Design and Simulation of Domestic Remote Control System using Microcontroller

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Abstract— **A microcontroller (or MCU) is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas a general purpose microprocessor requires additional chips to provide these functions. The need for a remote control system that can control domestic appliances, various lighting points and sockets has often been a concern for users. At times users find it inconvenient and time consuming to go around turning their appliances OFF when they are leaving the house for work. It has also often led to damage of appliances due to the fact that an appliance was not turned OFF before leaving the house. The objective of putting up this project therefore is to design and simulate equipment that can facilitate a convenient and easy way of controlling our domestic appliances, lighting points and sockets especially in powering them by ourselves. This objective will be accomplished using various components which include a microcontroller chip, capacitors, relays, etc**

Keywords- Microcontroller, Simulation, Teleautomatiom, Remote Control

I. INTRODUCTION

A microcontroller (or MCU) is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC) (*Martin Bates, 2006)*. A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas a general purpose microprocessor requires additional chips to provide these functions. A microcontroller is a single integrated circuit with the following key features (*Myke Predko, 1999)*:

- central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors
- input/output interfaces such as serial ports
- peripherals such as timers
- RAM for data storage
- ROM, EEPROM or Flash memory for program storage
- clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit

A Remote control system using microcontroller is basically a device used to control our domestic appliances, lighting points and sockets. It is a remote control alert based system which is used to power our appliances, lighting points and sockets ON or OFF. At times users find it inconvenient and time consuming to go around turning their appliances ON or OFF each time there is power outage or each time they are leaving the house for work. It has also often led to damage of appliances due to the fact that an appliance was not turned OFF before leaving the house. The paper consists of two sections, they are; the Transmitting side and the Receiving side. The Receiving side consists of a power supply section, a microcontroller and Relays. It also houses the Infrared Receiving Sensor circuit. The Transmission side is a smaller component which is inform of a hand held component. It has a power supply section that is powered using a 9v battery. The transmission side also has a microcontroller which coordinates the various button inputs. The last major component contained in the transmitter side is the Infrared emitter/sender which transmits signals received from the input buttons to the receiving side of the system. This transmission is accomplished wirelessly through the Infrared emitter/sender on the Transmitter section.

A. Objectives of Research

The Objective of putting up this project, therefore, is

1. To design and simulate equipment that can facilitate a convenient and easy way of controlling our domestic appliances, lighting points and sockets especially in powering them, without always going to appliances physically by ourselves.

2. To determine the use of various components which include a Microcontroller
3. To ascertain which other related components with the Atmel AT89C51 Microcontroller will act as the backbone to the design of remote control system

B. Statement of the Problem

Due to the advantages, flexibility, convenience and easy way of controlling our domestic appliances, lighting points and sockets especially in powering them, without always going to appliances physically by ourselves, this facilitates the design and simulation of a remote control system.

The issues of always forgetting our appliances ON when leaving the house has often caused fire outbreak and explosion in homes and this can be eliminated by this simulation.

C. Scope of Study

This paper focuses on the ease of putting our appliances, lighting points and sockets ON or OFF has made it necessary to develop this system in order to control our appliances, lighting points and sockets from a central point using a remote control.

II. RELATED LITERATURES

A. Remote Control Systems

One of the earliest examples of remote control alert was developed in 1893 by Nikola Tesla (Encarta, 2008). In 1898, he demonstrated a radio-controlled boat to the public during an electrical exhibition at Madison Square Garden. Tesla called his boat a "teleautomaton" (O'Neill, John J, 1944). With the invention of Relays previously in 1835 by Joseph Henry it became possible to use remote controls to drive other devices. This is because of the ability of relays to serve as a switch that can control devices when energized by electricity. Again with the invention of Integrated Circuits like 555 timers and Microcontrollers, more functionality was added to whole concept of Remote control alert (Wikipedia).

The first remote intended to control a television was developed by Zenith Radio Corporation in the early 1950's and made use of wire to connect to the television set. The remote unofficially called "Lazy Bones" used a wire to connect to the television set. To improve the cumbersome setup, a wireless remote control alert was created in 1955 1955 by Eugene Polley. The remote called "Flashmatic" worked by shining a beam of light onto a photoelectric cell (Wikipedia). In 1956 Robert Adler developed "Zenith Space Command", a wireless remote. It was mechanical and used ultrasound to change the channel and volume. When the user pushed a button on the remote control it clicked and struck a bar, hence the term "clicker". Each bar emitted a different frequency and circuits in the television detected this noise (Farhi, Paul, 2007). The invention of the transistor made possible cheaper electronic remotes that contained a piezoelectric crystal that was fed by an oscillating electric current at a frequency near or above the upper threshold of human hearing, though still audible to dogs.

The impetus for a more complex type of television remote control alert came in the late 1970s with the development of the Ceefax teletext service by the BBC. Most commercial remote controls at that time had a limited number of functions, sometimes only four: next station, previous station, and increase or decrease volume. This type of control did not meet the needs of teletext sets where pages were identified with three-digit numbers. A remote control to select teletext pages would need buttons for each number from zero to nine, as well as other control functions, such as switching from text to picture, and the normal television controls of volume, station, brightness, colour intensity and so on. Early teletext sets used wired remote controls to select pages but the continuous use of the remote control alert required for teletext quickly indicated the need for a wireless device. So BBC engineers began talks with one or two television manufacturers which led to early prototypes in around 1977-78 that could control a much larger number of functions. ITT was one of the companies and later gave its name to the ITT protocol of infrared communication. In the early 1980s, when semiconductors for emitting and receiving infrared radiation were developed, remote controls alert gradually switched to that technology which, as of 2006, is still widely used (SB-projects).

In 2006, Hillcrest Labs introduced the Loop pointer, a remote control that used Hillcrest's Freespace motion control technology to allow users to control their televisions with natural gestures. The Loop had just four buttons and a scroll wheel (Tynan Dan, 2006). Freespace-enabled remote controls use radio waves to communicate with a USB antenna connected to a computer that is also connected to the television, so they do not need to be pointed at the PC, or even have a direct line of sight (Webster Camilla, 2007).

Most modern remote control alert systems for appliances use infrared diode to emit a beam of light that reaches the device or equipment. Therefore the concept of remote control is further expanded in another form by applying it in a circuit that is used to power many appliances automatically by pressing buttons on the remote control.

B. Microcontrollers

Circumstances that we find ourselves in today in the field of microcontrollers had their beginnings in the development of technology of integrated circuits. This development has made it possible to store hundreds of thousands of transistors into one chip. That was a prerequisite for production of microprocessors (microcontrollers), and the first computers were made by adding external peripherals such as memory, input-output lines, timers and other. Further increasing of the volume of the package resulted in creation of integrated circuits. These integrated circuits contained both processor and peripherals. That is how the

first chip containing a microcomputer, or what would later be known as a microcontroller came about.
It is year 1969, and a team of Japanese engineers from the BUSICOM Company arrives to United States with a request that a few integrated circuits for calculators be made using their projects. The proposition was made to INTEL, and Marcian Hoff was responsible for the project. Since he was the one who has had experience in working with a computer (PC) PDP8, it occurred to him to suggest a fundamentally different solution instead of the suggested construction. This solution presumed that the function of the integrated circuit is determined by a program stored in it. That meant that configuration would be simpler, but that it would require far more memory than the project that was proposed by Japanese engineers would require. After a while, though Japanese engineers tried finding an easier solution, Marcian's idea won, and the first microprocessor was born. In transforming an idea into a readymade product, Frederico Faggin was a major help to INTEL. He transferred to INTEL, and in only 9 months had succeeded in making a product from its first conception. INTEL obtained the rights to sell this integral block in 1971 (*Jan Axelson, 1994).*

First, they bought the license from the BUSICOM Company who had no idea what treasure they had. During that year, there appeared on the market a microprocessor called 4004 (*Martin Bates, 2006).* That was the first 4-bit microprocessor with the speed of 6 000 operations per second. Not long after that, American company CTC requested from INTEL and Texas Instruments to make an 8-bit microprocessor for use in terminals. Even though CTC gave up this idea in the end, Intel and Texas Instruments kept working on the microprocessor and in April of 1972, first 8-bit microprocessor appears on the market under a name 8008. It could address 16Kb of memory, and it had 45 instructions and the speed of 300 000 operations per second. That microprocessor was the predecessor of all today's microprocessors. Intel kept their developments up in April of 1974, and they put on the market the 8-bit processor under a name 8080 which could address 64Kb of memory, and which had 75 instructions, and the price began at $360 (*Jan Axelson, 1994).* In another American company Motorola, they realized quickly what was happening, so they put out on the market an 8-bit microprocessor 6800. Chief constructor was Chuck Peddle, and along with the processor itself, Motorola was the first company to make other peripherals such as 6820 and 6850. At that time many companies recognized greater importance of microprocessors and began their own developments. Chuck Peddle leaves Motorola to join MOS Technology and keeps working intensively on developing microprocessors.

At the WESCON exhibit in United States in 1975, a critical event took place in the history of microprocessors. The MOS Technology announced it was marketing microprocessors 6501 and 6502 at $25 each, which buyers could purchase immediately. This was so sensational that many thought it was some kind of a scam, considering that competitors were selling 8080 and 6800 at $179 each. As an answer to its competitor, both Intel and Motorola lower their prices on the first day of the exhibit down to $69.95 per microprocessor. Motorola quickly brings suit against MOS Technology and Chuck Peddle for copying the protected 6800. MOS Technology stops making 6501, but keeps producing 6502. The 6502 is an 8-bit microprocessor with 56 instructions and a capability of directly addressing 64Kb of memory. Due to low cost, 6502 becomes very popular, so it is installed into computers such as: KIM-1, Apple I, Apple II, Atari, Comodore, Acorn, Oric, Galeb, Orao, Ultra, and many others. Soon appear several makers of 6502 (Rockwell, Sznertek, GTE, NCR, Ricoh, and Comodore takes over MOS Technology) which was at the time of its prosperity sold at a rate of 15 million processors a year! (*Myke Predko, 1999).*

Other new manufacturers like Zilog, Mostek, NEC, SHARP, and SGS also appear. Z80 was the heart of many computers like Spectrum, Partner, TRS703, Z-3 and Galaxy here at home. In 1976, Intel comes up with an improved version of 8-bit microprocessor named 8085.[1] However, Z80 was so much better that Intel soon lost the battle. Even though a few more processors appeared on the market (6809, 2650, SC/MP etc.), everything was actually already decided. There weren't any more great improvements to make manufacturers convert to something new, so 6502 and Z80 along with 6800 remained as main representatives of the 8-bit microprocessors of that time.

C. Choice of Design

The need for a remote control alert system that can control domestic appliances and various lighting points and sockets has often been a concern for users. The benefit of an automated solution was recognized from the start because of the ease of putting our appliances, lighting points and sockets ON or OFF from a central point using a remote control. This reason, thus, makes it possible to improve on its features.

III. METHODOLOGY

A. ATMEL AT89C51

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel’s high density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin-out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

It has the following Features**:**

- Compatible with MCS-51 Products
- 4K Bytes of In-System Reprogrammable Flash Memory
  – Endurance: 1,000 Write/Erase Cycles
- Fully Static Operation: 0 Hz to 24 MHz
- Three-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial Channel
- Low-power Idle and Power-down Modes

B. Infrared Transmitters and Recievers

Infrared (IR) radiation is electromagnetic radiation of a wavelength longer than that of visible light, but shorter than that of radio waves. The name means "below red" (from the Latin *infra*, "below"), red being the color of visible light of longest wavelength. Infrared radiation spans three orders of magnitude and has wavelengths between approximately 750 nm and 1 mm. Infra-red light is just below the red portion of the visible spectrum, and so is invisible to the human eye. Infrared (IR) light wavelengths correspond to a frequency range of approximately 1 to 400 THz, and include most of the thermal radiation emitted by objects near room temperature. Microscopically, IR light is typically emitted or absorbed by molecules when they change their rotational-vibrational movements.

Infrared transmitters are the devices that transmit signals through Infrared and these signals are received by Infrared receivers. Infrared receivers are signal sensors which are capable of receiving infrared rays and are able to transform these rays to an intended function.

C. The Transmitter Design

The transmitter (input) interface of the system is designed to be in form of buttons. These input buttons form part of the remote control transmitter. When this buttons are depressed, it sends a signal in form of command to the microcontroller on the transmitter circuit. On receiving the command, the microcontroller interprets them and sends out the resulting interpretation to the infrared transmitter which then communicates with the receiver on the receiver circuit.

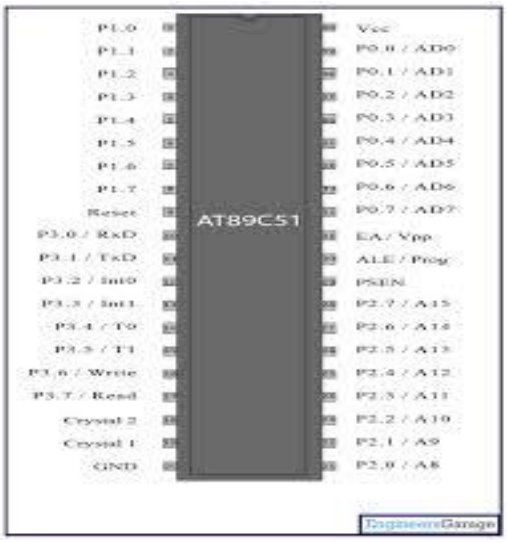

Figure 1 - Transmitting Section

D. The Receiver Design

The receiver (output) Interface of the system is a control circuit which receives inputs from the remote control transmitter and transfers this control signal received to their respective loads or outputs. The system uses an Infrared receiver sensor through which the transmitted signals are received wirelessly. The signal received by this infrared receiver is sent to the microcontroller which will perform the processing of the signals according to the commands on the microcontroller control program.

The next stage of the process is the transfer of the passed signals by the microcontroller from where the processed signals are sent to the Relay which will perform the control operation of the loads. These signals are transferred out from the microcontroller to the relays. The relays are powered by an unregulated 12v voltage from the power supply of the transmitter.

IV. DESIGN AND IMPLEMENTATION

A. System Testing

Testing is a vital process in the development and realization of any design, be it hardware based, software based or both. The various components and their circuitry have to be tested to ensure that all the components on board are certified okay and in good working condition. The components that did not give the required output specification where isolated and troubleshooted to determine the nature and cause of the component failure through careful analysis, that is examination of the working principles of the component(s). Here also during the testing analysis, modularization and Interface design were also tested. Each module in case of the

software were tested to know whether it performs the functions assigned to it and also to know whether each of the module can interact as required by transferring and returning data in form of a signal.

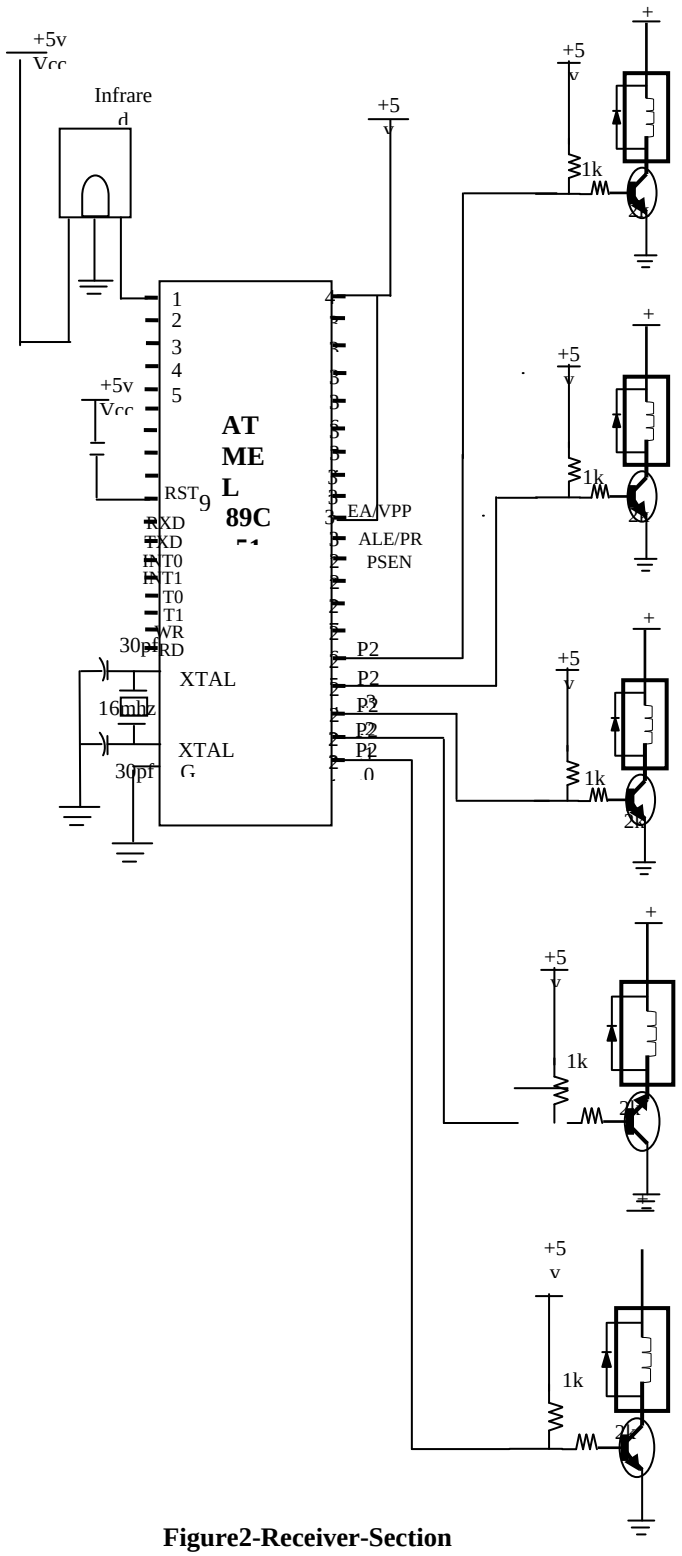

Figure2-Receiver-Section

A.1. Test Data

The functionality of the system depends to some extent on the correctness of the exact signal(s) being produced by different modules. Here the test data includes signal that emanates from each module for performing its intended task.

The test data are as follows: -

- The signal that comes out when the sensitive switches are being pressed or activated.
- The signal coming out from the Atmel AT89C51 microcontroller module of the transmitter and receiver units to their respective infrared transmitters and infrared receiver sensors.
- The signal coming out from the Atmel AT89C51 microcontroller module to the relays.

The above-mentioned test data was used to test for the functionality of the systems.

A.2. Choice of Programming Language

The source code will be written in C language and later complied with an HEX code to be loaded and programmed on the Atmel AT89C51.

V. SUMMARY AND CONCLUSION

A. Summary

For a paper to be executed, one has to reason out what the design is and how the design can be carried out and also be able to implement the design in order to achieve the aims and objectives of the research.

In the design and implementation of this project "domestic remote control for fans, lighting points and sockets, the Atmel AT89C51 microcontroller is programmed to coordinate the whole function of the design from the input when the button is pressed to the processing and sending of signals to the receiver sensor from where this signals are processed appropriately and transferred to the relay which are connected to outputs inform of our domestic appliances, lighting points, and so on.

B. Recommendation for Further Improvement

This research is a viable one in the sense that it will go a long way in making it more convenient and easier for users to easily control their appliances, lighting points and even sockets from a central point in their home using a remote control which has buttons for controlling each appliance connected to the system. Because of its importance as a household need, efforts must be geared towards designing a viable project like this one. I strongly recommend that this project should be seen as a priceless possession and more research works relating to this should be supported and encouraged. Likewise, this type of project is to be used not only in homes but also in offices, schools, industrial environment and so on.

C. Conclusion

In conclusion, this research is one which should be encouraged and put into large scale manufacturing and industrial application because of its various advantages.

REFERENCES

Clayton Hallmark (1986) IC Cookbook (Pin configurations of all the ICs)

Derene, Glen (2007). "Wii 2.0: Loop remote lets you click by gesture". *Popular Mechanics*. Retrieved November 11, 2011.

Farhi, Paul. "The Inventor Who Deserves a Sitting Ovation." *Washington Post*. February 17, 2007.

"Five Decades of Channel Surfing: History of the TV Remote Control". Archived from the original on January 16, 2008. Retrieved December 3, 2008.

Jan Axelson (1994) The Microcontroller Idea Book

Jonnes, Jill. *Empires of Light* ISBN 0-375-75884-4. Page 355, referencing O'Neill, John J., *Prodigal Genius: The Life of Nikola Tesla* (New York: David McKay, 1944), p. 167.

Kanellos, Michael (November 8, 2006). "Space-age remote control coming in 2007". Cnet.com.

Kaplan, Jeremy (January 11, 2006). "Anywhere, Anytime TV". *PC Magazine*.

Luecke G, J.P Mize and W.N Carr (1973) Semiconductor Memory Design and Applications

Martin Bates (2006) Interfacing PIC Microcontrollers

Microchip (2003) Data Sheet FLASH-based 8-bit CMOS Microcontroller

Microsoft Premium Encarta (2008)

Myke Predko (1999) Hand Book on Microcontroller

"Philips tops in converters". *The Toronto Star*: p. F03. November 29, 1980.

"SB-Projects: IR remote control: ITT protocol".

Taub, Eric (June 15, 2009). "A Wireless Mouse That's Surfaceless Too". *The New York Times*.

Tynan, Dan (October 2, 2006). "The Future of Fun. Coming soon: All the movies, music, and TV you want, when and where you want them". *PC World*

Webster, Camilla (November 16, 2007). "Dream Tech Toys". Forbes.com.

Wilson, Mark (June 15, 2009). "The Loop Controls Your TV Like the Wii for $100". Gizmodo.

.Wikipedia: Free Encyclopedia