware that a graphical user interface was used to create.net platforms. This can help to ensure effective, functional systems through the use of distinct processes and technology. Similarly, the system was developed using smart phones and databases. Last but not least, the advocates have chosen to investigate a prototype that can readily monitor and control the energy consumption of households through the use of an android application, which has a database accessible on the Internet.

3. CONCEPTUAL AND THEORETICAL FRAMEWORK

3.1 Conceptual Framework

The study was designed and developed to regulate the use of electricity. A diagram could then be drawn by the advocates showing the full study procedure (see Figure. 3.1). The advocates could decide which tools and software were required by using the diagram. The diagram also contributed to get the prototype for the advocates. The diagram starts with the sensors, as illustrated in Figure 3.1. The information collected by the existing sensor using Arduino sent to raspberry pi. Depending on the information collected, the raspberry pi processed the information and created an output. To send the data to the database, Raspberry Pi was linked to the web. The Android app has been collected through the internet in the database. It was also used to track power use and to regulate when the relays are activated or disabled.

Input, process, and system output are shown in Figure 2. The input was collected using the sensor linked to the Arduino by the module ACS758. The relays, which are attached also to the Arduino, are another input. The system process is the collection of actions that the system will take after receiving input information. Mostly on the raspberry pi side, the method transforms the data collected into information that can be sent to the database. The system output is what the system does afterwards depending on whether the input on the Android application can be viewed. The system read the electricity flow through sensors connected to the Arduino, as illustrated in figure 3 at the beginning. Raspberry Pi is used to collect electric power from present readings, which was sent via the internet to the database. After accessing the Android app the android app gets data from the database, so that the Android application can produce a graph displaying present energy usage. The request shall inform the user when the complete readings of the energy use reach the specified number of readings entered by the user.

The system is also controlled by android applications (see Figure 4). On the android implementation, there were virtual buttons where the user could activate or disable electric contacts via the relays. The android application sent to database button 1 is activated when the user pushed button 1. Once the information has been obtained from the database, the raspberry pin switched it on or off relay 1. It is the same with button 2. All other buttons are Button 3. If button 3 is on, it also implies all other buttons and vice versa.

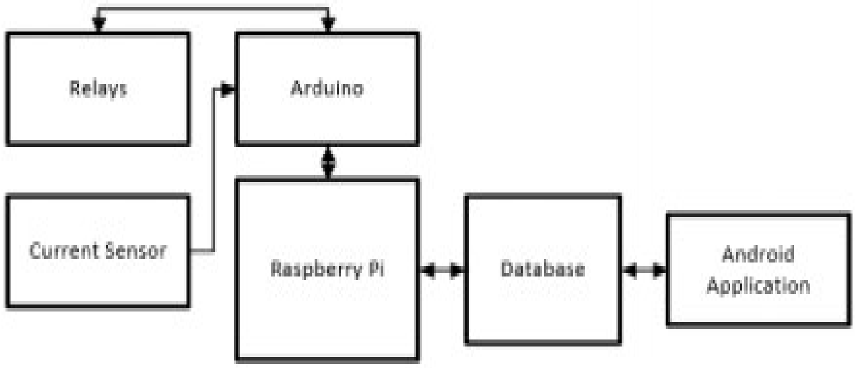

Figure 1. System Block Diagram

INPUT	PROCESS	OUTPUT
• Current Sensor • Relays	• Send information from Raspberry Pi to database	• Usage History • Relays on/off

Figure 2. IPO Chart

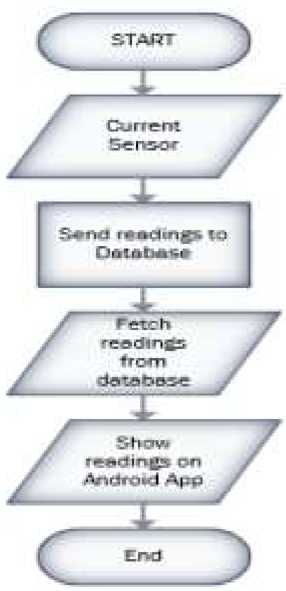

Figure 3. Flow Chart of the Monitoring System

3.2 System Architecture

The Arduino was linked to both the relay and present sensors. The Arduino has obtained analog feedback from the current sensor and the raspberry pi was regulated (see Fig. 5). The collected information was processed and sent via raspberry pi to the database. The inputs were obtained from Android app. The users holding the Android phone have chosen whether to switch on or off the relays. The readings were transmitted to android and shown for viewing by users.

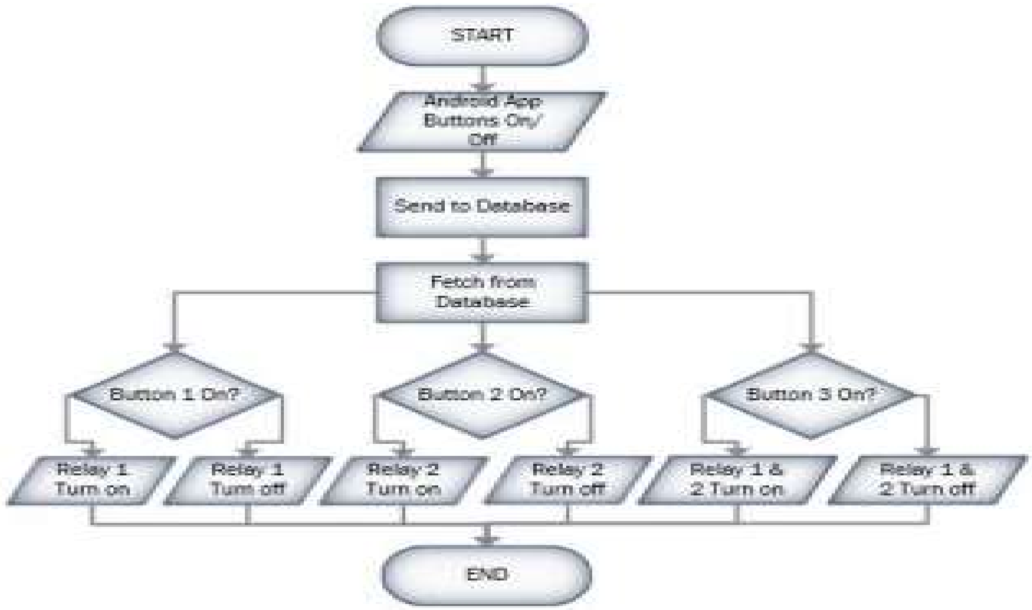

Figure 4. Flowchart of the Control System

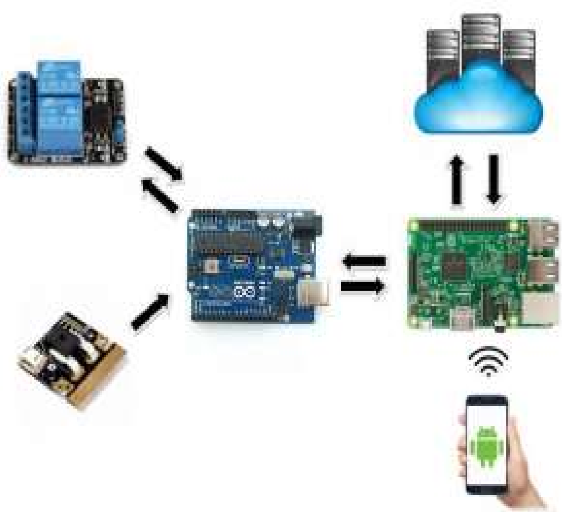

Figure 5. System Architecture

4. RESULTS AND ANALYSIS

The current sensor had one of the AC connecting lines in and out of and in sequence. It is linked to the Arduino Uno with blue, red and black. The red wire was connected to the Arduino Uno 5V, which is the VCC of the actual sensor. The dark wire was for the GND, while blue wire is Vout attached to the analog entrance which provides the Arduino Uno readings (see figure 6). The relay module includes VCC, Gnd and eight inputs.

5V DC powered the relay module. The VCC and the Gnd black wire are the red wire. Two inputs 1 and 3 were used by the advocates. Arduino Uno regulated the inputs of relays (see Figure. 7).

Figure 8 shows the android application's log-in UI (User Interface). The user is able to log in with the account of the user. If the user is not registered, the user will decide to use an existing google account or g-mail account or register via other e-mails. If you have decided to use a gmail account, you don't have to
register

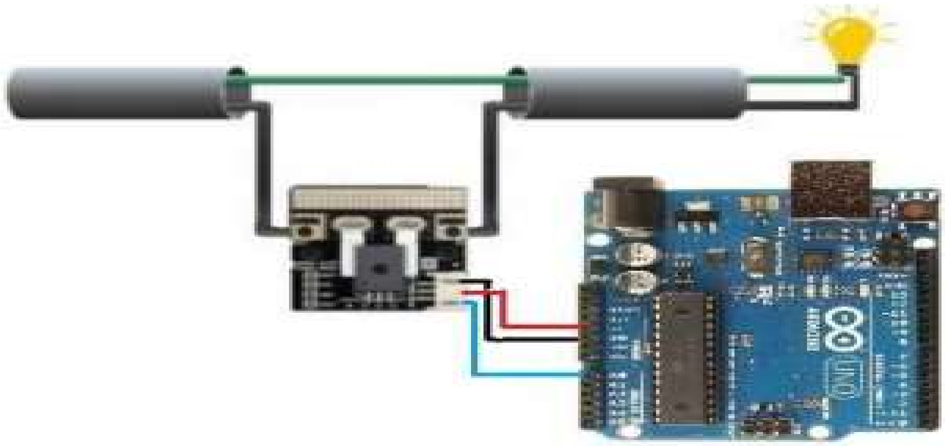

Figure 6. Current Sensor Connection to Arduino and AC Line

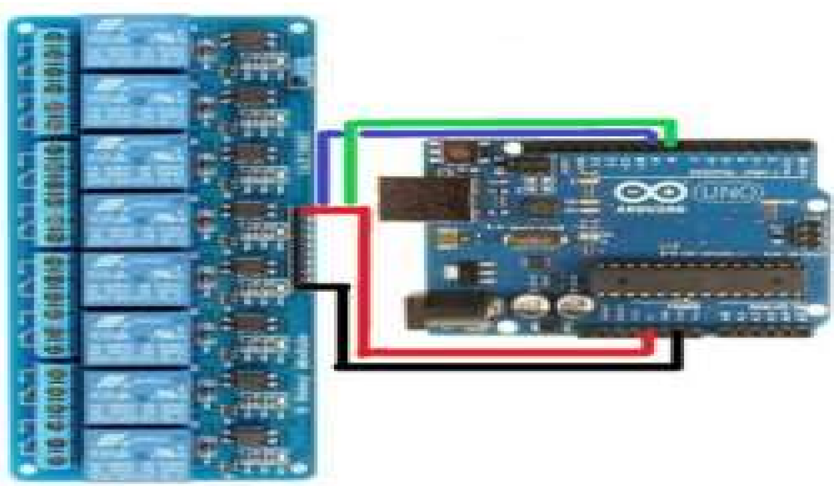

Figure 7. Relay Module

Figure 8. Android Application Log-in User Interface

Figure 9 demonstrates the control and tracking portion of on or off the relay of the android application by the user. The read of the corresponding switch was shown on the correct side of the switches. Every other switch was controlled by the power switch. Each other switch will also be on and vice versa if the energy switch is enabled. Logout implies returning to the website before. Figure 10 indicates a registration page, which indicates that users that choose to register on a Non-google mail account were sent and stored for information that was read from raspberry pi. This was also where the Android app requested the readings and sent the relay modules signal.

5. DATA AND RESULTS

The energy measurement devices used by the advocates are the light bulb, laptop charger, engine and amplifier (see Figure. 12).

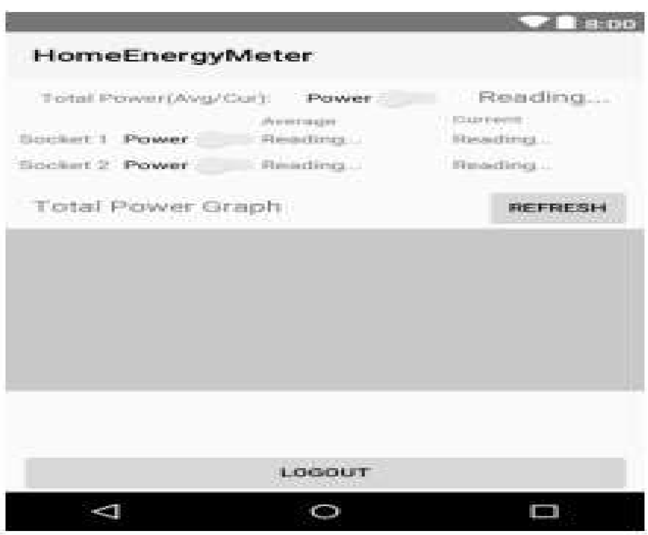

Figure 9. Monitoring and Control Arduino Application UI

Figure 10. Sign up page

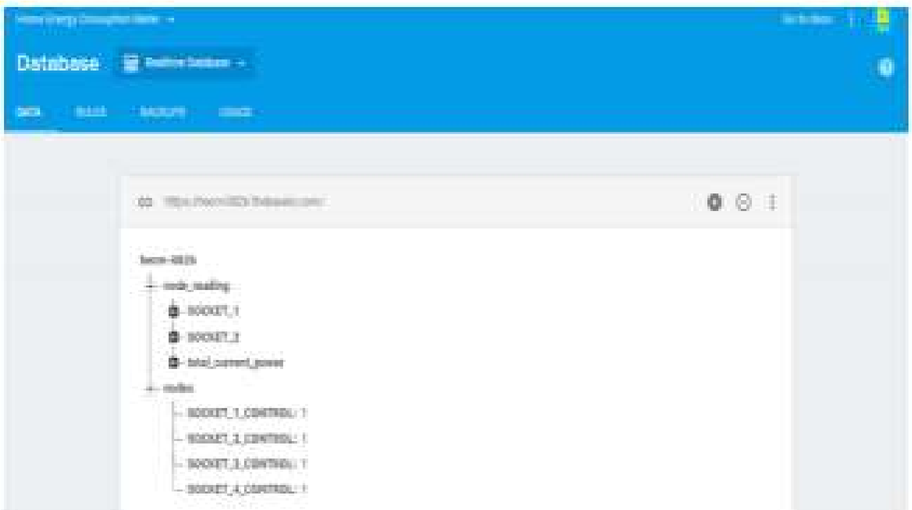

Figure 11. Firebase Database

Figure 12. Appliances Used for Testing

The outcomes of the energy measurement of the devices are shown in Table 1. This table indicates the average of 10 exams per proponent.

Table I: Measurement Of Single Appliances (Watts)

	Measurement of single appliances (Watts)										Average
Light Bulb	15.623	18.203	15.172	15.19	14.826	14.809	14.67	14.41	14.081	13.769	15.075
Laptop Charger	46.296	41.637	51.233	38.849	31.401	47.232	32.336	39.784	25.824	29.548	38.414
Motor	602.6	559.8	609.11	570.04	578.42	575.61	595.15	568.18	588.64	591.43	583.9
Amplifier	3.4986	4.4339	2.5634	5.3692	2.5634	3.4986	9.0757	2.5634	11.882	10.011	5.5459

The outcomes of evaluating the power consumed by various devices plugged in to one or two sockets are presented in Table 2 and are calculated as the complete electricity utilized. This table demonstrates the average of ten testing by supporters of various devices used simultaneously.

Table 2: Measurement Of Multiple Appliances (Watts)

	Measurement of multiple appliances (Watts)										Average
Light Bulb and Laptop Charger	75.688	60.672	44.98	56.948	63.599	54.125	61.728	68.154	42.14	62.594	59.063
Motor and Amplifier	626.78	597.94	571.91	593.3	588.64	575.61	614.27	626.78	556.08	598.87	595.02
Amplifier and Light Bulb	18.55	13.891	14.826	19.468	20.403	15.761	19.468	18.55	17.614	12.956	17.149
Laptop Charger and Amplifier	46.937	76.069	85.942	88.159	50.02	82.703	59.321	62.11	47.232	52.809	65.13
Light Bulb and Laptop Charger and Motor	626.41	684.3	679.74	645.38	632.04	616.54	656.39	646.16	635.99	659.27	648.22

Table 3 indicates an optimal or theoretical value comparing the outcomes of the experimental attributes or trials. This shows the percent error. This table shows that TVL B 20 per cent was used as an experimental and theoretical comparison for most of the percentage error in the reading. The only device that showed a very big percentage mistake as an amplifier affecting the amplifier reading and the other device tested using the amplifier. The advocates can take the position that the amplifier does not play music or video in the test, which greatly influenced the test outcomes.

The basis for proponents is Equations Formula 1. Since it was not a power factor that focused on this research, the promoters would use an optimal power factor or one. For the AC3-phase amps in watts, the equation was used.

$$\text{Watt} = 1.732 \times pf \times amp \times volt \quad (1)$$

Formula 2 was used by the proponents to calculate the percent error.

$$\text{Error} = \left| (Experimental\ Value - Teoretical\ Value)\ Teoretical\ Value \right| \quad (2)$$

Table 3: Comparison Of Results (Watts)

	Comparison (Watt)		
	Test Results in Average	Ideal	% Error
Light Bulb	15.075328	15	0.502186667
Laptop Charger	50.538028	65	22.24918769
Motor	583.897096	571.56	2.158484348
Amplifier	5.545864	30	81.51378667
Light Bulb and Laptop Charger	65.990932	80	17.511335
Motor and Amplifier	595.016476	636.56	6.526254242
Amplifier and Light Bulb	17.148532	45	61.89215111
Laptop Charger and Amplifier	65.130128	95	31.44197053
Light Bulb and Laptop Charger and Motor	649.260984	651.56	0.352847934

5. CONCLUSION

Researchers have evaluated the system's functionality through various devices connected to the sockets, and advocates can conclude that: The advocates have been able to develop a system that enables the user to monitor energy consumption at home. The advocates were allowed to remotely manage the relays linked to the electric lines with the use of an android application and visualize power consumption. The system has a database which the user can use to view previous energy consumption measurements. The advocates have been able to designate an android application that has both system monitoring and system control. The device could read the current to obtain power reading and regulate electrical lines.

END NOTE
This Journal Article was presented at the 19th iSTEAMS Conference, Offa, Nigeria

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