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Full Length Research

Design, development and performance evaluation of a smart office automation system

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ABSTRACT: This research work aimed at the design, development and performance of Office Automation System, using the Internet of Things (IoT) based and Voice Recognition Command. The data is stored in personal computer (PC) or android smartphone. Arduino IDE was the framework used in the development of the system, while C++ was the programming language used for programming the system. Similarly, a voice control was built using the This Then That (IFTTT) platform. The system developed was capable of enabling users to control office appliances like printer, air conditioner, light, fan, etc. with voice command using the Google home mini device. Results obtained from the laboratory test proved that the system had a very high (about 98%) performance rating. This system had shown that office automation system can use voice command to preform its task.

Keywords: Arduino IDE, automation, workers safety, smart office, voice command.

INTRODUCTION

In those days, people spend a lot of time and money in enhancing their office environment, since they believe that the employees will perform better in a conducive environment. Despite the improvement in the working condition, the overall productivity was still poor due to shortage of workforce. This condition gave birth to automated office systems. Office automation systems are computer-based information system that collect, processes, stores and transmits electronic messages, documents and other forms of communications among individuals, work groups and organizations (Davies, 2016). Automation systems help to increase managerial end users' productivity and other operational staff, by significantly reducing the time and effort needed to access and receive communications (Cameron, 2020). Li (2014) reported that an automated office makes life easy for both the employees and customers, empowered then and increased their productivity. Internet of things (IOT) technology is most synonymous with products pertaining to the concept of the "smart home", covering devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers (Pellegrino et al., 2016)

Recently, web services (Internet of Things) had been incorporated into office automation systems, to optimize its performance and enhanced the convenience of the users. The Internet of Things (IOT) is the extension of internet connectivity into physical devices and everyday objects. IoT technology has resulted in a new paradigm for industrial activities, and has been applied to various official and industrial tasks (Köksal and Tekinerdogan, 2019). These include the manufacturing, health, communications and agriculture industries, and had helped to reduce inefficiencies and improve the performance across all markets (Ayaz et al., 2018; Elijah et al., 2018; Zhang et al., 2018). These devices are embedded with electronics, internet connectivity, and other forms of hardware (such as sensors) and can communicate and interact with others over the internet; they can also be remotely monitored and

controlled (Wilson, 2018). Mainetti et al. (2015) developed IOT based smart home security and monitoring system, where essential appliances can be controlled from any location, provided there is internet network coverage. Similarly, Shaikh and Kapare (2017) designed and developed an IOT based Smart Office, in which all the electronic and electrical gargets were controlled electronically. Additionally, Wilson (2018) designed IOT based Farm Automation System, that enhances the automation of several agricultural operations. Although several smart systems have been developed, some of their limitations include inability of the system to send SMS to users, or the system can be accessed from a personal computer.

Several web services based architectures are provided with respect to office and communication applications. But most of them have challenges of using only telephone command, and not voice command. Therefore, the aim of this research was to design and developed an IOT based office automation system using telephone and voice recognition command. This system will control various office appliances using voice commands.

DESIGN METHODOLOGY AND SYSTEM ANALYSIS

To achieve the aim of this research work, Structured System Analysis and Design Methodology (SSADM) were used. This is because, SSADM is an international accepted software engineering model mainly used in most result oriented analysis. Two major activities were involved in the system design process, which were:

1. Software Architectural Design: the top-level structure and organization of the system is described with their various components.
2. Detailed Design: It pick each of the module and take internal design of each of the module (Figure 1).

Hardware and software components of the smart office system

Arduino IDE, Blynk Application and Google Assistant, were the major software components of the system. Similarly, Node MCU, relay, 5 Volt power supply, breadboard and connecting wires, were the major hardware component of the system

System design

The Blynk Application for Android is used to develop the mobile GUI Interface, while the Arduino IDE was used to build instruction for the board. Also, the visual studio environment was used to the web GUI. Software design is the process of designing software to solve one or more sets of problems (Porto, 2015). Some of the system designs procedures are:

User interface

User interface is the visual part of computer application or operating system through which a user interacts with a computer or software (Computer Hope, 2020). It determines how commands are given to the computer or the program and how information is displayed on the screen. The user interface was use to facilitate actions (commands) between the user and the system. This will greatly help in task completion at higher efficiency and satisfaction. Three main types of user interfaces were used in this design, which were:

1. Command language: the user must know the machine and program-specific instructions or codes.
2. Menus: user chooses the commands from lists displayed on the screen.
3. Graphical user interface (GUI): user gives commands by selecting and clicking on icons displayed on the screen.

Input design

The input design specifies how data are entered and accepted by the system for processing. This design specified that the user interacts with the system to direct the action to be taken. The Google home device, voice assistant, camera and the motion sensor were the input design elements used in this study.

Output design

This refers to the results that are generated by the system. The output of the design is through the use of labels and data grid views and reports that are populated from the processed data in the database. Electric fan and electric bulb are some of the output designs of the system.

Programming language and framework

The framework used for this design was the Arduino IDE using the C++ language and the Blynk platform. C++ is an elegant, flexible, simple, type safe, object-oriented language that allows enterprise programmers to build a breadth of applications.

Testing of the system

This involves the testing of the entire circuitry and cross examine it for errors like shorts circuits, leadflux, joining unwanted links, proper connections etc. After this cross checking, the system is powered on, and the performance of the system is determined.

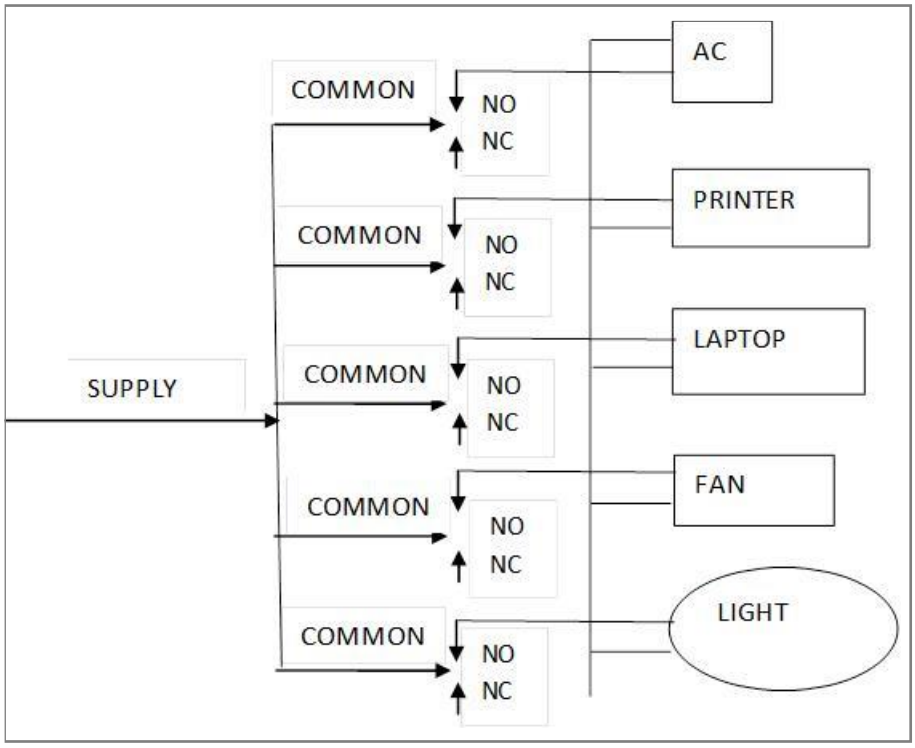

Figure 1. The system Architecture block diagram.

Table 1. Performance evaluation.

S/N	Process description	Expected result	Actual result
1.	Turn ON fan if count 0	Turn ON fan	Fan ON
2.	Turn OFF light if count 2	Turn OFF Light	Light OFF
3.	Turn OFF fan, if count 1	Fan OFF	Fan OFF
4.	Turn ON light, if count 0	Turn ON light	Light ON

RESULTS AND DISCUSSION

The results obtained from the trial test are presented in Table 1. The results showed that it is practically possible to use web services and voice recognition command to control various electrical appliances remotely in the office. Results obtained from the laboratory test proved that the system had a very high (about 98%) performance rating. As the system count is increased by 1, the system tripped ON the connected devices. At count 2, the system will turn off the devices. As shown in this operation, more devices can be connected to system to control various appliances in the office. This research followed similar prototype systems developed by previous researchers. Ayaz et al. (2018) and Tayyeb et al. (2019) designed smart systems for various civil applications, using the internet services, and the system recorded high success in controlling various civil applications. Tayyeb et al. (2019) developed a smart system for controlling the electric bulb (light) intensity in a room. Additionally, a smart automation system developed by Lavanya et al. (2020) using the IoT yielded high performance in the area agricultural operations.

The system flow chat presented in Figure 2 revealed the working operation of the system. During operation, the system will check for sensor's input. After this, the sensor's data will check for the threshold value. If it crosses the threshold value for the sensor as decided by the environment factors, the devise will be on. Otherwise, the controlling device will be off. The controlling devices which are used are bulb, fan, etc. This data is then displayed on GUI (Graphical User Interface). The sensor's data is viewed on webpage; the webpage can also be viewed on mobile screen. This information can be accessed through android or any internet enabled phone. To get this information on mobile phone (to view the webpage), the IP address of local host must be put on the mobile phone.

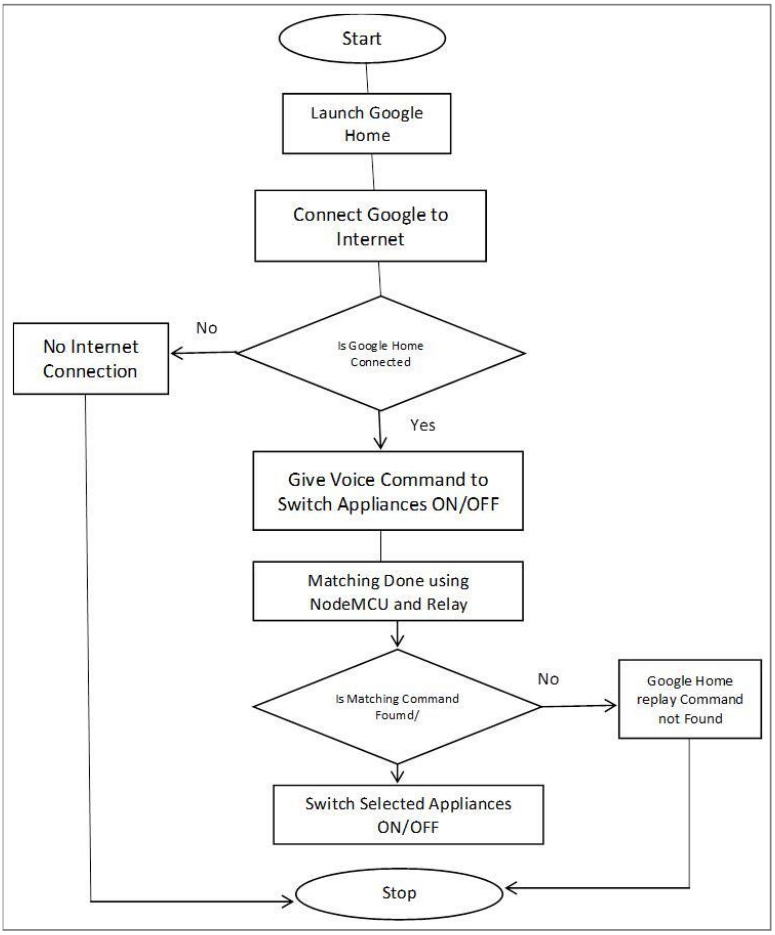

Figure 2. The system flow chat.

Conclusion

There is increase increased in labour demand to accomplish many industrial and official tasks, due to rapid industrialization growth in the world. This research work had shown that with science and technology, people can interact faster and safer with their surroundings. Office Automation system developed in this study revealed that the electrical appliances present in the office, which are linked electronically together can be managed automatically, leaving less burden on the human beings. Results obtained from the laboratory trials, revealed that the system was able to control most of the output devices linked to it. Based on the experimental results, it can be seen that this study will help a lot in promoting office automation, hence contributing greatly to energy conservation.

Future scope

1. This system of smart office can be extended to whole building, as it will be helpful in workers energy conservation.
2. Comparisons between the real office environment power consumption and smart office environment power consumption should be made, and the comparisons should be made under different methods.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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