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Design and Development of Internet of Things (IOT): Based Automation System for Smart Home

Rapheal Nyirenda

Department of Electrical Electronics, Information and Communications University, Lusaka, Zambia.

ABSTRACT

Home Automation System (HAS) gains popularity due to communication technology advancement. Smart home is one of the Internet of Things (IOT) applications that facilitates the control of home appliances over the Internet using automation system. This paper proposes a low-cost Wi-Fi based automation system for Smart Home (SH) in order to monitor and control home appliances remotely using Android-based application An Arduino UNO microcontroller provided with Wi-Fi module is utilized to build the automation system. In addition, several sensors are used to monitor the temperature, humidity and motion in home. A relay board is exploited to connect the HAS with home under controlled appliances. The proposed automation system, can easily and efficiently control the electronic or electrical appliances using Wi-Fi and Virtual Mobile Application. (Sneha shetty, ISO 9001:2008 Certified Journal | Page 7543 Research (IJSDR)

Keywords: HAS; Smart Home; IoT; Arduino; Virtuino

Introduction

This Chapter will discuss introduction, Motivation and significance of this study, scope of the study, problem statement, research objectives, Organization of the thesis and the summary. Today, as the world is still battling with the deadly Covid-19 pandemic, better techniques need to be implemented, especially to help with hygiene even at house hold level. For instance, lights, television and other household appliances can be automated to be controlled using a smart phone. Also, this project provides an opportunity to come to promote a very hygienic idea on market, such as constructing a new building without

traditional switches e.g. to turn bulbs ON/OFF. Presented here is a home automation project using a simple Android App, which you can use to control electrical appliances within a house by means of clicks or voice commands. All Commands are sent through Wi-Fi moderm ESP8266 to Arduino UNO. Arduino is an open source electronics platform based on easy-to-use hardware and software. It has been used to implement all kinds of projects ranging from home automation systems to drones. An extensive community of makers- hobbyists, programmers and professionals has greatly helped in the development worldwide. So you need not get up to switch on or switch off the device while watching a movie or doing some work or indeed when nor at home and / or workplace

Motivation

Home automation is a modern technology that modifies your home to perform different sets of tasks automatically. Today, automation technology is gaining more recognition among people not just for home modification but in industrial and business sectors too. Home automation technology is constantly improving its flexibility by incorporating modernized features to satisfy the increasing demands of people. When it comes to home automation, there are a few steps that must be followed in order to implement the home automation technology effectively. First, the automation needs should be planned. For example, if the overall objective is to improve your security system, then a checklist all its requirements is required before starting the automation process accordingly. If lighting units are
suspected to consume a large amount of energy, then they could be automated to avoid unnecessary waste of electricity. Such a step would provide comfort, security and save power. Home automation technology is growing drastically and its demand is increasing in a wide range of sectors. In this project, home automation has been considered. For convenience, a single room encompassing the main appliances has been used. (Bagenda, Dadan. 2018).

Scope

Examine the already available information about HAS in books, etc. and focus on addressing the limitations and adding further fascinating features so that we improve people's lives worldwide.
In other words, this project is full of hands on activities ranging from literature and practical research.

Problem Statement

In Zambia, implementation of room automation systems in existing residential buildings today require a drastic and expensive change since the room design and planning of appliances are not conducive to automation. This implies that it is often not feasible to install a proper home automation system. However, theft is one of the main problems faced by most home-owners in the country. Most houses in Zambia do not possess a complete security system. In addition, cases of fires due to carelessness are rising at a high rate nowadays. Hence, residential buildings are vulnerable to such acts. Energy consumption by the domestic sector has also been on the rise in the last decade, not to mention physical switch and door handles which can be the major contributor in the spread of Covid-19 virus, therefore the project aims at designing and implementing of an IoT-based automation system for smart home.

General Objective

The main objective of this project was to design and develop a solar based power generation for efficient transmission line in order to reduce over reliance on hydropower generation.

Specific Objective

- To design a circuit for an IoT based Automation system for smart.
- To write a code that will be uploaded in a microcontroller.
- To determine the effectiveness of the system

Research questions

1. How do you design a circuit for an IoT based Automation system?
2. How do you write a code that will control the microcontroller?

3. How do you determine the effectiveness of the system?

Literature Review

Nowadays, the large diffusion of smart devices with embedded sensors and wireless interfaces have enabled the rapid advancement of Internet of Things (IoT) [4]. The IoT plays a remarkable role in improving the quality of life and growing the world's economy. It facilitates global connectivity over the world-wide physical objects (e.g., sensors, RFID, smart-phones, vehicles, appliances) to serve people in a collaborative manner automatically and intelligently. The vision for the IoT states that various "things" are going to be connected and will be controlled across the Internet. Application domains of IoT cover smart home, smart healthcare, smart grid, smart transportation, smart city, industrial automation and surveillance. Among various IoT applications, the design of Smart Home (SH) has drawn great attentions from both academic and industrial because it is more related to people's lives. A smart home can be defined in many ways. One definition is a home with an automated system that comprises sensors and device controllers to provide a comfortable, intelligence and secure system to improve the quality of life and control home appliances easily, in particular for elderly and disabled people. The SH automation system may provide an interface between smart phone or personal computer and home appliances, via a wireless communication interface Bluetooth and Wi-Fi . (P. P. Gaikwad, J. P. 2015, pp. 0330-0335.)

There are many of the Home Automation Systems (HAS) that are commercially available and it can be categorized into two main categories: locally controlled and remotely controlled systems. In the first category, users can control their home appliance using an in-home controller with a stationary or wireless communication technology (Bluetooth, ZigBee and GSM) for achieving home automation. In the second category, users can remotely control their homes over Internet connection using their mobile devices or personal computers. However, there are several issues involved when designing such automation system and it should be considered. Home automation system should provide a user- friendly interface to allow setup, monitoring and controlling home appliance easily and efficiently. In addition, the automation system should be fast enough and provide reliable connection with acceptable data rate and communication range to realize the true power of wireless technology. Finally, the system controller should be cost effective to allow public users to possess and justify its application in home automation. To overcome these design issues and minimize the shortcomings of home automation systems, this paper proposes an integration for locally and remotely controlled home automation systems.

The proposed system will provide a locally controlled home automation system via a Wi-Fi interface and the low cost Arduino microcontroller in addition to the use of the IoT concepts for remotely control. This allows the system to be independent of both user location and mobile provider. It also allows the developed automation system to be used locally with various Android-based smart phones via Wi-Fi or to operate remotely via an IoT platform which allows individuals to manage, monitor, and control their appliance and devices through the Internet. The remaining part of this paper is structured as follows: The next section discusses the background of home automation systems and their benefits. Section III introduces an overview of the adopted methodology and materials. The implementation of the proposed system is discussed in in Section IV. The results and discussion are introduced in Section V. Finally, a conclusion is drawn up and the future work is highlighted in Section VI

Related works

IOT-BASED HOUSEHOLD ENERGY CONSUMPTION PREDICTION USING MACHINE LEARNING.

Kuantan, Pahang, Malaysia
2013

There have been several attempts to develop energy saving solutions in the residential sector due to the significant energy consumption in recent years. One of the promising solution is energy prediction in smart houses. The main idea behind this solution is that the residences are instrumented with different sensors and actuators in order to monitor and control energy usage of a household. For this purpose, this chapter presents a framework for energy consumption prediction in a household. Our framework collects real data from a residential house by a collection of sensors and then prepossesses the data. After that, it utilizes two well-known prediction models (multi-layer perceptron (MLP) and K-nearest neighbor (K-NN)) for energy consumption prediction at the current time. Moreover, our framework can predict the next hour energy consumption using long short-term memory (LSTM) as one of the widely used recurrent neural networks. Our obtained results on a real dataset show that MLP provides substantial prediction accuracy improvement over K-NN based model. The performance metric in terms of root mean square error (RMSE) metric for K-NN and MLP are 1.80 and 1.62, respectively. Furthermore, our results show that LSTM can achieve a minimum RMSE value (0.07).

SMART HOME: INTEGRATING INTERNET OF THINGS WITH WEB SERVICES AND CLOUD COMPUTING.
O. T. Algoiare,
2014

Smart Home (SH) promises the potentials for the user to measure home conditions (e.g., humidity, temperature, luminosity, etc.), manipulate home HVAC (heating, ventilation and air conditioning) appliances and control their status with minimum user's intervention. Researchers and practitioners have made a great deal of efforts in facilitating the concept. For example, for smart home management, Son et al. proposed a resource-aware management system using a domain-object hierarchical model for representing home context. Technically, they utilized Web Services Description Language (WSDL) and Simple Object Success Protocol (SOAP) to enable remote access of home information using mobile devices. For efficient energy management, Han et al. suggested a new Smart Home Energy Management System (SHEMS) based on IEEE802.15.4 and ZigBee. They designed a SHEMS-based multi-sensing and light control application for reducing total energy cost.

Concerning “home nature” of a smart home in serving its users. presented a frame work to model the interaction relationship among services, spaces, and users, and fulfill the human-centric interaction requirement of a smart home. Using the framework, they developed two pervasive applications of “Media Follow Me (MFM)” and “Ubiquitous Skype.” To predict the user activity, Alarm. proposed an algorithm, called sequence prediction via enhanced episode discovery (SPEED). SPEED classes the user behavior into distinct episodes, which consist of sequence activities. Based on human activity patterns, they used SPEED to extract episodes and user actions represented in a finite-order Markov model and the partial matching (PPM) algorithm for improving prediction accuracy, also introduced a knowledge-driven approach to real-time, continuous activity recognition based on multi-sensor data streams in smart homes. The approach consists of context ontologies modeling, the situation formation process, and a knowledge-driven activity recognition architecture. In this way, activity recognition can be conducted from low-level sensor data collection, middle-level data fusion, to high level activity recognition. The SemWeb semantic technologies was used for the creation, management, and query of the semantic data. The Euler inference

engine was used for semantic reasoning. The aforementioned research efforts focus on the SH features of context-awareness, energy efficiency, natural interaction, and user activity recognition. This paper proposes an approach to facilitate SH implementations. The approach integrates the emerging concepts of Internet of Things (IoT) and Cloud computing. IoT embeds computer intelligence into home devices and provides the user with a convenient way to measure home conditions and monitor home appliances. Cloud computing provides scalable computing and storage power for developing, maintaining, and running home services. In addition, using cloud computing allows the user to access (monitor and/or control) home devices anytime and anywhere.

TOWARDS THE DEVELOPMENT OF AN EFFICIENT AND COST EFFECTIVE INTELLIGENT HOME SYSTEM BASED ON THE INTERNET OF THINGS.
W. A. Jabbar, M. Ismail, and R. Nordin,
2018

Internet of Things (IoT) is an emerging technology which is covering everyday things from industrial machinery to consumer goods in order to exchange information and complete tasks while involved in other work. IoT based smart home automation system is a system that uses PCs, mobile phones or remote devices to control basic operations for home automatically from anyplace around the world using internet. The proposed intelligent home automation system differs from existing systems as it allows the user to operate the system from anywhere around the world by using internet connection along with intelligent nodes that can take decisions according to the environmental conditions. We implemented a home automation system using sensor nodes that are directly connected to Arduino microcontrollers. Microcontroller is programmed so that it can perform some basic operations on the basis of sensors data. e.g. fan is controlled on basis of temperature value and light is controlled on the basis of occurrence of motion in the room etc.

Furthermore, Arduino board is connected to the internet using Wi-Fi module. An extra feature this system provides is to monitor power consumption of different home appliances. The designed system provides the user remote control of numerous appliances locally as well as outside the home. This designed system is expandable, allowing multiple devices to be controlled. The objective of the proposed system is to provide a low cost and efficient solution for home automation system by using IoT. Results show that the proposed system is able to handle all controlling and monitoring of home.

METHODOLOGY

Introduction

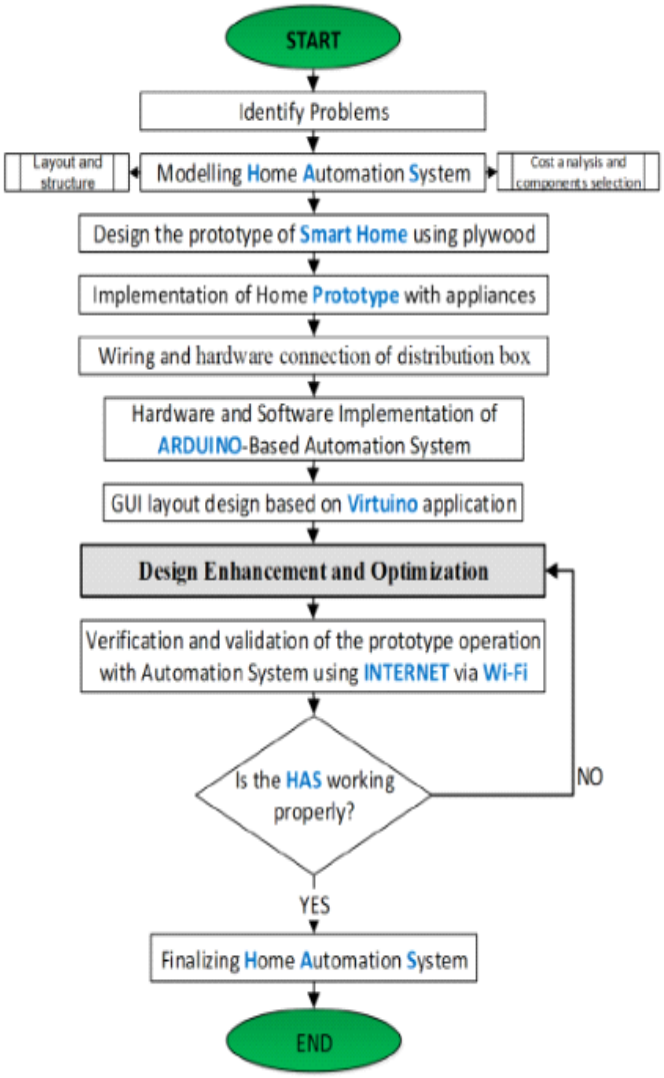
This chapter gives the detail of methodology regard to study base line, system design and each major component used in this project with regard to system design requirements, types and operational conditions of each component.

Hardware

1. Housing
2. Laptop
3. Router
4. Wi-Fi-Module
5. Bulb Holder
6. Relay

7. Microcontroller or Arduino
8. Bulbs
9. DC power adaptor
10. Smart phone
11. AC power input

Flow chart of the system design.



Baseline Study

This section describes the conceptual framework and the methodology adopted for this work including the systematically organized different stages of the research in conjunction with the detailed implementation features of the proposed system. In addition, it clarifies the structural components of the proposed system and their integration to achieve the research aim. The flowchart in Figure illustrates the research stages followed in the present study

Operation

This section presents an example to verify and validate the implementation of the proposed HAS. The preliminary results that we obtained in this paper will be used for further extension and enhancement This paper was managing to successfully develop a Wi-Fi-Based Automation System for Smart Home Using

Android Mobile Phone. Firstly, we need to connect our Android-Based smart phone with the available Wi-Fi. Then open Virtuino application in our mobile and fill in the IP address before connect. The IP address can be found in command prompt in PC. Connect Virtuino application to Wi-Fi. Now we can control all the electrical appliances and able to monitor the motion, temperature and humidity of the house. The electrical appliances such as bulbs can be controlled and monitored using Android app which is Virtual. Further, sensors such as DHT22 (not connected at the moment) can measure and monitor the temperature and humidity in the house from the android-based mobile phone and these parameters can be used in the next step to fully automated the AC system and fans. Also the motion sensor (not connected) can detect if there is any motion in a certain area and give alarm via buzzer, which can be used later on in the security system or in automated the operation of lights.

At the end of this stage of our project, all the electrical appliances can be controlled by using Virtual application. Moreover, the humidity and temperature as well as the motion in a house can be monitored from the Android-Based Smart phone.

Advantages

- It offers isolation to a technician or an engineer when testing equipment after repairing. It's much safer compared to testing an equipment directly into the mains supply.
  - This is the best solution to switching and saving power in homes, since the connected appliances can be viewed on the phone and equipment not in use can be conveniently switched ON/OFF. Power utility companies like Zesco can use this projects to help its esteemed customers Switch and Save, the idea which they are currently advertising and whose achievements can only be currently performed manually, hence the need to embrace such technology.
- Easy to install and operate App on the phone
- It can be operated using more than one phone provided predefined App is installed on them
- Safe to operate indoors
- Since operations are Wi-Fi based, appliances able to be operated on anywhere in the world using the ESP8266 modem
- **Applications**
- It can be used in the workshop to verify equipment is off and safe even if one has already left the office
- It can be used by technicians to test equipment safely at a distance
- It can be used in hospitals by a Doctor to alert the next patient
- Even at household level, it is convenient for switch and save purposes as appliances are monitored in real time
- Can also be used especially in bedroom, where one may need change bed positions without necessarily calling electrician to change physical switch positions too
- It can be installed in an electronic device such as a television set to activate additional tracking devices placed inside the set for security purposes

The Baseline Study

This project report has been approached primarily by literature and practical research. Focusing firstly on gaining a wide and comprehensive understanding of the chosen subject area, a literature review was completed. The literature review included the reading of a range of textbooks along with credible internet sources journals and practical experience. Relevant aspects of these sources were then used to formulate notes, which were then used in their relevant section of the report. The knowledge gained from the

literature review was then applied to design and implementation of Internet of Things(IoT)-Based Automation System for Smart Home.

Conclusion

This research project has proposed, designed and fabricated a low cost Wi-Fi based Automation System for Smart Home prototype using Arduino and Android smartphone. It enables the control all the electrical appliances such as the bulb and fan at home easily and efficiently via Wi-Fi. The sensor can monitor the motion, humidity and temperature of the house. Buzzer will be ON when there is a motion detected in the house. The Smart Home Automation

System provide a comfortable, intelligence, good security and improve the quality of life. By using this smart home system, electric bill can be reduced because the user can control the electrical appliances anytime without using human energy. The next step of our research will be enabling the remote control of the developed system based on IoT concept so that the user can control it using webserver even when they are not around their house. We are going to increase the number and variety of sensors for more safety and security in addition to provide option for the fully-automated of home appliances.

We will implement a gateway to connect all sensors to an IoT platform and we may replace some sensors with a wireless sensor to overcome some wiring problems. Our final product should be a compact box which is easy to be integrated to an existing switching board of real houses appliances via relay board and provide safer control.

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Recommendation / Future Works

Develop another simple tracking circuit which can be used together with this automated system so that we save televisions from being stolen worldwide.

Develop three more additional circuits and install in vehicles to help with Global Positioning System (GPS), send SMS to next of king in case of a car crush and turn OFF sophisticated electrical systems when suspicious of vehicle being stolen, while sending live positioning to owner

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