Design and Implementation of Household Electrical Appliances Control System: An Approach to Learning Python in NCE Curriculum

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Abstract: **The development of a society necessitates the resolution of societal issues, which can be accomplished by developing, promoting, and improving education and information. The cost of energy has been rising along with the demand for it in society. Several systems have been created in this age of technical advancement, particularly in ICT, to control and preserve the amount of electricity used in our homes, offices, and communities while also preventing disasters. The Nigeria Certificate in Education (NCE) Curriculum included the study and practical application of programming language as a core course, requiring students to learn C++, Visual Basic, Python, and other High Level programming languages at the NCE level. Knowledge is the foundation for all of these presumptions. In light of these, the focus of this research was on Developing and Implementing a Home Electrical Appliances Control System, which is a method for practically learning Python programming at the NCE level, as specified in their curriculum. The project's goal was to regulate the ON and OFF times and states of household electrical equipment. An Arduino Nano was incorporated into the design, and it was programmed to work in time with a mobile application to regulate each electrical device. The system was put through testing, and it was discovered to be functional in accordance with the specifications needed by NCE programming students to acquire the necessary abilities in the curriculum's programming language.**

Keywords: **Arduino, control, curriculum, education, electrical, implementation, learning, python.**

1. Introduction

Education is acknowledged as one of the most fundamental means of ensuring one's survival and enhancing one's own and society's well-being. The introduction of formal education is regarded as the cornerstone of national progress and the surest path to achieving all long-term goals. Therefore, without having educated citizens with the necessary abilities to address problems, no nation, government, business, or family can have an effective impact and long-lasting successes in their day-to-day operations.

The availability of employment options is one of the main advantages of computer science. In order to improve human capability at all educational levels, this made the Federal Government of Nigeria (FGN) to incorporate computer science into the curriculum for the Nigeria Certificate in Education (NCE) programme. In view of this, Computer science offers pertinent skills for possibilities to increase capacity, including design, implementation, programming, and problem-solving abilities, which is viewed as a means of developing some capacity in students generally [1].

According to [2], the rapid change in human lifestyle is a result of the emergence of digital information. Using electricity is crucial because it is one of the primary energy sources that is essential to modern life. As time passes, technology continues to advance, leading to the creation of new methods for the simpler, safer operation of electrical equipment for improved power management in homes and workplaces. When leaving their homes, the majority of people invariably leave the lights, fans, and other appliances on, wasting energy and wasting money. Although being personally present or close to the home environment is not always possible, great effort should be made to forecast future energy usage while continuously monitoring and managing all building energy use.

This paper was designed and implemented to allow home owners to turn ON and OFF linked devices using an APP on their smartphone using Bluetooth. Since most houses in the rural areas and those with low-income earners do not use high voltage systems in their houses settings, it is also intended for low voltage devices.

A. Problem statement

Switching On and Off of electrical appliances with the switch is inconvenient as the switches are stationed so this means that before any changes can be made a walk to the switch is required irrespective of how busy the person might be with other things, it can also cause a domestic accident if the switch is moist and a person places a hand on it the person will get electrocuted.

B. Justification of the Study

The Nigeria Certificate in Education (NCE) minimum standard for school of sciences most especially Computer Sciences stated course in programming languages and computer logics whereby a student is expected to be able to write, develop and demonstrate practical application of those learnt courses. This research work will provide job opportunities to many of these students that have interest in this modern microprocessor-

based technology. Investment made in this research will ensure convenience, time saving and safety as well.

C. The Objective of the Study

The objective of this research is to design, build and implement the smartphone control for electrical appliances using python programming skills and Arduino equipment for the electrical build-up.

2. Literature Review

The authors in [3], discussed an electronic appliance monitoring and control system based on GSM. Which can be achieve by connecting their home or business equipment to the developed system in order to monitor and control their electrical appliances remotely using a Short Message Service (SMS). Users can check on linked electrical appliances' status and decide whether to switch any of the equipment on or off by remotely controlling them. Their work is constrained by the requirement that the gadget have network coverage in order for it to function.

In [4], they focused primarily on achieving a standardized, low-cost, and simple to install communication protocol that employs RS-485. We utilize an 8-bit MCU to meet the system need since messages for home intercom and home security are all short packets and MCU process data is 8 bits. In the protocol, messages are transmitted via packets, each of which contains a sum of data. They make a recommendation for a large-scale building's home intercom and security system that improves system performance and reliability through module design. Because the system is installed for use over a long time, our design is dustproof and waterproof and tolerates high temperatures.

Today, the advancement of communication technology has accelerated the advancement of remote-control technology. The GSM protocol is the most basic form of communication technology currently in use. [5] proposes a prototype for an SMS-based GSM tool for controlling electric appliances. The GSM protocol was chosen because it is independent of the operating system of mobile devices. Here, a relay module was controlled by an Arduino and a GSM SIM 900. The mobile device then received the command's feedback once the relay module had completed its work in accordance with the instructions sent via SMS.

Looking at the advantage of Arduino and programing skills, [6] describes the architecture of a smart door sensor that is affordable and will alert a user to door opening events in a home or workplace via an Android application. The Elegoo Mega 2560 microcontroller board, which is compatible with Arduino, and the Raspberry Pi 2 board are used in the proposed design to connect to a web server that employs a RESTful API. The implementation of the door sensor uses a number of programming languages and other applications.

The authors in [7] stated that in the last ten years, consumer electronics and embedded systems have drastically improved and advanced. As a result, there is now a home setting where wireless technology and an Android smart phone may be used to connect and manage products, therefore they based their work on how an automated system can be designed to help and support people who are physically impaired or old in controlling electrical appliances in their homes. The wireless Bluetooth technology at the center of the control system allows for remote access from a smart phone to a Bluetooth module, which is subsequently connected to a control and switching unit. The system can communicate wirelessly through Bluetooth with an Android smart phone running a Java application. The system-connected home appliances may be simply controlled by the user by touching the phone's screen. This technique, which takes little human effort, can help old, ill, and crippled people who have trouble moving around. As a result, a control system that is easy to install, has a quick response time, and has a user-friendly interface has been created for regulating household electrical equipment.

Researchers work were design to solve the problem of electrical fault by switching OFF or ON any electrical appliances in the house, however most of the researches did not take into consideration if there is a fault in the smartphone used for the control, non-availability of the smartphone or when the phone battery is OFF or stolen. Therefore, this research is looking at having a two way switch wiring system as alterative, whereby apart from using the smart phone which might get lost or damaged.

3. Methods

A. Hardware Components and Development

A smart home control system is a system comprising of electronic devices into one functional device that has the capability of controlling electrical or electronic driven devices in a specific jurisdiction (called home). The system was built with the capability of controlling a bulb, fan and a socket in a home. Figure 1 shows the flow of the system.
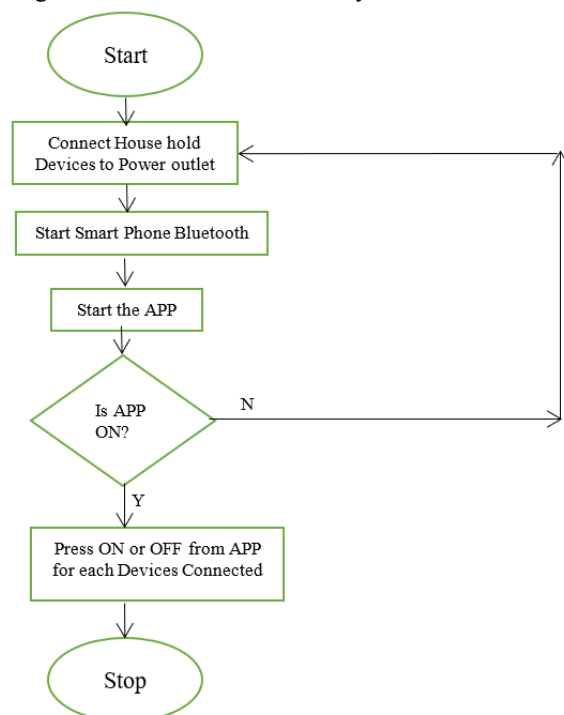

Fig. 1. Flowchart diagram

The Android phone is being paired with the HC-06 Bluetooth module before opening the app, then on the android app, their about 5 rows (on and off button per row), one each for the relay controlling one device and the last button for controlling all the relay. When the first, second, third or fourth is turn on or off, the Arduino sends a HIGH or LOW to the relay that turns ON or OFF the device while the last ROW turns everything ON or OFF.

B. Hardware requirements for the design and implementation

1) Solderless Breadboard

Is the board that connects many components together without requiring them to be joined. It has a number of holes, each of which is connected by a different set of holes. It is separated into two sections: the center, where links are connected horizontally, and the exterior, where links are connected vertically.
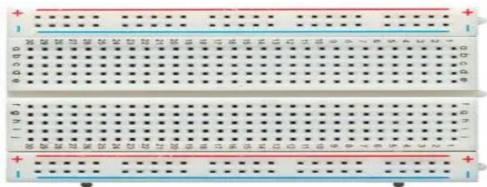

Fig. 2. Solderless breadboard

2) Arduino Nano

This component is the brain box of the system, it receives and send signals to appropriates part of the electronics devices. E.g., when a high is sent from the Bluetooth (which comes through the mobile app) to the Arduino, it turns ON the appropriate device.

3) Bulb, Fan, Socket and Lamp Holder

These are the devices that are controlled by the smart home control system. They are connected to the four-channel relay, which switches them on and off based on commands received from the user through the Bluetooth module. The bulb, fan, socket, and lamp holder are connected to the relay through wires and are controlled by the relay's switches.
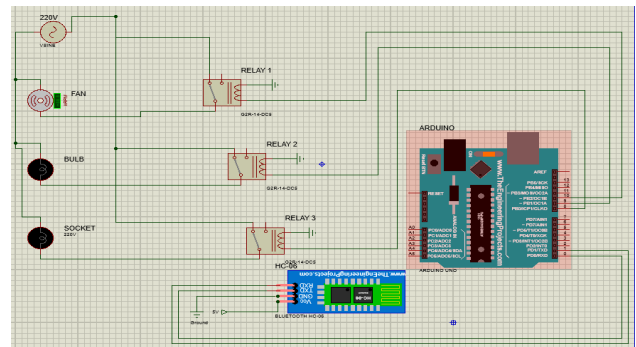

Fig. 3. Arduino nano board

Fig. 4. The schematic diagram of the connection

C. Software Component: Software employed in order to complete this project

1) Proteus

A simulation software that is used for prototyping of the system before the main hardware component are connected. It contains the components being used, in a software-like form in other to perform a simulation before putting the real hardware component together.

2) Arduino IDE

The Arduino IDE is used to program required functionality into the Arduino. It makes use of a high-level Programming language for writing instruction about the functionality that is later going to be burnt into the Arduino Uno hardware component through a cable.

4. Results

A. Implementation Steps

These are the steps taken in connecting the system;

a) The Bluetooth module has for pins (V_{cc}, Gnd TXD and RXD), V_{cc} pin is connected to the 5v V_{cc} on the Arduino and Gnd to Gnd of the Arduino, TXD pin of the HC-06 (named version of Bluetooth module) is connected to the RXD of the Arduino and the RXD of the HC-06 is connected to the TXD of the Arduino (located bottom right of the Arduino board).

b) The 4-channel relay has 6 pins, 2 pins representing the V_{cc} and Gnd connected to the 5v V_{cc} and Gnd of the Arduino board while the 4 pins in the center represent the 4 different relay input signal which is connected to the port 7, 8, 9, 10 of the Arduino.

c) The bulb, fan and socket have a single leg connected to the 220v power supply and the other leg passing through the relay for the open and close circuit of the power supply.

d) A mobile app is developed using the MIT studio online.

Table 1
Results

Test Case	Test Event	Description of Test	Expected Outcome/Result
1	Testing the bulb with an ON and OFF command.	The communication between the smartphone and the electric bulb will be tested to turn it ON and OFF.	The electric bulb will turn on with the ON command and turn off with the OFF command.
2	Testing the Fan with an ON and OFF command.	The communication between the smartphone and the Fan will be tested to turn it ON and OFF.	The Fan will turn on with the ON command and turn off with the OFF command.
3	Testing the Electric Socket with an ON and OFF command.	The communication between the smartphone and the electric socket will be tested to turn it ON and OFF.	The electric socket will turn on with the ON command and turn off with the OFF command.

5. Conclusion and Future Work

In this work the system uses a Bluetooth connection to communicate with a programed Arduino Nano and Mobile application. The user effortlessly operates the home appliances by touching the developed phone screen, using a remotely voice Call to dictate the ON and OFF of any of the devices connected. This work looks at a way of reducing stress of elderly, and physically challenge people in the society and as well as those living in the rural areas where they used devices with low voltage such that they can control and monitor their power consumptions and also prevent any loss to their devices. It also provides opportunity in the offices to manage their electricity consumption and reduce government expenses on paying electricity bills, just with a smartphone the ON and OFF these devices can be controlled.

Future work is to use different technology or devices that can enhance and improve the capability of the mentioned functions of this system. A high voltage system is also required to monitor and regulate high voltage capacity devices, as well as a system to track the amount of energy used by the linked devices at any given time should be considered in future.

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