DESIGN AND CONSTRUCTION OF MOBILE

PHONE/ PERSONAL COMPUTER REMOTE

CONTROLLING DEVICE

BY

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2001/12137EE

SUBMITTED TO

THE DEPARTMENT OF ELCTRICAL AND COMPUTER

ENGINEERING

SCHOOL OF ENGINEERING AND ENGINNERING

TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY

MINNA, NIGER STATE

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE

AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE

IN ELECTRICAL AND COMPUTER ENGINEERING

NOVEMBER 2007

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DEDICATION

This project is dedicated to Almighty God, my parents Hon. & Mrs D. N. N. Umeano, and my sisters.

DECLARATION

I, Umeano Ogochukwu declare that this project work "Design and Construction of Mobile Phone/ Personal Computer Remote Controlling Device" presented for the award of Bachelor of Engineering (B.Eng.)degree is a result of my personal effort. It has never been presented elsewhere either wholly or partially for either a degree or diploma. I hereby also relinquish the copy to the Federal University of Technology Minna.

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ACKNOWLEDGEMENT

ABSTRACT

The Mobile Phone / Personal Computer Controlling (MPRC) device was designed to control appliances connected to it via any mobile phone anywhere in the world or a personal computer (PC).

This was achieved by interfacing the PC and an Ericsson T10s (slave) phone to an ATmega 8515 Microcontroller.

Appliances connected to this device are controlled (either turned on or off) when the MPRC device receives a valid command either as an SMS (short message service) message or a command from the personal computer.

The MPRC Device is used to make an extended range remote, operable from anywhere in the world. It finds use in Global positioning Satellite (GPS) such as in Based Car Tracker where the engine of a stolen car can be made to switch off by sending an SMS to the circuit board. It can also be used for Industrial and domestic purpose where appliances and equipments connected to it can be remotely controlled and monitored.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

Technological advancement in the world have paved way for remote controlling of equipment rather than manually operated equipments. It is in the light of this that the **Mobile Phone/Personal Computer (MPRC) Device** was conceptualized.

This project is about a circuit connected to the parallel port of a **Personal Computer (PC)** and the serial port featured by many **Mobile phones. MPRC** device function is to provide an input and an output capable of being remotely controlled using another mobile phone or personal computer.

Control from the mobile phone takes place by means of **SMS** (Short Message Service) Text. When the mobile phone receives a predefined **SMS**, like "**FN ON1**" or "**BB OFF**", the device automatically recognizes it as a command, and switches the appliance accordingly. The PC can also be used to send similar commands to the device.

To know the input status at any time, MPRC device can send back an SMS message, describing the status of the input, as a response to a request message.[1]

SMS are simple and convenient and can be entered, stored, and read directly on the cell phone itself. In coming messages are completed with the time of reception, and stored automatically in the mobile's memory. By means of one of the various services offered by network providers, they can be converted to faxes, mails, and even voice calls spoken by a synthetic voice.[2] As an additional benefit, SMS are fairly priced since they don't require precious real-time bandwidth; in fact the three main GSM operators in

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Nigeria; Glo, Celtel, and MTN are providing some level of cheap and free text messages. For this project, a Glo SIMCARD will be used.

1.2 OBJECTIVES

This project is principally concerned with building a device that can remotely control other devices through a mobile phone and a personal computer.

The application of the MPRC device is countless; It can be used to make an extended range remote control operable from anywhere in the world.

In the industry it can monitor if a machine is running, or if some threshold is surpassed. The technical staffs are alerted automatically and can remotely operate an immediate counter measure.

It can also be used in the GPS (Global Positioning Satellite) such as in a based car tracker. If a car gets stolen, the engine of the car can be switched off remotely by just sending an SMS to the circuit board[3]. This is closely in application to car immobilizers.

All the components of a home automation system can be conveniently controlled and monitored from a mobile phone.

1.3 METHODOLOGY / LAYOUT

To achieve the objective above, we would be interfacing an ATmega8515 microcontroller to an Ericsson T10s mobile phone and a computer.

The serial port of the Microcontroller would be interfaced with the serial port of the Mobile phone, while the parallel port of the Microcontroller would be interfaced to the Parallel port of the PC.

Our commands are to be sent through the mobile phone and the computer. The mobile phone communicates with the microcontroller through its AT Command set.

When the MPRC device is turned on, the phone is powered and the microcontroller selects the phone memory as its default storage location. At some periodic interval, the microcontroller assesses a pre assigned memory location for a new text message. The text message received is then analyzed by the microcontroller to see if it is a valid or an invalid command. If it is an invalid command, the microcontroller deletes it is from the phone memory and then waits for another message. In the case of a valid command, the microcontroller then analyses it to see what command it is and then executes it. The valid command include: 'BULB ON1', 'BULB OFF', 'TV ON', 'TV OFF', 'FAN ON1', 'FAN ON2', 'FAN ON3', 'FAN ON 4', 'FAN ON5'and 'FAN OFF'.

The MPRC device after executing any command sends a feedback SMS to your phone to let you know whether your command was successfully executed or not. It could also notify you of the current status of your appliance.

On the computer, a program will be developed to send commands to the microcontroller, just as the mobile phone does. The program on the computer will be updated by the microcontroller after a change has been effected on the status of each of the devices connected. This update is done irrespective of where the command was sent from (either the computer or the mobile phone).

This thesis is divided into chapters. The first chapter contains a brief Introduction of the ideas, objectives and motivations, and methodology presented in the thesis. The second chapter focuses on the literature review and the background that aids the reader in

gaining information in order to understand the important ideas by which the thesis is based in respect to the hardware and software design. The third chapter includes the detail on how the **MPRC** Device was designed and analyzed. The fourth chapter covers the implementation and the testing procedure. The theses closes with the fifth chapter where the conclusion was drawn and recommendation suggested for further work.

CHAPTER TWO

LITERATURE REVIEW AND BACKGROUND

2.1 LITERATURE REVIEW

The first remote control, called "lazy bones" was developed in 1950 by Zenith Electronics Corporation (known as zenith Radio Corporation)[4]. Lazy bones was a cable that ran from the device to a TV set, then to the viewer. A motor in the TV set operated then tuner through the remote control. By push buttons on the remote control, the viewer rotated the tuner clockwise or anticlockwise, depending on whether he wanted to change the channel to a higher or lower number. The remote control included buttons that the tuned the TV on or off.

Zenith engineer Eugene Polley invented the "Flashmatic" which represented the country's first wireless TV remote. Introduced in 1955, the flashmatic operated by means of four photocells, one in each corner of the TV screen. The viewer used a highly directional flashlight to activate the four controls which turned the picture and sound on and off and changed channels.

By 1990, the industry moved to infrared remote control technology (IR). The IR remote works by using a low frequency light beam, so low that human eye cannot see it, but which can be detected by a receiver in the TV set.

Modern electronics is about embedded electronics, this is the use of electronics for the purpose of controlling devices. Its applications are numerous for the purpose of controlling devices. More discoveries, innovation and inventions are expected in this new world of electronics and software engineering.

With the increasing production of mobile phones, it became a great thing to find use for old mobile phones that work but are not up to date with the latest gismo[5].

2.2 HARDWARE DESCRIPTION

Hardware is equipment involved in the function of a machine device or computer. They consist of the components that can be physically handled. The function of these components is typically divided into three main categories: input, output, and storage. This section deals with the hardware aspect of the project. This composes of the Personal Computer (PC), the mobile Phone, some basic electronic components and the programmer.

2.2.1 PERSONAL COMPUTERS

Computers are machine that performs tasks, such as mathematical calculations or electronic communication, under the control of a set of instructions called a program[6]. Computers are used to perform a wide variety of activities with reliability, accuracy, and speed[7].

2.2.1.1 PC PARALLEL PORT

The PC Parallel Port is the most commonly used port for interfacing home made projects. This port will allow the input of up to 9 bits or the output of 12 bits at any one given time, thus requiring minimal external circuitry to implement many simpler tasks.

The port is composed of 4 control lines, 5 status lines and 8 data lines. It's found commonly on the back of PCs as a D-Type 25 Pin female connector.

The output of the Parallel Port is normally TTL logic levels. The voltage levels are the easy part. The current one can sink and source varies from port to port. Most Parallel Ports implemented in ASIC, can sink and source around 12mA of current.

2.2.1.2 PC PORT ADDRESSES

The Parallel Port has three commonly used base addresses. These are listed in **table2.1.** LPT1 is normally assigned base address 378h, while LPT2 is assigned 278h. The lower case **"h"** denotes that it is in hexadecimal. These addresses may change from machine to machine.

Parallel port has three software register these are Data Register, Status Register and Control Register. Each of the register is an 8 bit register which is byte addressable and not bit addressable. This means that individual bit can not be changed without affecting other bit in the same register.

*The base address:-The base address, usually called the Data Port or Data Register is simply used for outputting data on the Parallel Port's data lines (Pins 2-9). This register is normally a write only port. If you read from the port, you should get the last byte sent. However if your port is bi-directional, you can receive data on this address.

*The Status Port:-The Status Port (base address + 1) is a read only port. Any data written to this port will be ignored. The Status Port is made up of 5 input lines (Pins 10,11,12,13 & 15).

* The Control Port:- The Control Port (base address + 2) was intended as a write only port. When a printer is attached to the Parallel Port, four "controls" are used. These are

Strobe, Auto Linefeed, Initialize and Select Printer, all of which are inverted except Initialize.

2.2.2 MOBILE PHONES

These are also called cellular telephones or cell phones. They are low-powered, lightweight radio transceiver (combination transmitter- receiver)[8].

2.2.2.1 ERICSSON T10S SERIAL PORT

The serial port is TTL compatible that is, it can be interfaced directly with TTL devices or Integrated Circuit (i.e. Microcontrollers). The serial port is working at 5 volts with AT commands (like the modem commands, but for mobile phones).

2.2.3 ELECTRONIC COMPONENTS

Components are classified into two categories active or passive. Passive elements never supply more energy than they absorb; active elements can supply more energy than they absorb. Passive components include resistors, capacitors, and inductors. Components considered active include batteries, generators, vacuum tubes, and transistors.

2.2.3.1 AVR MICROCONTROLLERS

A microcontroller (often abbreviated MCU) is a single computer chip (Integrated Circuit) that executes a user program, normally for the purpose of controlling some device, hence the name microcontroller. The program is normally contained either in a second chip, called an EPROM (Electronic Programmable Read-Only Memory), or

within the same chip as the microcontroller itself Microcontroller-based systems are generally smaller, more reliable, and cheaper. They are ideal for the types of applications described above where cost and unit size are very important considerations. In such applications it is almost always desirable to produce circuits that require the smallest number of integrated circuits, that require the smallest amount of physical space, require the least amount of energy, and cost as little as possible.

The AVRs are 8-bit RISC platforms with a Harvard architecture (program and data memory are separate). **Figure1** details the Atmega8515 AVR chip internal organization. Like each member of a family, it has its own particular combination of I/O and peripherals, but it shares a basic architecture and instruction set with all the other AVRs..
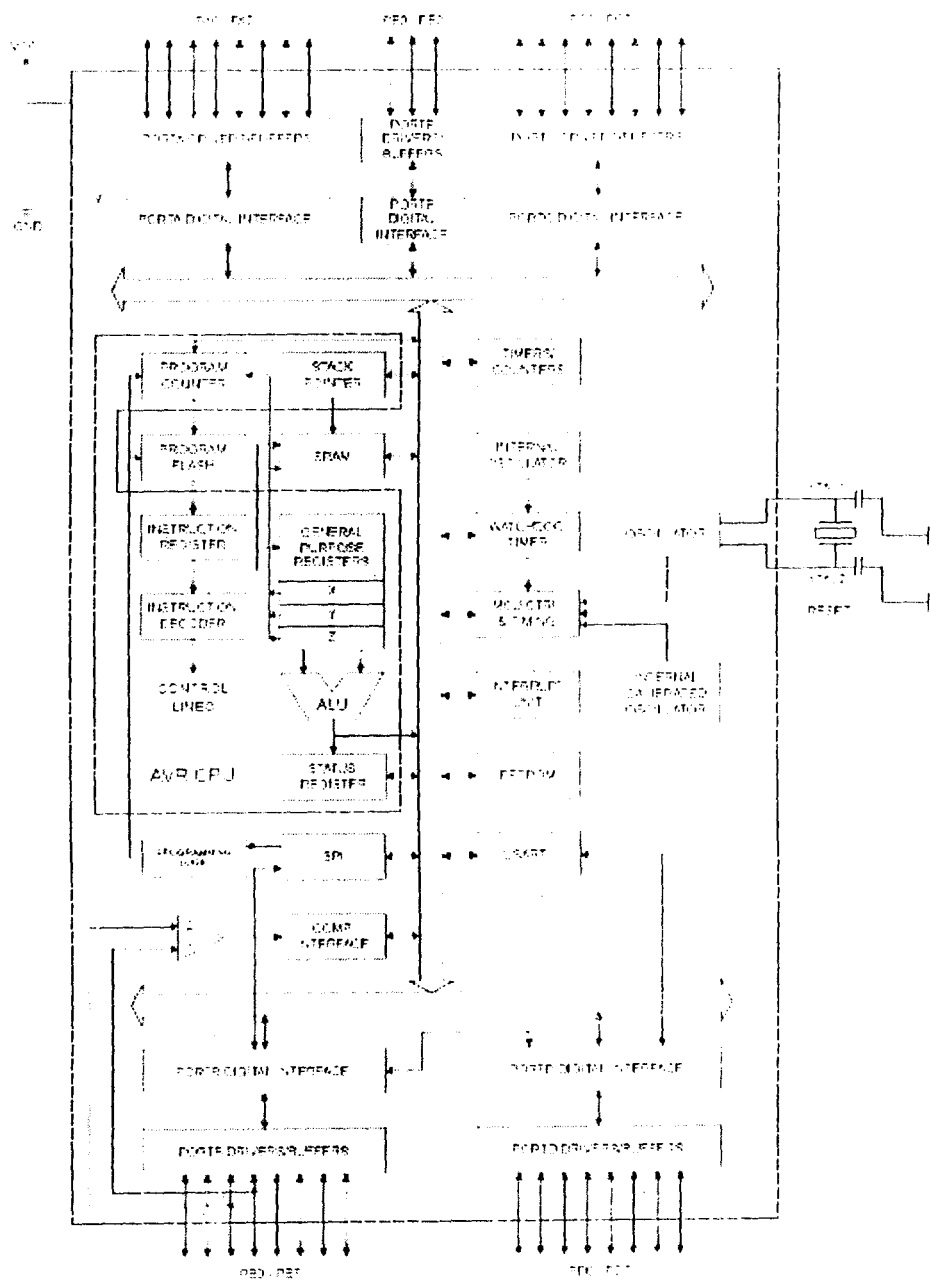
Figure 2.0 Atmega8515 Block Diagram

2.2.3.2 TRANSFORMERS

A transformer is a component that is made up of two (inductive) coils which are magnetically linked but electrically separated. By the process of mutual inductance, if one coil is connected to an alternating voltage source, a voltage which is also alternating

is set up in the other coil, helped by the presence of a laminated core on which both coils are wound. One coil is called a primary winding and the other is called a secondary winding. The frequency of both voltages is the same. An ideal transformer has no losses at all but an actual transformer does.

A transformer can either be a step-up (transforms low voltage to high voltage) or a step down (transforms high voltage to low voltage).

2.2.3.3 VOLTAGE REGULATORS

Voltage regulators can be categorized as discrete component circuits or as integrated circuits. They are used in low power, high power, low-drop out devices and feature high precision and self-protection. They are basic devices that maintain the output voltage of an ordinary power supply irrespective of load variation or charges in AC input.

One most popular IC regulator product is a 3-terminal regulator. The output is either fixed or adjustable or both and are available in variety of positive or negative output voltages and current ranges. These 3-terminal voltage regulators are used frequently as on-card regulators. The advantage of three-input voltage regulator include:

i.   Comes in a wide variety of output currents and voltages

ii.   Easy to use and readily available at low cost.

iii.   They are robust with regard to their internal over current and thermal protection.

The voltage and current ratings for voltage regulator is usually specified by the manufacture.

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2.2.3.4 TRANSISTORS

The amplifying action of the first transistor was demonstrated at **Bell Telephone Laboratory in December 23rd 1847** by **Walter H. Brattain and John Bardeen**. The first transistor was called **Point-Contact Transistor[9]**.

There are two types of standard transistors **NPN** and **PNP**, with different circuit symbols. The letters refer to the layers of semiconductor material used to make the transistor. Most transistors used today are NPN because this is the easiest type to make from silicon.

Transistors are employed in electronic devices either as switches or as amplifier. When a transistor is used as a switch it must be either **OFF** or **fully ON**.

- In the **OFF** state: power = Ic × V_{CE}, but Ic = 0, so the power is zero.

- In the **full ON** state: power = Ic × V_{CE}, but V_{CE} = 0 (almost), so the power is very small.

The important ratings in switching circuits are the **maximum collector current Ic(max)** and the **minimum current gain h$_{FE}$(min)**.

2.2.3.5 RELAYS

Relays are electromechanical devices or solid state devices which operate in response to a signal which may be voltage, current, temperature etc. Electromagnetic relays operate due to magnetic fields. They are composed basically of two parts:

i.   The operating coil

ii.   The magnetic switch

When an input pulse is introduced in the coil, a magnetic field is produced in the core of the electromagnet. This action causes the switch to slide. Relays are either normally open or normally close. Relays are available for DC or AC excitation and coil voltages range from 5V to 230V. The primary use of relays is in remote switching, whereby the circuit is to be switched is electrically isolated from the switching circuit.

2.2.3.6 OTHER COMPONENTS/MATERIALS

---Resistors:- They were invented in 1850. These are electronic components used to control flow of current in an electronic or electrical circuit [10]. Resistors have color codes used to identify their resistances.

---Capacitors:- The first capacitor was invented by Leyden in 1745 to solve the problem of storing energy[11]. This component stores electric charges. Basically it consist of (2) plates separated by an insulator called dielectric. They include mica, ceramic, film, and electrolytic types. The electrolytic type is to be used in this project.

---**Diodes:-** These are semiconductor devices that allow current to flow in only one direction. Diodes are made from mainly silicon and germanium.

Other materials to be used for this project include: **Inductors, Light Dependent resistors (LDR), Thermistors, Vero boards, Jumpers, Soldering Iron, Soldering Lead, Cutters, hand saw, etc.**

2.3 SOFTWARE DESCRIPTION

Software is the set of instructions a computer used to manipulate data, such as a word-processing program or a video game. These programs are usually stored and transferred via the computer's hardware to and from the CPU. Software also governs how the hardware is utilized; for example, how information is retrieved from a storage device. The interaction between the input and output hardware is controlled by software called the Basic Input Output System software (BIOS). Although microprocessors are still technically considered to be hardware, portions of their function are also associated with computer software. Since microprocessors have both hardware and software aspects they are therefore often referred to as firmware.

2.3.1 PROGRAMMING

This is the art of communication with devices using an artificial language that can be used to define a sequence of instructions that can be processed and executed by such devices[12].

There are two broad classifications of programming languages: the low-level and the high-level languages.

2.3.2 LOW LEVEL LANGUAGE

This type of language is written specifically for a particular type of micro-controller or microprocessor.

2.3.2.1 MACHINE LANGUAGE

This is a sequence of carefully timed series of on and off signals that can also be called high and low pulses or digital zeros and ones [13]. The code usually represents numbers, data and instructions for manipulating those numbers and data.

2.3.2.2 ASSEMBLY LANGUAGE

These are sets of rules that are used in writing a program for an MCU. The assembly language can be understood by man but not by the computer. Hence, for the computer to receive instructions, it needs to be given the instructions in a language that it can understand. The computer understands machine language. This is a methodical arrangement of 'zeros' and 'ones' that is (0's and 1's) respectively

2.3.3 HIGH LEVEL LANGUAGE

This type of language is formed from parts of natural language such as English. It is a high level of abstraction between what is asked by the computer and what the computer actually understands. It is easily understood by humans more easily than assembly languages. But, like the assembly language the computer cannot understand it.

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They therefore have to be translated into machine code the language the computer understands.

2.3.4 ERICSSON T10S AT COMMAND SET

This section describes how AT commands are used to exchange information with your mobile telephone and Infrared Modem. AT commands are used to:

* Configure your mobile telephone and Infrared Modem;

*Request information about the current configuration or operational

status of your mobile phone/modem;

* Test availability and request the range of valid parameters, when

applicable, for an AT command.

The standard format for entering a set command is given below:[14]

AT<command>=<parameters> <CR>

Where: **AT**   Notifies the Infrared Modem that a command is being entered.

<command>   The name of the command being entered.

<parameters>   The values to be used by the command.

<CR>   All command lines are terminated by pressing the <CR>

Command: **AT+CPMS = <mem1>,[<mem2>],[<mem3>]**

Options: **<mem1>**   Memory from which messages are read and deleted

"ME" ME message storage.

"SM" SIM message storage.

<mem2>   Memory to which writing and sending operations are made

<mem3>   Memory to which received SMs are preferred to be stored

Response: **AT+CPMS:<used1>,<total1>,<used2>,<total2><used3>,<total3>**

Where: **<used1>,<used2>,<used3>** Total number of messages currently in

<mem1>,<mem2> and <mem3>respectively.

<total1>,<total2>,<total3> Total number of message locations in

<mem1>,<mem2> and <mem3>respectively.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

This chapter will give a thorough description of the design and implementation of the MPRC device. It is divided into two sections, the hardware design and the software design.

```
                    ┌─────────────────────┐
                    │  Personal Computer  │
                    │        (PC)         │
                    └─────────────────────┘
                              ▲
                              │
                              ▼
┌──────────────┐    ┌─────────────────────┐    ┌──────────────┐
│ Mobile Phone │◄──►│ Microcontroller Unit│────►│Appliance Unit│
└──────────────┘    └─────────────────────┘    └──────────────┘
                              ▲
                              │
                    ┌─────────────────────┐
                    │  Power Supply Unit   │
                    │        (PSU)         │
                    └─────────────────────┘
```

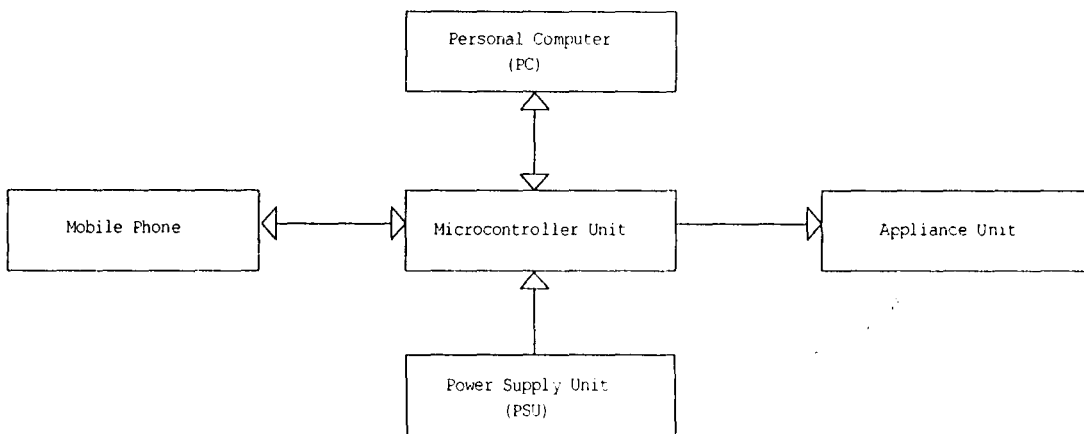Fig3.1 Block diagram of the Hardware Design

3.1 HARDWARE DESIGN

This section deals with the physical aspect of the MPRC device. It is divided into three units, the input unit, the control unit and the output unit.

3.1.1 INPUT UNIT

This unit is sub-divided into the mobile phone interface unit, the personal computer interface unit and the power supply unit.

3.1.1.1 MOBILE PHONE INTERFACE

The mobile phone used for the MPRC device is an ERICSSON T10s. The signal names for the Ericsson T10s communications port include the following: audio input and output to connect to an external hands free, mute control, flash programming signal, battery, external power, and two serial pins receiver (RX) and transmitter (TX). The communication port is TTL compatible. This means that, it can be interfaced directly to a TTL compatible device i.e. a microcontroller. The interface between the communication port and a microcontroller is given below.
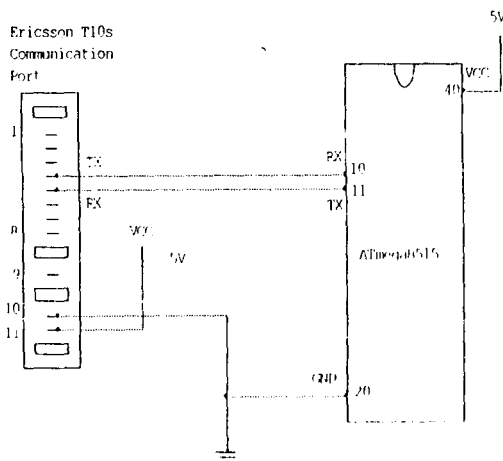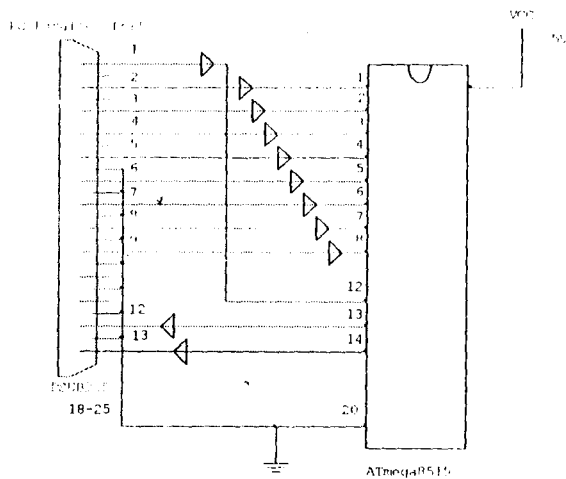

Fig3.2 Interface between the Ericsson T10s and the ATmega8515

3.1.1.2 PERSONAL COMPUTER INTERFACE

The Personal Computer (PC) is interfaced directly to a microcontroller through its Parallel Port; this is possible because the Parallel Port is TTL compatible working on +5V. Below is an interface between the PC Parallel Port and the ATmega8515 microcontroller.

Fig3.3 The interface between the PC Parallel Port and the ATmega8515 microcontroller

From the circuit diagram above, the PC data Pin (Pin2-9) is used to send data to the microcontroller. Pin 1 is used to generate interrupt on the external interrupt pin of the microcontroller (Pin 12), while pin 13 and 14 are used to get the status of **BULB** and **TELEVISION.**

3.1.1.3 POWER SUPPLY

The unit is necessary for the provision of regulated (stepped-down rectified) DC power supply (from AC mains) to circuit components (IC's, relays, microcontroller etc). In designing the power supply the following was taken into considerations.

* The maximum voltage rating of the ATmega8515 microcontroller

* The transient response of the ATmega8515 microcontroller

* The maximum voltage rating of the Ericsson T10s mobile phone

* The maximum voltage rating of the Relays

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After much consideration, it was concluded that a dual power supply will be suitable for this project. A 5V regulated DC for the microcontroller and a 12V regulate DC supply for the relay. The block diagram of the power supply unit is shown.
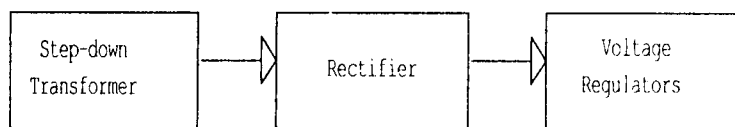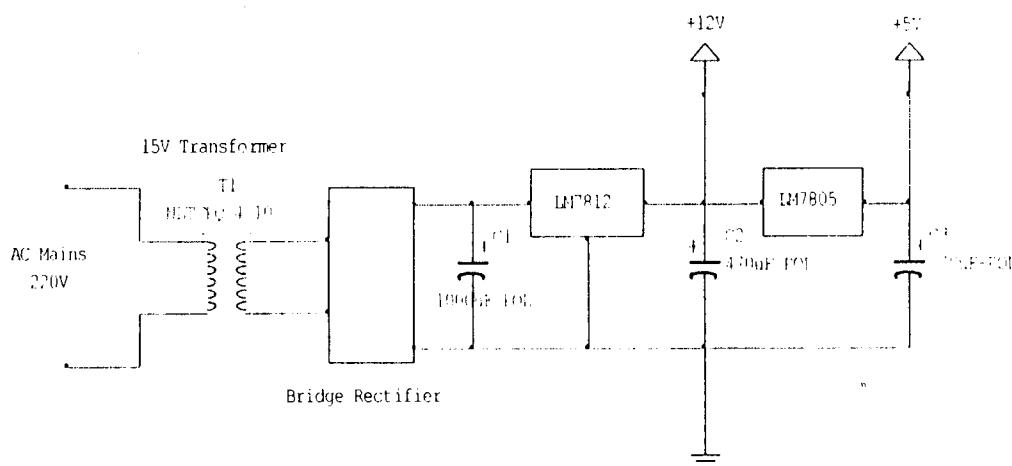

Fig3.4 Block diagram of the Supply unit

From fig 3.4, The AC mains is stepped-down using a set-down transformer, and the output of the step-down transformer is feed through a rectifier. The output of the rectifier is then feed through two voltage regulators. Filter capacitors are placed across the rectifier and across the voltage regulator. The circuit diagram of the power supply is shown below

Fig3.5 Circuit diagram of the Supply unit

The 240V AC is passed to the primary winding of a 240/15V step-down transformer i.e. secondary voltage ≤ primary voltage. The transformer internal analysis is described below.

Primary winding: secondary winding

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$$\frac{V_2}{V_1} = \frac{N1}{N2} = \frac{240}{15} = 16 \qquad (3.0)$$

$$\frac{N2}{N1} = 10^{-1}; \frac{N1}{N2} = 10 \qquad (3.1)$$

$$\frac{V_2}{V_1} = \frac{I_1}{I_2} \qquad (3.2)$$

The ratio N_1/V_1 is called the forms-per-volt-ratio. The primary and secondary of the transformer have the same turns-per-volt-ratio.

The two voltage regulators are used to give a constant DC voltage of 12V (LM7812) and 5V (LM7805). They act as stabilizers due to the fact that the circuit components are to run on DC voltage that contains negligible or no pulsations at all. These regulators give an unvarying output.

Capacitor C1 is used for filtering while C2 and C3 are used to increase the transient response.

3.1.2 CONTROL UNIT

This unit is the heart of the MPRC device. The main component used here is a microcontroller.

3.1.2.1 MICROCONTROLLER

In order to choose an appropriate Microcontroller for this project several microcontrollers were considered using their Architecture, The architecture considered includes AVR, PIC, and 8051.The comparison was based on the following:

* **Cost:** The order of cost include AVR, 8051, PIC

* **Availability:** The order of availability include 8051, AVR, PIC

* **Speed:** The order of speed include AVR, PIC, 8051

* **Built-in Peripherals:** This one is difficult to answer since all Microcontroller families offer comparable features in their different chips. For a just comparison, I would rather say that for a given price AVR, PIC, 8051.

* **Tools and Resources:** 8051 has been around from many years now, consequently there are more tools available for working with it. Being a part of many engineering courses, there is a huge community of people that can help you out with 8051; same with books and online resources. In spite of being new the AVR has a neat tool chain. Availability of online resources and books is fast increasing. Here 8051, AVR, PIC.

Having compared the different Microcontroller in the different architecture, it was concluded that the best microcontroller to use for this project is an ATmega8515 microcontroller. (From Atmel's AVR family). Atmel's AVR Microcontrollers have a Reduced Instruction Set Computer (RISC) core running single cycle instructions and a well-defined I/O structure that limits the need for external components. Internal oscillators, timers, USART, SPI, pull-up resistors, pulse width modulation, ADC, analog comparator and watch-dog timers are some of the features you will find in AVR devices.

The standard way of connecting a reset circuitry and a crystal oscillator to an ATmega8515 as stated in the datasheet is shown below.

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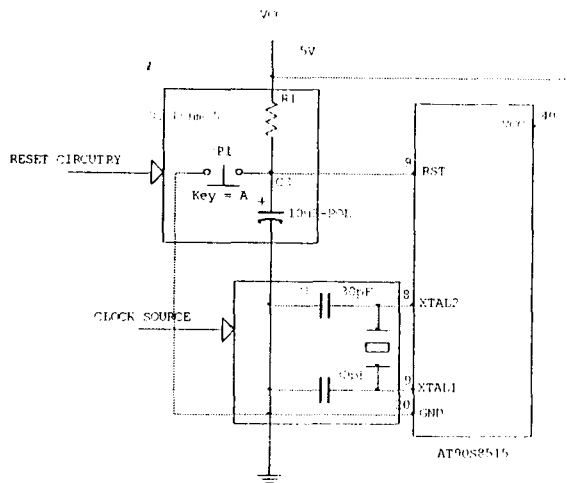
Fig3.6 The ATmega8515 microcontroller circuitry

Where C1=C2=30+-10 pf

C3=10uf

X1<=Speed of the ATmega8515 in Hz

R1=8.2K Ohms

P1=Normally Open push button

The clock source is use to generate the appropriate clock signal needed by the microcontroller to execute its instruction set. Without this the microcontroller will not function.

The reset circuitry is used to reset the microcontroller. A pull-up resistor is connected to the reset pin while a capacitor is connected across this pin and ground. This configuration prevents the microcontroller from resetting. To manually reset it, a normally open push button is connected across the reset pin and ground as shown above.

3.1.3 OUTPUT UNIT

This unit is divided into two sub-units, the interface between microcontroller and the appliances, and the appliances indicator.

3.1.3.1 THE APPLIANCE INTERFACE

Home appliances cannot be directly interfaced to microcontroller; this is because microcontrollers are low voltage DC operated devices, while Home appliances are AC operated devices. Therefore, to control AC devices from dc voltages a relay or a traic is needed. This project makes use of a relay. A switching transistor is also required, this is because most relays have voltage ratings from 6V-230V dc which is higher than the output of most microcontrollers or because the output of a microcontroller can not be used to drive a relay. The fig below shows the configuration of a switching transistor with an inductive load. The diode connected across the relay is to prevent the switching transistor from the charge reversal from the inductive load.
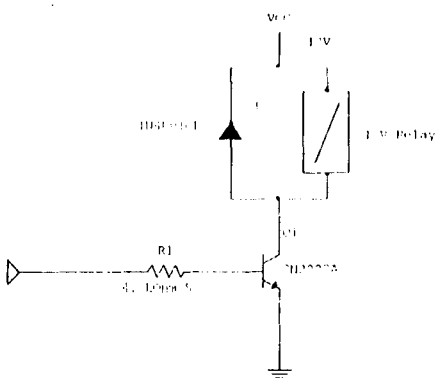
Fig3.7 Switching Transistor

The procedure below explains how I choose a suitable switching transistor

1. The transistor maximum collector current must be greater than the load current Ic

    Where Load current Ic = supply voltage / load resistance

$$= 12 / 400$$

$$= 0.03A$$

2. The transistor minimum current gain hFE must be greater than five times the load current divided by maximum output current from the chip.

$$hFE > (5 \ X \ 0.03) / 40mA$$

$$= 3.75$$

Therefore a transistor whose maximum collector current Ic is greater than 0.03A and the minimum current gain h_{FE} is greater than 3.75 can be used for switching a 12V relay of 400 Ohms. One of the transistors that satisfy this condition is an NPN transistor (2N2222).

In choosing the appropriate base resistor, the formula below was adopted.

Base Resistor (Rb) = (Chip supply voltage X h_{FE}) / (5 X maximum collector current)
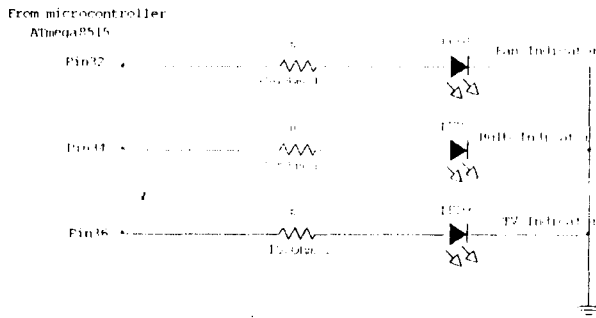
$$= (5 \ X \ 300) / (5 \ X \ 0.8)$$

$$= 375 \ Ohms$$

A resistor whose resistance is greater than 375 Ohms can be used. For this project a 4.7k Ohms was used.

3.1.3.2 THE APPLIANCE INDICATOR

The status of each appliance is indicated using an LED. The interface between the LED indicators and the microcontroller is shown in fig 3.8.

Fig3.8 The LED interface

A current limiting resistor of 100 Ohms was used so that excess current does not pass through the LEDs. This prevents them from damaging.

3.2 SOFTWARE DESIGN

This section will describe the software design aspect of the project. These will include the firmware that will be written or burned into the microcontroller and the software that will run on a personal computer.

3.2.1 MICROCONTROLLER FIRMWARE DESIGN

The firmware for the ATmega8515 microcontroller will be written in assembly language, using the AVR instruction set provided by Atmel Corporation. The flow chart that will be adopted for the firmware is given below.

When the program starts up, input /output port will be setup, the serial port will also be setup, and the external interrupt will be enabled. The External interrupt routine is illustrated in the flow chart in Fig 3.9a, while the serial routine is illustrated in fig 3.9b.

3.2.1.1 PROGRAM UPLOADING

The firmware will be uploaded into the ATmega8515 using an AVR programmer. The programmer is a full featured AVR Development Board manufactured by Microelectrinika. This programmer connects to a Personal Computer (PC) via a **Universal Serial Bus (USB).**

3.2.2 PERSONAL COMPUTER (PC) SOFTWARE DESIGN

The software that will run on a Personal Computer will be written in Visual C++. The software will be able to communicate with the microcontroller. The flow chart that will be adopted for the PC software is shown in fig 3.10.
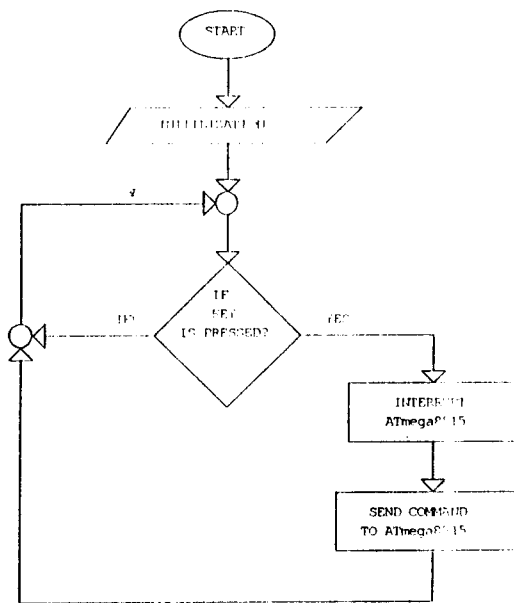
Fig3.10 Flow chart for the PC software

CHAPTER FOUR

CONSTRUCTION AND TESTING

4.1 CONSTRUCTION

The circuit diagram of the MPRC device was carefully constructed. Due to the encouraging assurance of the workability of the circuit design, the circuit construction was directly performed on a Vero board.

The Power supply unit was first constructed and tested, while the construction of the other unit followed. No much problem was encountered due to the experienced gained over the years in design and construction.

4.2 TESTING

After constructing, three major tests were carried out. These include testing the power supply unit, testing the serial port of the T10s mobile phone and finally testing the MPR device.

4.2.1 POWER SUPPLY UNIT TEST

The power supply unit was tested. The result obtained were tabulated and compared with the theoretical values.

Table 4.0 Power Supply Unit Test

	EXPERIMENTAL VALUE	THEORITICAL VALUE
AC Mains (V)	195.60	240.00
Output of the Transformer (V)	12.60	15.00
Output of the rectifier (V)	15.20	13.60
Output of the 7812 (V)	12.11	12.50
Output of the 7805 (V)	5.96	5.35

From the table above it was observed that some of the values were slightly different. these could be attributed to some of the followings.

1. The percentage error of the measuring instrument used.

2. Low battery of the measuring instrument used.

3. Manufactures error.

4. Tolerance of each of the component used.

5. Human error which cannot be totally eliminated.

4.2.2 T10S SERIAL PORT TEST

The T10s mobile phone was connected to the serial port of a personal computer. The hyper terminal program on windows was started, and the serial port of the PC was set to 9600 baud rate. And all the command that was intended to be sent by the microcontroller was typed and sent to the T10s mobile phone. Below is a table of some of the AT commands that was tested on hyper terminal grogram.

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Table 4.1 Ericsson T10s serial port test

COMMAND	RESPONSE	MEANING
AT	OK	There is a valid connection
AT	ERROR	There is no valid connection
AT+CPMS="ME","ME"	+CPMS: 0,15 ,0,15 ,0,15 OK	Phone memory is free and will be used for sending, writing and receiving SMS.
AT+CMGR=15	+CMGR: 0,12< pdu> OK	There is a new SMS. The pdu length is 12 byte
AT+CMGR=15	+CMGR: ERROR	There is no SMS in memory 15
AT+CMSS=1	OK	Message on memory 1 is sent
AT+CMGR=15	OK	Message on memory 15 is deleted

Messages to be sent as Status report was also saved on some memory locations of the slave phone (Ericsson T10s). Table 4.2 Shows the memory locations and the status messages saved on them.

Table 4.2 Status Messages and Their Location

PHONE MEMORY LOCATION	STATUS MESSAGES	REQUEST
1	Your BULB is OFF	BBSTS
2	„ BULB is ON	„
3	„ TV is OFF	TVSTS
4	„ TV is ON	„
5	„ FAN is OFF	FNSTS
6	„ FAN IS ON SPEED 1	„
7	„ „ „ „ SPEED 2	„
8	„ „ „ „ SPEED 3	„
9	„ „ „ „ SPEED 4	„
10	„ „ „ „ SPEED 5	„
11	Your Device is working	DVSTS
12	Your Device is not working	„
13	Your Last Command was Successfully executed	
14	Your Last command was not Successfully executed	
15	* Reserved Memory for receiving SMS Command	

4.2.3 MPRC DEVICE TEST

The PC software was started up and a parallel port cable was used to connect the MPRC device to a PC; the T10s mobile phone was also connected to the device; a bulb was connected to the device as well and finally the device and the T10s mobile phone were switched on. It took about 22 seconds for the mobile phone to be fully initialized.

The first command was sent from the PC; the time it took for the device to execute was taken and recorded. The table below shows the time taken to execute some of the command sent by the PC to the device.

Table 4.3 Personal computer test

COMMAMD	EXECUTION TIME (s)
Bulb ON	1-2
Bulb OFF	1-2
TV ON	1-2
FAN ON	1-2

From the table above it will be observed that the executing time varies between 1 to 2 seconds. This variation could be due to one of the following.

1. The present location of the program counter in the ATmega8515 memory

2. The location of the command sent in the compare routine in the ATmega8515 memory

3. The time delay by the ATmega8515 in reading the PC parallel port.

4. Other factors which were not known at the testing stage.

It should be noted that the time it took to send an SMS report to the remote mobile phone was not recorded.

The remote phone was used to send some of the SMS command needed to activate the appliances. The time between the reception of the SMS command and execution is about 1 to 4 seconds. This variation could be as a result of one of the reasons highlighted above. The time between sending and receiving the SMS command was not recorded; this was because the time depends solely on the Network that was used (Glo Network). For documentation purposes, it took about 6 seconds when the Network is good, and about 30 minutes when the Network is bad. This is one of the limitations of the MPRC device.

4.3 MPRC DEVICE PACKAGING

The complete unit was housed in a white plastic case. The case is rectangular in shape with the following dimension in centimeter (cm).
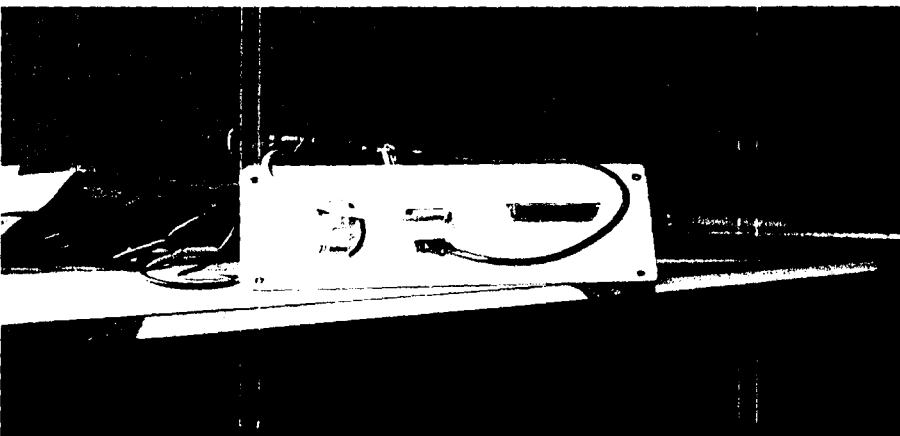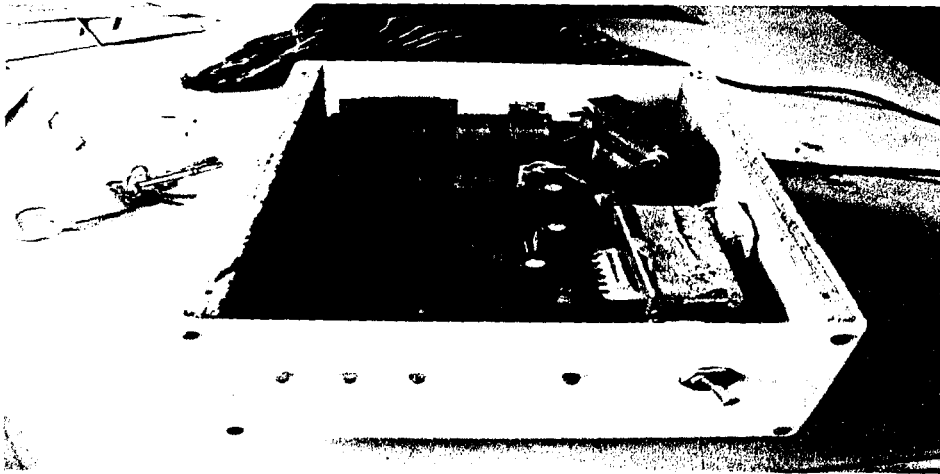
Length = 22.50

Breath = 18.50

Height = 8.50

The total volume of the casing is given by the formula below.

Volume = Length X Breath X Height

$$= 22.50 \ X \ 18.50 \ X \ 8.50$$

$$= 3538.125 \ cm^3.$$

Fig 4.0 The MPRC device (a) Front view (b) Isometric view (c) Back view

CHAPTER FIVE

CONCLUSSION AND RECOMMENDATION

5.0 CONCLUSSION

The Mobile Phone/ Personal Computer remote controlling device was designed and constructed successfully and the aim of the thesis was achieved from the satisfactory results obtained from testing. The MPRC device was discovered very efficient in remotely controlling appliances.

5.1 RECOMENDATION

* In this project, the appliances to be controlled were directly connected to the MPRC device. Further work on this project could be designing a wireless means of communication between the appliances and the MPRC device in order to accommodate more appliances/equipment.

* As a result of the fact that recently built computers don't come with parallel port connectors anymore, improvements should therefore be made so that the MPRC device utilizes the USB port or computers.

* It is also recommended that improvement be made on the MPRC Device so that it cannot be assessed by everybody through SMS.

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CIRCUIT DIAGRAM OF A MOBILE PHOANE/ PERSONAL COMPUTER REMOTE CONTROLLING DEVICE