International Journal of Basic and Applied Sciences. Vol. 7 No. 4. 2018. Pp. 129-134

Full Length Research Paper

Implementation of PC Automation using Radio Frequency (RF) and Tera-Term Software

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Article history
Received: 03-08-2018
Revised: 10-08-2018
Accepted: 15-08-2018

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Abstract
Home appliances such as security and climate control systems have become more advanced with improvement in micro-controllers and wireless technologies, these created difficult and complex users' interfaces. In other to alleviate the problem, radio frequency is being introduced as a replacement for Infra-red and Bluetooth application. The paper presents this novel method to automate the control of appliances through laptop or PDA by incorporating the developed transmitting and receiving modules to the pre-existing system; Home/Office Electrical Distribution Board (DB) while Graphical User Interface (GUI) was enabled through Laptop using Tera-term Software and resulted signal initialized from the PC was transmitted via Radio Frequency to the DB. The developed circuit was practically implemented and the obtained result was quite satisfactory and can serve as relieved mechanism for disabled person.

Keywords: *Automation, Microcontroller, Receiver, Tera-Term, Transmitter.*

Introduction

The advent of integrated circuit has led to the emergence of computers and digital systems. Microprocessor is one of the solid state devices whose applications in the modern day electronics cannot be overemphasized. The reason behind the enormous usage of this device is attributed to low cost, easy modification of design through software, security, speed, accuracy and precision. Remotely control system has been in existence for the past few years through remote, internet, sensor, mobile phones and personal computer system. Therefore the ability to control your TV or even the entire home theatre while sitting on the chair has become a way of life. Now imagine, been able to control every system in your home in such a way that you open your system and activate the appliances anywhere you are. With advancement of automation things are becoming simpler and easier for us. Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Automation plays important role in the world economy and in daily experience. Automatic systems are being preferred over manual system and through this automatic control of buildings (residential and office) can be established, as a result of this power is saved to some extent (Alkar & Buhur, 2005).Home automation is one of the most exciting developments in technology for home and hundreds of products available today allow us to control the devices automatically, either by remote control; or even by voice command. Home automation is the residential extension of *"building automation*". It is automation of the home, housework or household activity. Home automation may include centralized control of lighting, HVAC (heating, ventilation and air conditioning), appliances, and other systems, to provide improved convenience, comfort, energy efficiency and security. Also it provides disable people with increased quality of life for persons who might otherwise require caregivers or institutional care.

However, there have been many attempts to standardize the forms of hardware, electronic and communication interfaces needed to construct a home automation system. Some standards use additional communication and control wiring, some embed signals in the existing power circuit of the house, some use radio frequency (RF) signals, and some use a combination of several methods. Control wiring is hardest to retrofit into an existing house. Some appliances include USB that is used to control it and connect it to a domotics network. Bridges translate information from one standard to another, *e.g.*, from X10 to European Installation Bus. Out of all, this paper employed the application of RF because it is not characterised by requiring *"line of sight"* style of remote control. However, the effects of destructive interference through the scattering of waves from floor, ceiling, walls, furnitureand various objects are still a subject of concern.

Literature Review and Theoretical Background

Electricity is the driving force behind the electrical revolution and first arrived in homes around 1920s, although it was initially used for lightning purposes only, by 1940s mains electricity was readily available to around 65 per cent of the total of houses in the

UK(Ciubotaru-Petrescu et al, 2006). Soon after it reached a critical mass; producers of electrical appliances inundated the market with all sorts of items. Attempt to create a *"home automation*" system was firstly occurred in 1966 when Westinghouse proposed the experimental – and quite bulky – Electronic Computing Home Operator (ECHO) IV. Although the original system was supposed to automate the family finances, it was soon extended to include recipes; shopping lists, family inventory, and, in its final versions, added home temperature control and the ability to control appliances. In 1975, it was the turn of the Altair 8800, followed by the Apple II in 1977 and the IBM PC in 1981. While these computers were slowly finding their ways into the home, they also contributed to the creation of the idea of "smart machines". In 1978, after a few years of experimentation and refinement, PICO Electronics patented the X10 technology. This technology can be considered the first "home network" as, differently to other networks available at the time, it enabled the existing electrical wiring in anyone's home to also be used as the media for the communication network. By doing so, X10 made home automation a reality for the majority of the household at an affordable price. Nowadays, an increasing number of houses have home computers, game consoles and always-on internet connections that extend the availability of services and resources to the household beyond the physical boundaries of home.

The first question that might come to mind is why we would need a Smart Home and why we would want to find different ways of doing ordinary things, such as washing clothes, cooking, or even turning a light on or off. A similar question could have been asked at the beginning of the 20th Century, at the dawn of Mechanical Revolution. In late 1800's, the middle class was experiencing a shortage of domestic servants which created the need to find new ways to provide help in home reported (Conteg and Scaradozzi, 2003). Such necessity was the initial driving force behind the inventions of the first domestic appliances, which had the purpose of making household chores easier and do more with less.

In 1911, Frederick Winslow Taylor published *"The Principles of Scientific Management"*, which advocated the use of efficiency to maximize results through minimal effort. This theory is today known as Taylorism and, though it was originally intended to be applied in industrial settings, this concept soon spilled over into the domestic realm due to the need at hand. Christine Frederick (1911) was one of the first to recognize that the challenges tackled by Taylorism which directly applicable to domestic issues and captured these in her book *"Household engineering: Scientific Management in the Home",* published in 1915. In her book, Frederick predicts that mechanical appliances would be the ones which were to take up the work originally performed by servants *"where every possible purely manual task is done by arms of steel and knuckles of copper"*. She also put forward the idea of a Smart Home where she foretells that *"such machinery will be far more unified than at present … with various pieces related to one another",* as reported by Conteg and Scaradozzi, (2003).

Ciubotaru-Petrescu et al, (2006) reported that the problems with the implementation of home automation systems and the possible solutions are devised through various network technologies. Several issues affecting home automation systems such as lack of robustness, compatibility issue and acceptability among the old and disabled people are discussed. Conteg and Scaradozzi, (2003), also present a design and implementation of SMS based control for monitoring systems. The paper has three modules involving sensing unit for monitoring the complex applications. A processing unit that is microcontroller and a communication module that uses GPRS modem or cell phone via serial port RS-232the SMS is used for status reporting such as power failure.

Conteg and Scaradozzi (2003) stated that the home automation systems as multiple agent systems (MAS). In the paper home automation system has been proposed that includes home appliances and devices that are controlled and maintained for home management. The major task is to improve performance. *Alkar and Buhur (2005)* also reported a proposed of an Internet Based Wireless Home Automation System for Multifunctional Devices. This paper proposes a low cost and flexible web-based solution, but this system has some limitations such as the range and power failure.*Murthy (2008)* explored primary health-care management for the rural population. A solution proposes the use of the mobile web-technologies providing the PHC services to the rural population. The system involves the use of SMS and cell phone technology for information management, transactional exchange and personal communication.

This system employed the indoor propagation of radio frequency application as a medium of automating appliances using tera-term as a user interface of PC, so as to alleviate the rigours faced by the disabled fellow in ON|OFFof home and office appliances. Most wireless designer used to ask *"what is the maximum distance for which wireless is going to work"* or *"is there going to be a communication link between two ends"*. The simplest approach to this is by comparing two things; the dynamic range of the system and the electromagnetic waves propagation loss. The main characteristics that determine former are the power and receiver sensitivity while latter are influenced by reflecting or scattering of waves from floor and other related objects. To calculate the face space propagation loss, it is possible to use Ferris Transmission equation

$$\frac{P_r}{P_t} = g_r g_t \left(\frac{\lambda}{4\pi R}\right)^2 \qquad (1)$$

P_r = Recovered power, P_t = Transmitted power, g_t and g_r are the gain value of the transmitting and receiving antennas respectively, and R is the physical distance between the transmitter and receiver.Equation (1) can be transformed into a logarithmic scale and the propagation loss in dB units can be written as

$$PL = G_r + G_t + 22 + 20\log\left(\frac{R}{\lambda}\right) \quad (2)$$

For the indoor propagation, there is always a Propagation Loss which can be determined by using empirical model based on active measurement made in a typical environment, that is similar to the one in which the system is commonly needed to operate. Through this a linear fit equation could be generated. Another factor is when a transmitting and receiving antennas are placed above a reflective surface, a significant degradation of received signal may be observed and it has been established mathematically that when distance covered by both reflected and direct waves is almost equal, both waves shown destructive interference and the breakpoint distance is given by

$$R_{breakpoint} = \frac{4h_1h_2}{\lambda} \quad (3)$$

At this juncture the device may not be automated.

Design Consideration and Analysis

System development was categorized into two**;** Transmitting Module (fig 1)and, this module consists of personal computer, MAX 232, microcontrollers, RF transmitter, and encoder. Receiving Module (fig 2) which consists of microcontrollers, RF receiver, decoders, MAX 232, ULN 2003 and relays.

Transmitting Module

For the serial Communication, we had to interface microcontroller with computer, a particular mode had to be chosen .Choosing mode 1, the standard UART mode is 10bit full duplex transmitted and received mode. Transmitted data is supposed to be sent as a start bit, eight data bits and a stop bits while the baud rate generator for transmitting and receiving would be set using T2CON and BDRCON for the transmission baud rate desired (AT89C51 data sheet). A 12 megahertz crystal oscillator was selected. To obtain the standard baud rate of 9600Hertz, the setting of TH 1 will be as follows

$$BRL = 256 - \frac{2^{SMDD} \times F_{PER}}{6^{(1-SPD)} \times 32 \times Band-Rate} \quad (4)$$

For mode 1 baud rate is 1/32 of oscillatory frequency $\left({}^{F_{osc}}/_{12}\right)$, then

$$TH1 = 256 - \frac{2 \times 12 \times 10^6}{6^{(1-4)} \times 32 \times 9600 \times 12} = 253D, \qquad Th1 = 0FDh$$

To convert the parallel inputs from PC into serial output, HT12E encoder with 8 address bits and 4 data bits was employed. They were paired with 12(12) series of decoders 8 address bits and 4 data bits used in the remote of system. HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. The RF module operates at frequency range between30 kHz and 300GHz using Amplitude Shift Keying (ASK) modulation technique. However, RF module used operates at a frequency of 434MHz for the transmitter and receiver at the rate of 1Kps-10Kps.Fig1shows detail of transmitting modules.

Receiving Module

For successful interfacing, all the components such as RF receiver, ULN 2803, paired HT12E decoder with similar feature (to restructure serial data back to parallel)and relays were also interfaced with the micro-controller AT80C51. The ULN2803A is a high-voltage, high-current Darlington transistor array. The device consists of eight NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each Darlington pair is 500 mA. The Darlington was connected in parallel for higher current capability.

Power supply; the ampere rating of the battery, 13.8V was used for E_{dc} with consideration of maximum rating (15mA) of the I.Cs employed in the model and since the exposure to maximum rating for extended period may affect device reliability, 12mA was chosen (fig 3)

Since; $E_{dc} = \frac{2E_{max}}{\pi}$ (5)

And $E_{rms} = \frac{E_{max}}{\sqrt{2}}$ (6)

Then $E_s = 15.33\ Volts$

To minimise resistance and inductance leakage 15.5V was chosen, and similarly

$$I_{dc} = \frac{2I_{max}}{\pi} \quad (7)$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} = \quad (8)$$

$$Is = I_{rms} = 13.33mA$$

From $\frac{E_S}{E_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$ (9)

Chosen N_p to be 450 turns, $N_S = 27\ turns, I_P = 800\mu A$ with power rating of 200mW

To rectify the signal, $E_{dc} = E_m - \frac{I_{dc}}{2\pi fc}\ (mehta, 2004)$ (10)

Then $C_4 = 5.58\mu F$

With the circuit developed, a software called Tera terminal was installed on the system to communicate with the microcontroller through USB serial cable so as to send the result via encoder HT12E to 434MHz Radio Frequency transmitter.

In order to actualize the workability of the circuit and behavioral nature under various conditions for better construction, a multimeter was used to measure voltages at different terminal in the circuit. The result obtained was recorded and compared with the respective theoretical values to meet the level required. Followed by appliance interface test, bulbs were connected to the relays and the power supply was switched on. The system was placed in different places to check environmental effect on radio frequency application

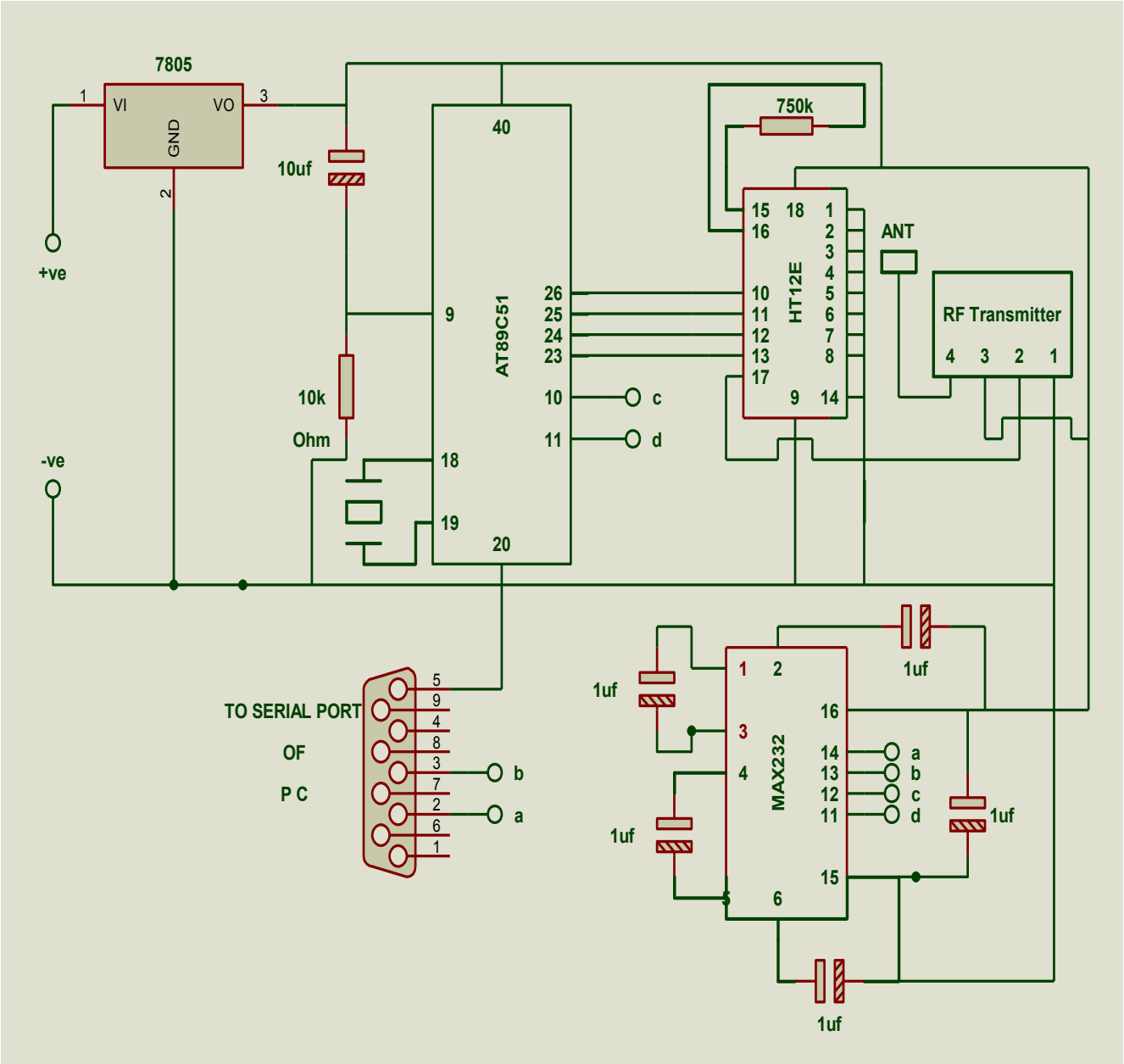

Fig 1: Transmitter Cicuit Diagram

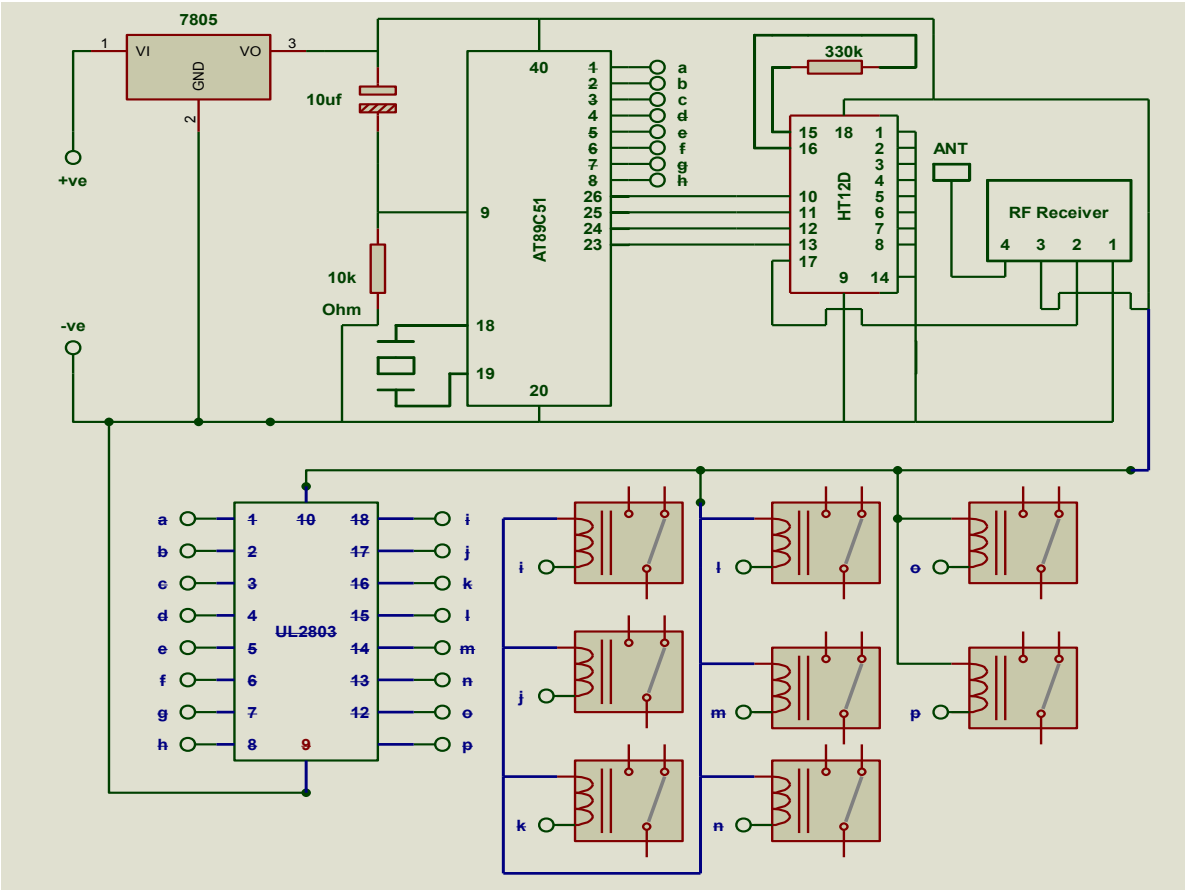

Fig 2: Receiver Circuit Diagram

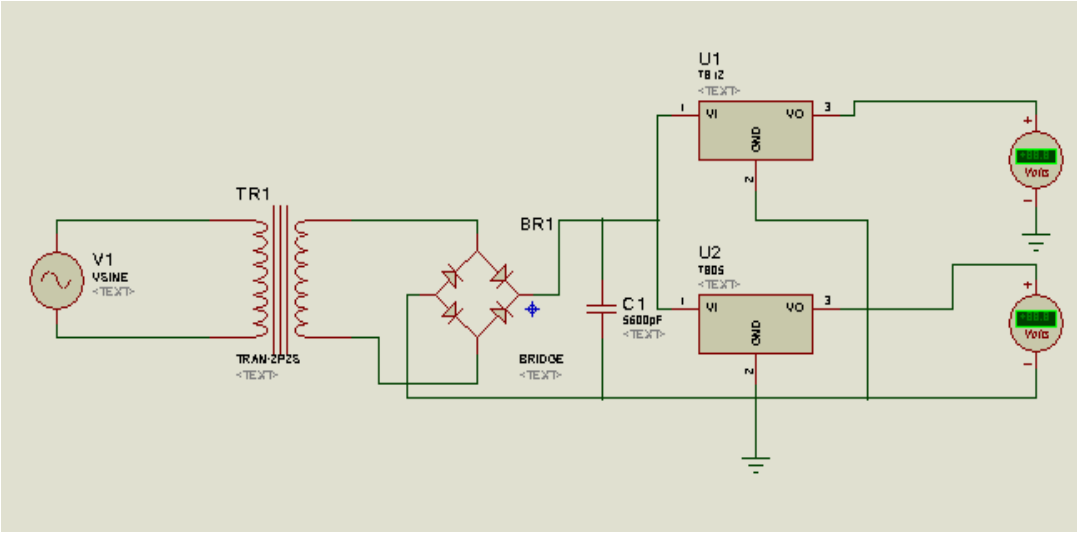

Fig 3: Power Supply

Experimental Result Analysis and Discussion

When the system was powered started working by displaying titled name of the work and status of the system on tera-term user interface, confirming the workability of the circuit. TypingON11 to activate appliance one and type OFF1 to deactivate appliance one. All other appliances were controlled interdependently with corresponding ON22, ON33, ON44, ON44, ON55, ON66, ON77, and ON88 respectively (fig 4) .Similarly OFF2 up to OFF8 deactivated the appliances (Fig 4). Moreover, tera-term displayed the current status of the corresponding device when energized or de-energized laptop and sent message with immediate effect to the remote user (Fig4 and (fig 5).

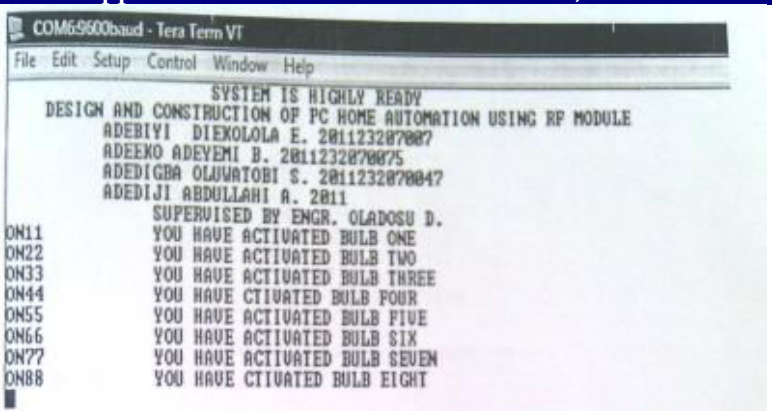

Fig 4: Tera-Term Activation of Appliances

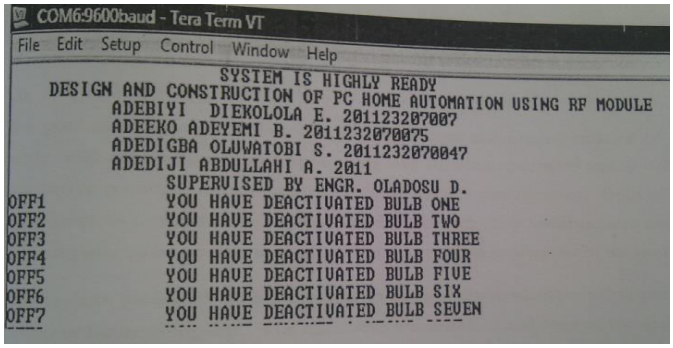

Fig 5: Tera-Term Deactivation of Appliances

It was fully established that the system was properly functioned; also good response was observed at the desired device control interfaces. However, the time of response of the system varied with environment subject to propagation loss, the response was very fast in free space, followed by indoors line of sight, conference room, student hostel and the least was indoor office building without line of sight. As a result of this, home and office appliances can be effectively controlled using personal laptop. User can remotely have access to the appliances thereby serving as a method of managing time.

Conclusion and Recommendations

Indeed, Automation has become invaluable part of our life, this implemented system is smart, cheaper and communicate remotely with appliances. The method used to developthe appropriate design for the system goes a long to relieve ups and down of the impaired ones, it is not necessary for him to move around the corners of his residence before turning ON or OFF of house or office appliances. Besides, the system developed could also reduce the energy cost for the users by remotely monitor and control of appliances, Thus, systems can be used as a test bed for any application that requires on-off switching base applications. Moreover, the potential for practical applications of this system cannot be quantified; it can be used to control devices in offices and industries, also it can be developed to transfer information from one office to another and can be further expanded to provide such control over the internet.

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