Password Protected Smart Control System of Home Appliance Using SMS

This Major project in partial fulfillment for the award of the degree of Bachelor of Science
In
Electronics and Telecommunication Engineering

Department of ECE, Faculty of Science and Engineering
East West University, Dhaka
Bangladesh

Developed By

Anirban Sarkar
#ID: 2012-1-55-036
Sadia Sultana
#ID: 2012-2-55-005

Under the supervision of

Dr. Md. Habibur Rahman
Professor
Dept. of Electrical and Electronic Engineering
University Of Dhaka

DECLARATION

We hereby declare that we carried out the work reported in this project in the Department of Electronics and Communications Engineering, East West University, under the supervision of **Dr. Md. Habibur Rahman**. We solemnly declare that to the best of our knowledge, no part of this report has been submitted elsewhere for award of a degree. All sources of knowledge used have been duly acknowledged.

Signature:

Anirban Sarkar
ID: 2012-1-55-036

Sadia Sultana
ID: 2012-2-55-005

Supervisor
Dr. Md. Habibur Rahman
Professor, Dept. of Electrical and Electronic Engineering
University Of Dhaka

CERTIFICATE

This is to certify that the major project entitled "**Password Protected Smart Control System of Home Appliance Using SMS"** being submitted by Anirban Sarkar and Sadia Sultana of Electronics and Communications Engineering Department, East West University, Dhaka in partial fulfillment for the award of the degree of Bachelor of Science in Electronics and Telecommunication Engineering, is a record of major project carried out by them. They have worked under my supervision and guidance and have fulfilled the requirements which to my knowledge have reached the requisite standard for submission of this dissertation.

Dr. Md. Habibur Rahman
Professor
Dept. of Electrical and Electronics Engineering
University of Dhaka

Dr. M. Mofazzal Hossain
Professor & Chairperson
Dept. of Electronics and Communication Engineering
East West University

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The completion of our project work brings with it a sense of satisfaction, but it is never complete without thanking everyone who made it possible and whose constant support has crowned our efforts with success.

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Anirban Sarkar
Sadia Sultana

ABSTRACT

This paper presents the development of GSM-based home appliance control for smart home system. The main aim of the prototype development is to reduce electricity wastage. GSM module is used for receiving short message service (SMS) from user's mobile phone that automatically enable the controller to take any further action such as to switch ON and OFF the home appliances such as light, air-conditioner, fan, water pump, door, TV etc. The system is integrated with Arduino and GSM network interface using a programming language named Processing or Wiring which is the combination of C/C++ language. Arduino software (version 1.6.8) was utilized to accomplish the integration. The system is activated when only the password authorized user sends the SMS to controller at home. Upon receiving the SMS command, the microcontroller unit then automatically controls the electrical home appliances by switching ON or OFF the device according to the user direction. In other words, it reads message from the mobile phone and responds to control the devices according to the received message. The prototype has been successfully developed and it could provide an effective mechanism in utilizing the energy source efficiently.

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Password Protected Smart Control System of Home Appliance Using SMS

Chapter-1

INTRODUCTION

Nowadays mobile is an important part of our daily life. Day by day people are become more dependent on science and technology. In this project, we have designed and developed GSM based password protected smart control system of home appliance using SMS. We can control (ON/OFF) every electronics and electrical devices (operated by 220V or more) of our home like lights, fans, AC, refrigerators, TVs, doors etc without any physical touch. The main advantages of this project is we can control this system remotely at any time from any place in the world. This system ensures security because it is password protected.

1.1 Literature Survey

With the development of the electronics technology in the last two decades, a new concept called Smart Home has become prevalent. In line with this concept of smart home, people have been trying to control and secure their home appliances automatically. With the recent rapidly advancing mobile communication technology and the decrease in costs has also made it possible to remotely control and secure our home appliances.

In the literature, there are few contributions proposed in recent years in machine-to-machine, mobile-to-machine, or machine–to-mobile communication. These include: designing prototype integrated mobile telemedicine system interfaced with sensors to a patient's body using GSM simulation [1]; implementing measurement system to monitor the ambient air quality using GPS, GPRS modem and advanced RISC machine [2].

Meanwhile, the system developed by [3] is automating the power reading meter to send the energy consumed to e-billing system at authorized office. The system works by integrating the GSM modem that was embedded with digital kWh power meter. It utilizes the GSM network to send power usage reading using SMS to the authorized office. The authorized office collect and manage the received SMS message contains the meter reading to generate the billing cost and send back the cost to the respective consumer through SMS. The work presented by [4] is about the development of Integrated Water Billing System with SMS capability. The system is designed to facilitate the Water authorized to manage the monthly billing system without the use of human services. The system receives SMS from the meter to central databases. Then the information received is processed to generate current billing. The system again sends a SMS notification to the user regarding the total amount that has been billed. The system was implemented using Visual Basic and database in order to perform the prototype and the system works successfully in sending SMS to user for notification.

Moreover, the projects for Acquiring Water Level and Temperature Status via SMS [5] also have similarity with this project. This project utilized PIC 16F877 and MPLAB IDE software for programming. The project was designed to detect level and temperature of the water in a pool. The system functions when the level of water and the temperature in pool exceed the desired limits. At the same time the PIC circuit will automatically interface to the mobile phone and send the alert message to the user.
In line with these works, we developed a low-cost and simple approach to designing intelligent home system using the concept of mobile-to-machine and machine-to-mobile communication. First, we developed a general purpose electronic circuit design that can control and monitor a variety of home appliances with interface that can be plugged into GSM modem unit. The design comprise of microcontroller, adaptation circuit, power circuit, and RS232 interface. Then, we tried to develop prototype home appliance control system with devices as an application example of the designed system.

1.2 Motivation

Electricity has become an essential part of our life. We can't even imagine our life without electricity. It is becoming the limiting source now. So, we can't afford to misuse any fraction of it. If we accidentally leave any of the home appliances (bulb, microwave oven, TV, fan etc.) switched on, we can access them remotely through our cell phone and switch it off through SMS.

It's not always feasible to be physically near to the home still sometimes it's very important to control the appliances for many purposes. So the remote controlling takes the control of the home beyond the home and to the hands of the people. If a simple mobile phone takes the added responsibility to control the smart home then the control is reachable from almost everywhere people travels and lives on earth.

Now a day's most of the people are using mobile services. So, designing a system which can control home appliances from remote places using SMS can benefit a large population which may not be possible using other services like INTERNET.

1.3 Objectives

Now a day's mobile phone is a part and parcel of our daily life. We can control every electronic device of our home like Light, Fan, AC, Refrigerator, TV, Door, Water Tank etc by using mobile phone through SMS. In this project, we describe how to control and designing a smart home appliance control system which is based on microcontroller. We design a system which can turn on and off with or without any switch. We can apply this system in any big office, industry, shop or university class room etc. It also used for secured our home or workplace.

The followings are the objectives of this project to ensure it meets the aim.

- To design a control system for smart home application using GSM network.
- To design a circuit that can efficiently and automatically read the status of the different home appliances connected to the control system.
- To design a circuit that can automatically switch ON and OFF the home appliance using GSM library command.
- To test our designed system with a wide range of electrical and electronic equipment and troubleshoot any errors.

Chapter-2

MICROCONTROLLER

2.1 Introduction to Microcontroller

A microcontroller is a small computer (SoC) on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Input and output devices include solenoids, LCD displays, relays, switches and sensors for data like humidity, temperature or light level, amongst others. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems.

Microcontroller 8051

Microcontroller is an IC chip that takes input process data according to program written in its memory and gives output as control signal for controlling other machines and devices. Microcontroller is used to control the operation of various machines and devices according to the program or given instructions in the memory or ROM of the Microcontroller. The program that is needed for proper working of Microcontroller is called Firmware and is written in ROM (Read Only Memory). ROM is a non-volatile memory that is its contents are permanent. Some latest ROMs can be Re-Programmed, but mostly it doesn't require.

2.1.1 Types of Microcontroller

There are several different kinds of programmable microcontrollers. Microcontrollers are categorized by several parameters including Bits, Flash size, RAM size, number of input/output lines, packaging type, supply voltage and speed. Programmable microcontrollers contain general purpose input/output pins. The number of these pins varies depending on the microcontroller. So let's discuss types of microcontrollers:

Bits:

- 8 bits microcontroller executes logic & arithmetic operations. Examples of 8 bits micro controller is Intel 8031/8051.
- 16 bits microcontroller executes with greater accuracy and performance in contrast to 8-bit. Example of 16 bit microcontroller is Intel 8096.
- 32 bits microcontroller is employed mainly in automatically controlled appliances such as office machines, implantable medical appliances, etc. It requires 32-bit instructions to carry out any logical or arithmetic function.

Memory:

- External Memory Microcontroller – When an embedded structure is built with a microcontroller which does not comprise of all the functioning blocks existing on a chip it is named as external memory microcontroller. For illustration- 8031 microcontroller does not have program memory on the chip.
- Embedded Memory Microcontroller – When an embedded structure is built with a microcontroller which comprise of all the functioning blocks existing on a chip it is named as embedded memory microcontroller. For illustration- 8051 microcontroller has all program & data memory, counters & timers, interrupts, I/O ports and therefore its embedded memory microcontroller.

Instruction Set:

- CISC- CISC means complex instruction set computer, it allows the user to apply 1 instruction as an alternative to many simple instructions.
- RISC- RISC means Reduced Instruction Set Computers. RISC reduces the operation time by shortening the clock cycle per instruction.

Memory Architecture:

- Harvard Memory Architecture Microcontroller
- Princeton Memory Architecture Microcontroller

2.1.2 Applications of Microcontrollers

Programmable microcontrollers are designed to be used for embedded applications, unlike microprocessors that can be found in PCs. Microcontrollers are used in automatically controlled devices including power tools, toys, implantable medical devices, office machines, engine control systems, appliances, remote controls and other types of embedded systems. Microcontrollers are mostly used in electronic equipments such as Mobile Phones, Auto Mobiles, CD/DVD Players, Washing Machines, Cameras, In Computers, Modems and Keyboard Controllers, Security Alarms, Electronic Measurement Instruments, Microwave Oven etc.

Application of Microcontroller in Day to Day Life Devices:

- Light sensing & controlling devices
- Temperature sensing and controlling devices
- Fire detection & safety devices
- Industrial instrumentation devices
- Process control devices

Application of Microcontroller in Industrial Control Devices:

- Industrial instrumentation devices
- Process control devices

Application of Microcontroller in Metering & Measurement Devices:

- Volt Meter
- Measuring revolving objects
- Current meter
- Hand-held metering systems

2.1.3 Advantages of Microcontroller

Microcontroller's use increased rapidly. Now these are used in almost every electronic equipment like Washing Machines, Mobile Phones and Microwave Oven. Following are the most important facts about Microcontrollers, which causes rapid growth of their use:

- Microcontrollers act as a microcomputer without any digital parts.
- Microcontrollers are cheap and very small in size; therefore they can be embedded on any device.
- Programming of Microcontrollers is simple to learn. It’s not much complicated.

- We can use simulators on Computers to see the practical results of our program. Thus we can work on a embedded project without even buying the required components and chips. Thus we can virtually see the working of our project or program.
- Usage of microcontroller is simple, easy for troubleshoot and system maintaining.
- Most of the pins are programmable by the user for performing different functions.
- Easily interface additional RAM, ROM,I/O ports.
- Low time required for performing operations.

2.2 Arduino

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

Arduino is a software company, project, and user community that designs and manufactures computer open-source hardware, open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can interface to various expansion boards shields and other circuits. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages, C and C++.

2.2.1 History

Colombian student Hernando Barragán created the development platform *wiring* as his Master's thesis project in 2004 at the Interaction Design Institute Ivrea in Ivrea, Italy. Massimo Banzi and Casey Reas (known for his work on Processing) were supervisors for his thesis. The goal was to create low cost, simple tools for non-engineers to create digital projects. The Wiring platform consisted of a hardware PCB with an ATmega128 microcontroller, an integrated development environment (IDE) based on Processing and library functions to easily program the microcontroller.

In 2005, Massimo Banzi, with David Mellis (then an IDII student) and David Cuartielles, added support for the cheaper ATmega8 microcontroller to Wiring. But instead of continuing the work on Wiring, they forked (or copied) the Wiring source code and started running it as a separate project, called Arduino.

The Arduino's initial core team consisted of Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, and David Mellis.

The name Arduino comes from a bar in Ivrea, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

Following the completion of the Wiring platform, its lighter, lower cost versions were created and made available to the open-source community. Associated researchers, including David Cuartielles, promoted the idea. Arduino's initial core team consisted of Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, and David Mellis.

2.2.2 Types of Arduino

Different boards support the use of different Arduino shields. These shields are add-ons that add features to the board. Many accessories allow extra USB connectors or screens, which most of the boards support. The original Arduino hardware was produced by the Italian company Smart Projects. Some Arduino-branded boards have been designed by the American companies SparkFun Electronics and Adafruit Industries. As of 2016, 17 versions of the Arduino hardware had been commercially produced.

Arduino Boards:

A. The Arduino Uno:

The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

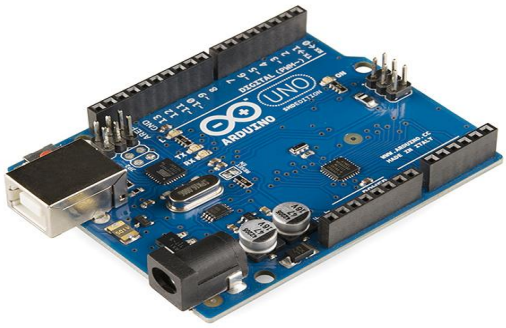


Fig: Arduino UNO

B. The Arduino Due

The Arduino Due is the second iteration of the classic Arduino and offers more features for advanced users. The Due's processor is faster, has more memory, and more I/O ports. It does not support many shields. Because of the faster CPU, the Arduino Due runs on a lower voltage: 3.3V over the Uno's 5V. This means it cannot always support the same devices.

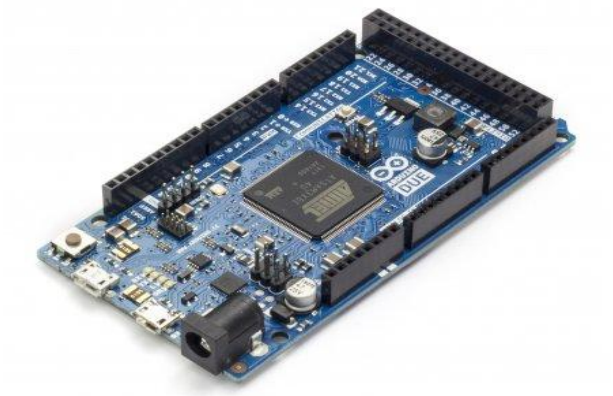


Fig: Arduino Due

C. The Arduino Mega

The Arduino Mega is a microcontroller board based on the ATmega1280 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

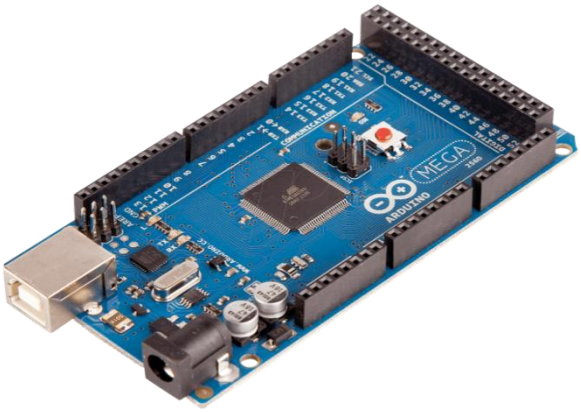


Fig: Arduino Mega

D. The Arduino Leonardo

The Leonardo is not a common board, but has similar features to the Uno, including the 5V power supply and the processing power. It is a good board for those who need more input and output ports than the Arduino Uno, but do not need the horsepower or size of the Due. It uses a micro-USB adapter instead of the Uno's full-size USB port.

Fig: Arduino Leonardo

E. Arduino Lilypad

The LilyPad Arduino Main Board is based on the ATmega168V (the low-power version of theATmega168) or the ATmega328V. The LilyPad Arduino was designed and developed by Leah Buechley and SparkFun Electronics.

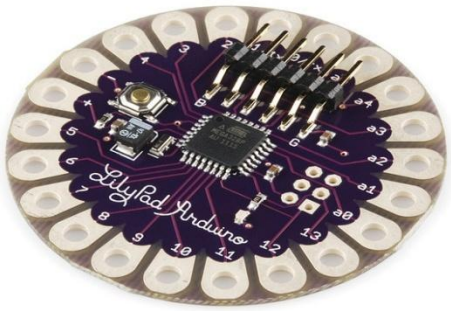


Fig: **Arduino Lilypad**

F. Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x) orATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.

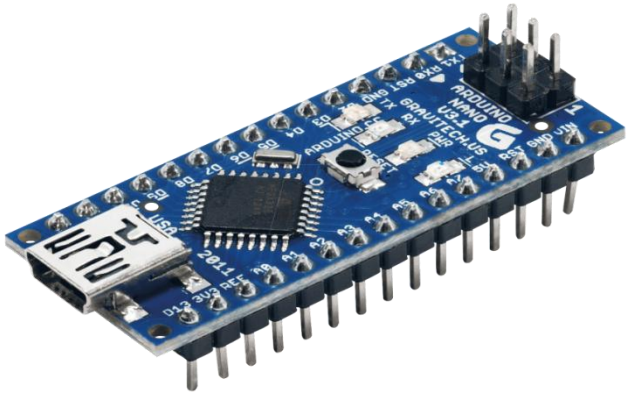


Fig: Arduino Nano

G. Arduino Yun

The Arduino Yún is a microcontroller board based on the ATmega32u4 and the Atheros AR9331. The Atheros processor supports a Linux distribution based on OpenWrt named Open Wrt-Yun. The board has built-in Ethernet and Wi-Fi support, a USB-A port, micro-SD card slot, 20 digital input/output pins (of which 7 can be used as PWM outputs and 12 as analog inputs), a 16 MHz crystal oscillator, a micro USB connection, an ICSP header, and a 3 reset buttons.

Fig: Arduino Yun

The Arduino Shields:

Arduino Shields are boards that connect to a number of different Arduino models. They extend the abilities of the basic board by adding features such as wireless network access, cell access, or the ability to prototype circuits.

A. Wireless Shields

The wireless-enabled shields for the Arduino come in two types. One, the Wi-Fi Shield, allows the board to access the Internet through an 802.11 b/g-supported network and has a built-in micro-SD card slot to host files accessible through the Internet or the network. The Wireless SD Shield has an XBee module and enables communications between the Arduino and other XBee-supported devices, including the Wireless Proto Shield.

Fig: Wireless Shields

B. The GSM Shield

The Arduino GSM Shield connects your Arduino to the internet using the GPRS wireless network. Just plug this module onto your Arduino board, plug in a SIM card from an operator offering GPRS coverage and follow a few simple instructions to start controlling your world through the internet. You can also make/receive voice calls (you will need an external speaker and microphone circuit) and send/receive SMS messages. There are different type of GSM shield like SIM900, Sim900A,SIM808 etc.

Fig: Different Types of GSM Shield

C. The Ethernet Shield

Description: The Arduino Ethernet Shield 2 allows an Arduino Board to connect to the Internet. It is based on the Wiznet W5500 Ethernet chip. The Wiznet W5500 provides a network (IP) stack capable of both TCP and UDP. It supports up to eight simultaneous socket connections.

Fig: Ethernet Shield

D. The Proto Shields

These shields allow users to practice or "breadboard" their designs without needing to solder anything. There is the Wireless Proto Shield and the Proto Shield available. The Wireless Proto Shield uses the XBee chip to communicate with other devices, while the Proto Shield connects directly to the Arduino board. They support through-hole integrated circuits as well as surface mount integrated circuit.

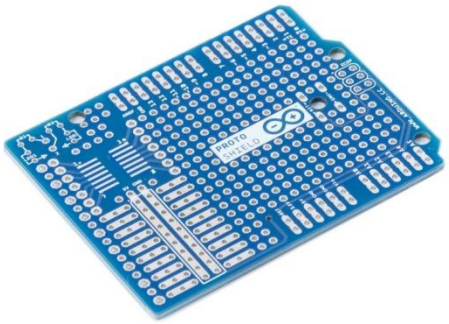


Fig: Proto Shields

2.2.3 Advantages and Disadvantages of Arduino

In last years' the use of Arduino increases exponentially due to its readability and easiness. Arduino has some advantages and some disadvantages:

Advantages:

- **Ready to Use:** The biggest advantage of Arduino is its ready to use structure. As Arduino comes in a complete package form which includes the 5V regulator, a burner, an oscillator, a micro-controller, serial communication interfaces LED and headers for the connections.

- **Examples of codes:** Another big advantage of Arduino is its library of examples present inside the software of Arduino. For example if we want to measure voltage using ATmega8 micro-controller and want to display the output on computer screen then we have to go through the whole process. The process will start from learning the ADC's of micro-controller for measurement, went through the learning of serial communication for display and will end at USB - Serial converters.

- **Effortless functions**: During coding of Arduino, we will notice some functions which make the life so easy. Another advantage of Arduino is its automatic unit conversion capability. We can say that during debugging we don't have to worry about the units conversions.

- **Large community:** There are many forums present on the internet in which people are talking about the Arduino. Engineers, hobbyists and professionals are making their projects through Arduino. You can easily find help about everything. Moreover the Arduino website itself explains each and every functions of Arduino.

Disadvantages:

- **Structure:** The structure of Arduino is its disadvantage as well. During building a project you have to make its size as small as possible. But with the big structures of Arduino we have to stick with big sized PCB's. If we are working on a small micro-controller like ATmega8 we can easily make our PCB as small as possible.

- **Cost:** The most important factor which you cannot deny is cost. This is the problem which every hobbyist, Engineer or Professional has to face. Now, we must consider that the Arduino is cost effective or not.

Chapter-3

HARDWARE & SOFTWARE

3.1 Hardware

Hardware is the physical parts or components of the system. In this project work, we've used some hardwares Arduino, GSM, Relay, switch, transformer etc.

3.1.1 Block Diagram and Description

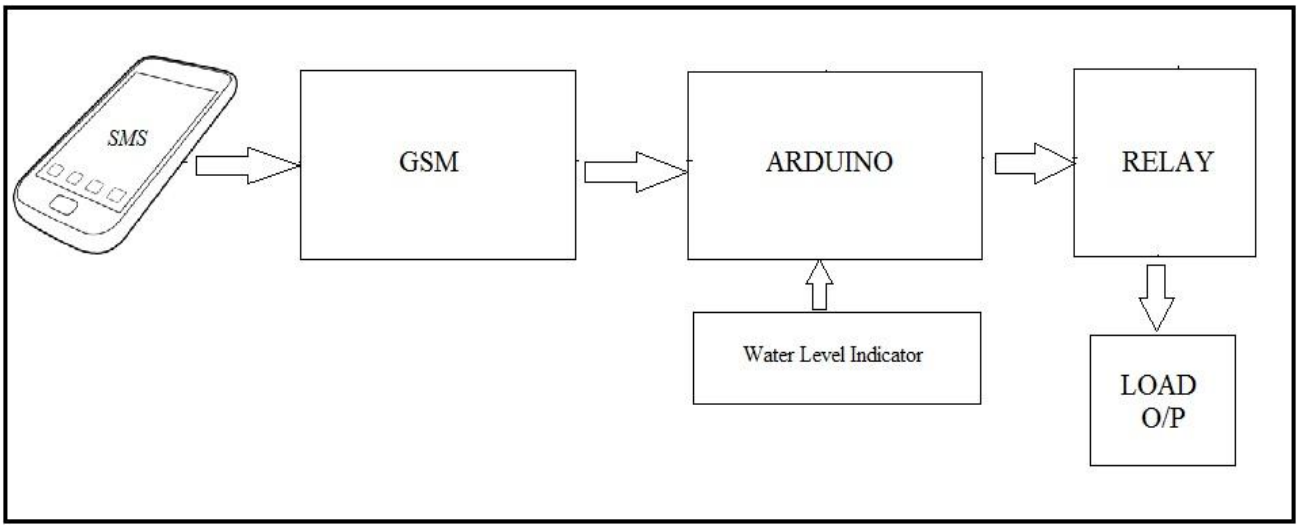


Fig: Block Diagram of Full Project

In this project Arduino is used for controlling the whole process. Arduino is interfaced with commands supporting GSM module. The user at a remote place sends SMS to control the home appliances. After receiving given commands by Arduino through GSM, Arduino send signal to relays, to switch ON or OFF the home appliances using a relay driver.

When we send SMS to GSM module by Mobile, then GSM receives that SMS and sends it to Arduino. Now Arduino reads this SMS and extract main command from the received string and stores in a variable. After this, Arduino compare this string with predefined string. If match occurred then Arduino sends signal to relay via relay driver for turning ON and OFF the home appliances.

The methodology followed in our Home Appliance Control System is as follows:

- GSM hardware tests are run in order to check the hardware support. The system calls GSM modem and it get activated.
- After activation the Modem checks for hardware support. If the hardware is missing or some other hardware problem there is error, resulting in communication failure and the application is terminated.
- If hardware responds then the serial port is opened for communication and GSM hardware allows transmission of SMS.
- The system is then connected and after connection establishment the system is able to switch ON and OFF and similarly the system will update status of appliances by receiving SMS from the pre-defined cell number.

Required Equipments:

i. Arduino UNO
ii. SIM 808 Module
iii. 4-Channel 5V Relay Shield
iv. Relay Driver ULN2003A
v. Water Level Indicator
vi. Dc 5V Motor(for making mini water pump)
vii. Load (220V/60W Bulb-3Pcs)
viii. 12V/2A Adapter
ix. Bread Board
x. Some Jumpers & Wires
xi. Other equipments which is required to make the module (like soldering iron, driver, glue etc)

3.1.2 Arduino UNO

The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins in which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. Simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

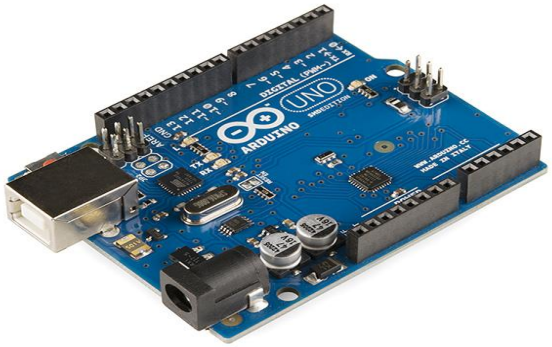


Fig: Arduino UNO

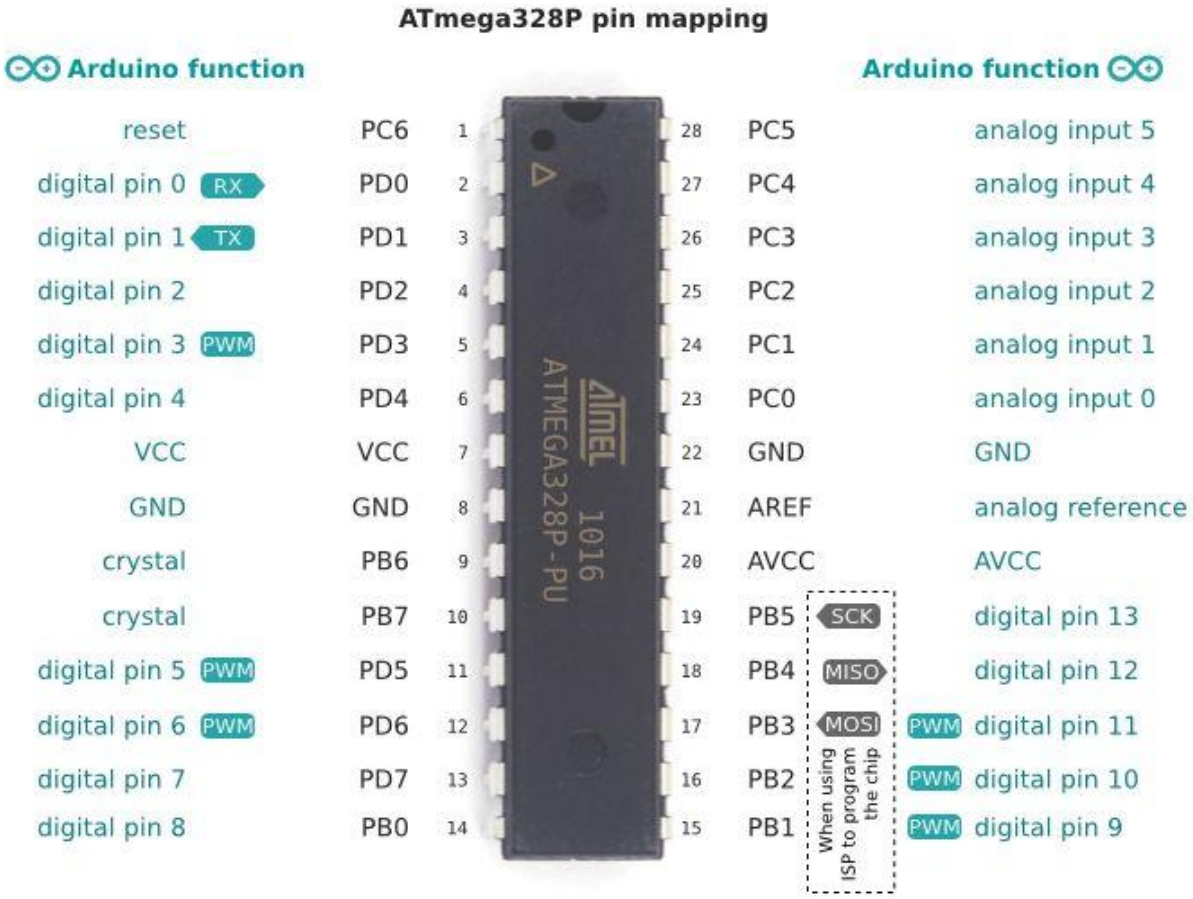
Technical Specs:

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Memory:

The ATmega328 has 32 KB (with 0.5 KB occupied by the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Pin Mode:



Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

In addition, some pins have specialized functions:

I. Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
II. External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt () function for details.
III. PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite () function.
IV. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
V. LED: 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
VI. TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

Communication:

The Uno has a number of facilities for communicating with a computer, another Uno board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

3.1.3 4-Channel 5V Relay Shield

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. A relay is also an electrically operated switch. It is mainly used to control higher voltage circuits with lower voltage. For example, a relay can make a 5V

DC battery circuit to switch a 230V AC mains circuit. Thus a small sensor circuit can drive, say a fan or an electric bulb.

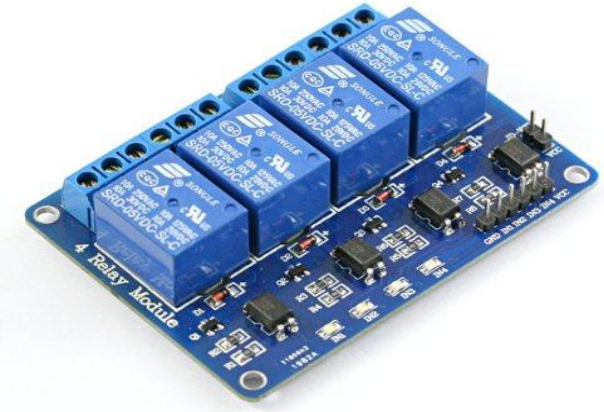


Fig: 4-Channel 5V Relay Shield

A **relay switch** can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. Commonly used relays are available in different configuration of operating voltages like 5V, 6V, 9V, 12V, 24V etc. The output section consists of contactors which connect or disconnect mechanically.

In a basic relay there are three contactors:

1. Normally-Open (NO): The circuit is disconnected i.e. open when the relay is inactive.
2. Normally-Closed (NC): The circuit is connected i.e. closed when the relay is inactive.
3. Common (COM): This is the common port which is normally connect with NC in inactive mode and in active mode it is connected with NO

At no input state, the COM is connected to NC. When the operating voltage is applied the relay coil gets energized and the COM changes contact to NO. To connect with the load with the relay at first we have to connect the direct power to the load and another connection has to connect with COM and another connection of load will connect with NO. And if we want to add the switch board with the relay shield then the connection will be the same way with the switch board. The Relay Shield is an Arduino compatible smart module with 4 mechanical relays providing an easy way to control high voltage.

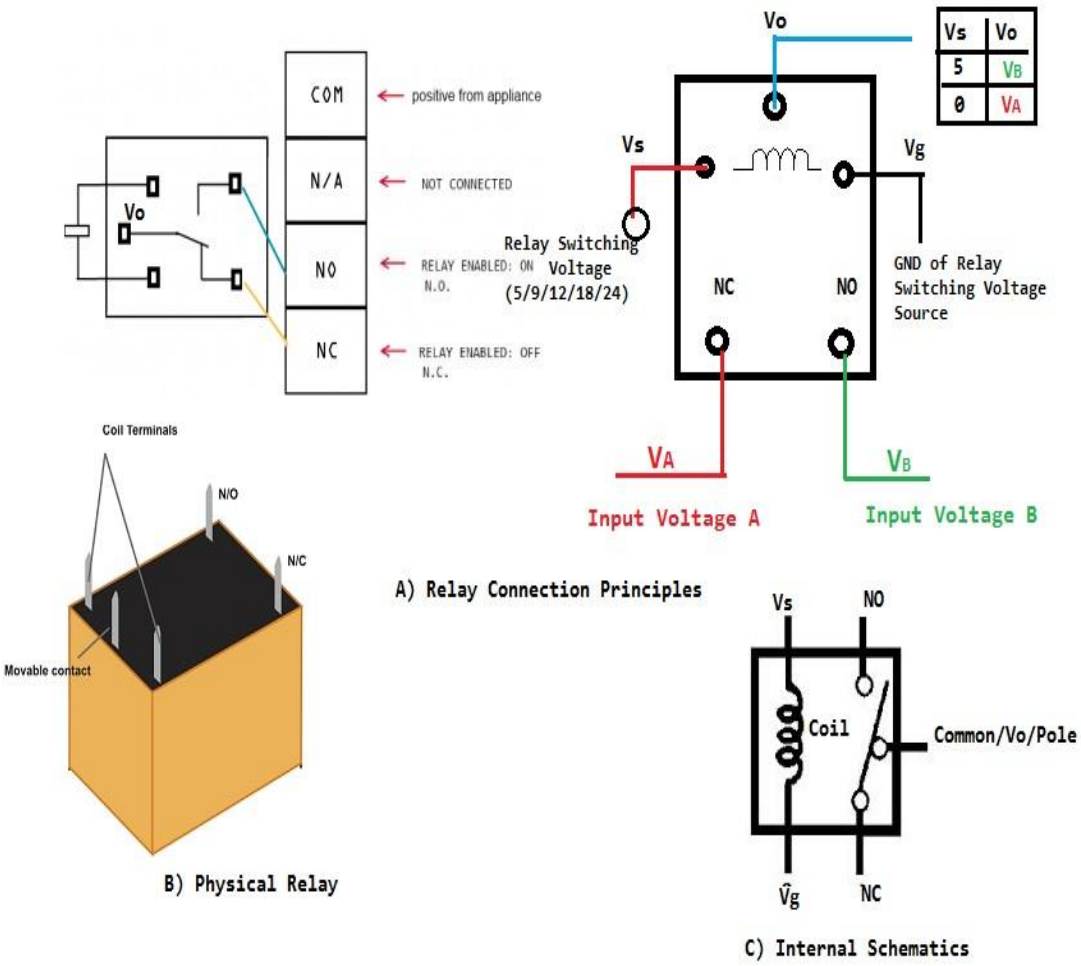
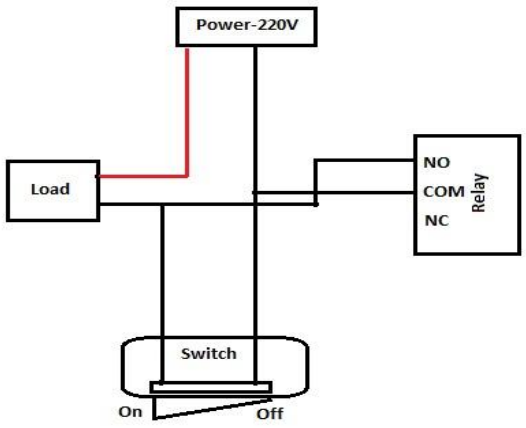


Fig: Schematic diagram of Relay

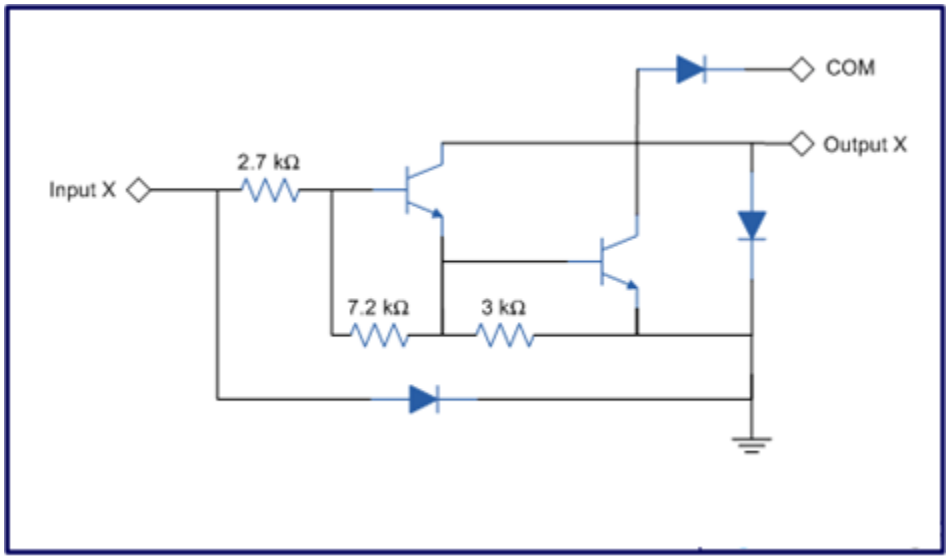
Connection between Relay, Manual switch & Load:



3.1.4 Relay Driver ULN2003A

ULN2003A is a high voltage and high current Darlington array IC. It contains seven open collector darlington pairs with common emitters. A darlington pair is an arrangement of two bipolar transistors. Darlington transistors capable of 500mA, 50V output. The ULN2003 is known for its high-current, high-voltage capacity. ULN2003 is for 5V TTL, CMOS logic devices. It can also be used for interfacing with a stepper motor.

The schematic for each driver is given below:



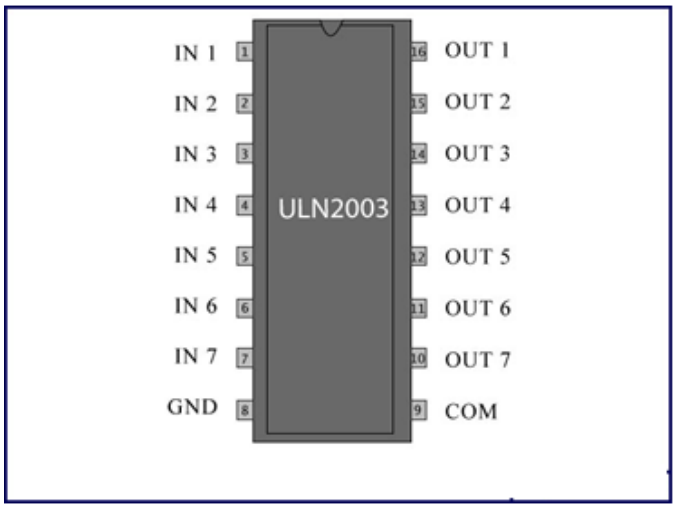


Fig: ULN2003A pin out

3.1.5 SIM 808 Module

SIM808 module is a GSM and GPS two-in-one function module. It is based on the latest GSM/GPS module SIM808 from SIMCOM, supports GSM/GPRS Quad-Band network and combines GPS technology for satellite navigation. It has high GPS receive sensitivity with 22 tracking and 66 acquisition receiver channels. Besides, it also supports A-GPS that available for indoor localization. The module is controlled by AT command via UART and supports 3.3V and 5V logical level.

Fig: GSM SIM808

SIM 808 Key Features:

Feature	Implementation
Power supply	3.4V ~ 4.4V
Frequency band	SIM808 Quad-band:GSM 850,EGSM 900, DCS 1800,PCS 1900MHz
Power saving	Typical power consumption in sleep mode is 1.07 mA
GPRS connectivity	• GPRS multi-slot class 12(default) • GPRS multi-slot class 1~12 (optional)
Temperature range	• Normal operation:-40°C~ +85°C • Storage temperature -45°C~ +90°C
Dimensions	24.0*24.0*2.6mm
Command	Control via AT commands
SIM supported	Standard Micro SIM Card

Interface Function:

- GPS Antenna: This is an uFL GPS antenna connector. You can connect either passive or active GPS antenna to it. Active GPS antenna runs at 2.8V voltage.
- MicroUSB: The charging interface for Li-Ion battery, of input voltage range from 5V to 7V. Besides, it is also the software debugging interface for SIM808 that you can upgrade firmware and debug software.
- Power Button: This is the hard power switch for the module. When the module is power up, you can turn on or turn off the module by pressing the button for 2s.
- Net Indicator: Red LED, it will tell them what status is about the module linking to network.
- Status Indicator: Green LED, it will tell whether the module is on, light when the module is running.
- Li-ion Battery: This is power supply for the module; input voltage is from 3.4V to 4.4V. It uses the XH-2.0mm connector that makes it convenient to connect to 3.7V Li-Po Battery.
- GSM Antenna: This is an uFL GSM antenna connector; just connect it to a GSM antenna for receiving GSM signal.
- SIM - Card Holder: SIM card holder for standard SIM card.
- Microphone: This is the reserved interface for 2.8V microphone. By using the microphone, you can make voice calls and collect speech data around the module.
- VRTC: RTC backup. You can add external capacitor or rechargeable battery on it

SIM 808 PIN Diagram:

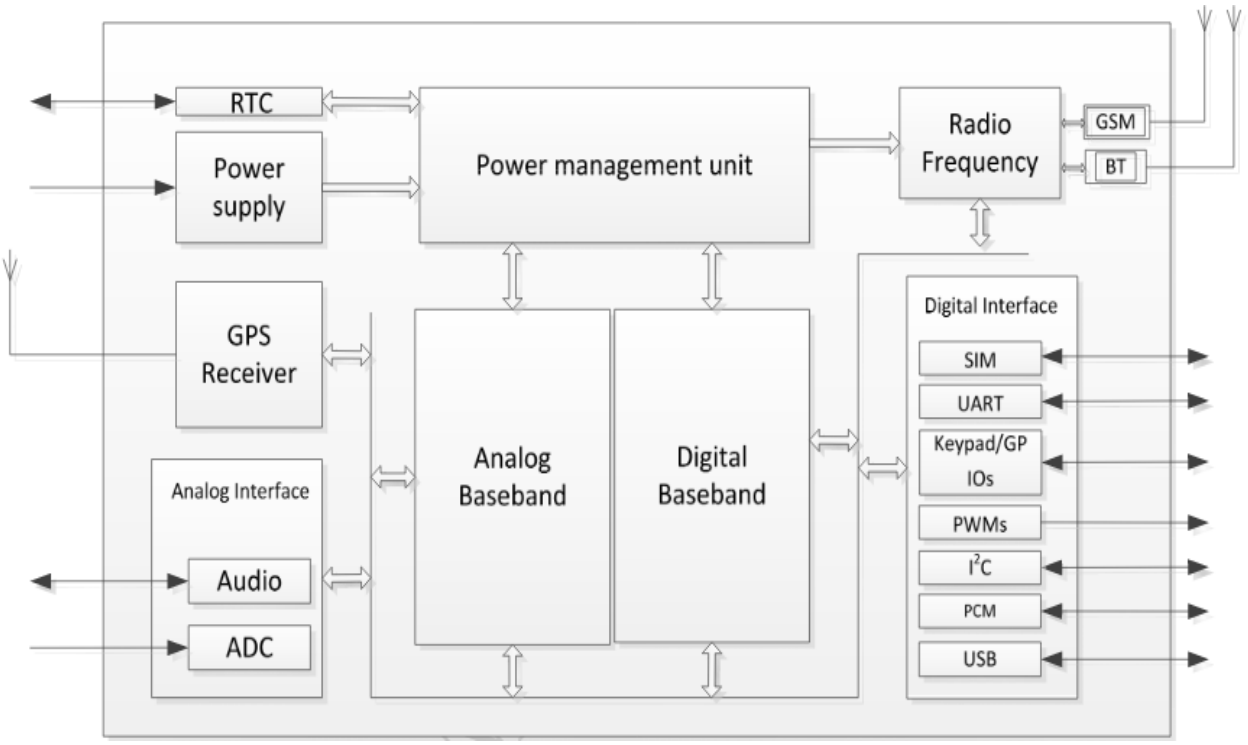


Fig: SIM808 Pin Diagram

3.1.6 Water Level Indicator

This simple transistor based water level indicator circuit is very useful to indicate the water levels in a tank. Whenever tank gets filled, we get alerts on particular levels. Here we have created 2 levels (low, full). We have added 2 LEDs to indicate initial two levels low (Green LED) and high (Red LED). When Green LED glow it sends signal to the pin mode 12 of the Arduino. When Yellow LED glows it sends signal to the pin mode 13 of the Arduino.

Circuit Components:

a) BC547 Transistors -2 pcs
b) Resistors 330Ω -2 pcs
c) Color LED -2 pcs
d) 9V Battery Battery clip

Diagram of Water Level Indicator:

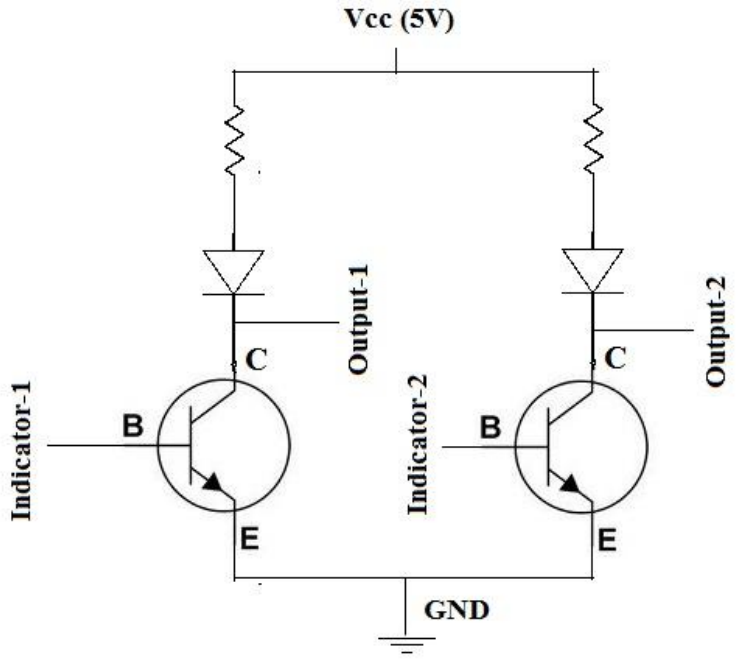


Fig: Circuit diagram of Water level Indicator

BC547 Transistor:

A BC547 transistor is a negative-positive-negative (NPN) transistor that is used for many purposes. Together with other electronic components, such as resistors, coils, and capacitors, it can be used as the active component for switches and amplifiers. NPN transistors, this type has an emitter terminal, a base or control terminal, and a collector terminal. In a typical configuration, the current flowing from the base to the emitter controls the collector current. There are various types of transistors, and the BC547 is a bipolar junction transistor (BJT). There are also transistors that have one junction, such as the junction field-effect transistor, or no junctions at all, such as the metal oxide field-effect transistor (MOSFET**).** The negative (N)-type material inside an NPN transistor has an excess of electrons, while the positive (P)-type material has a lack of electrons, both due to a contamination process called doping.

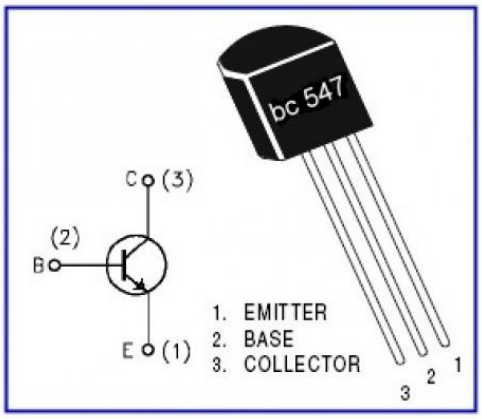


Fig: BC547 Transistor

The BC546 and BC547 are essentially the same as the BC548 but selected with higher breakdown voltages while the BC549 is low noise version, and the BC550 both high-voltage and low-noise. The BC556 to BC560 are the PNP counterparts of the BC546 to BC550, respectively. Some manufacturers specify their parts with higher ratings, for example the Fairchild 1997 datasheet (547ABC, Rev B) for the BC547, sourced from Process 10 gave 500mA as the maximum collector current, and while their datasheets dated 2002 have dropped the current rating to the standard 100mA.

Typical applications include audio amplification and small signal circuits. It has a transition frequency range up to 100 MHz. When using the transistor as a switch, the max current rating poses a limit on the type of loads that it can drive. This transistor has a max collector rating of 100 mA which is enough to drive an LED circuit, or an LDR circuit, or a NOT gate. In addition, this transistor can switch low current Arduino microcontroller circuits, and even a low current micro relay.

3.1.7 Circuit Diagram

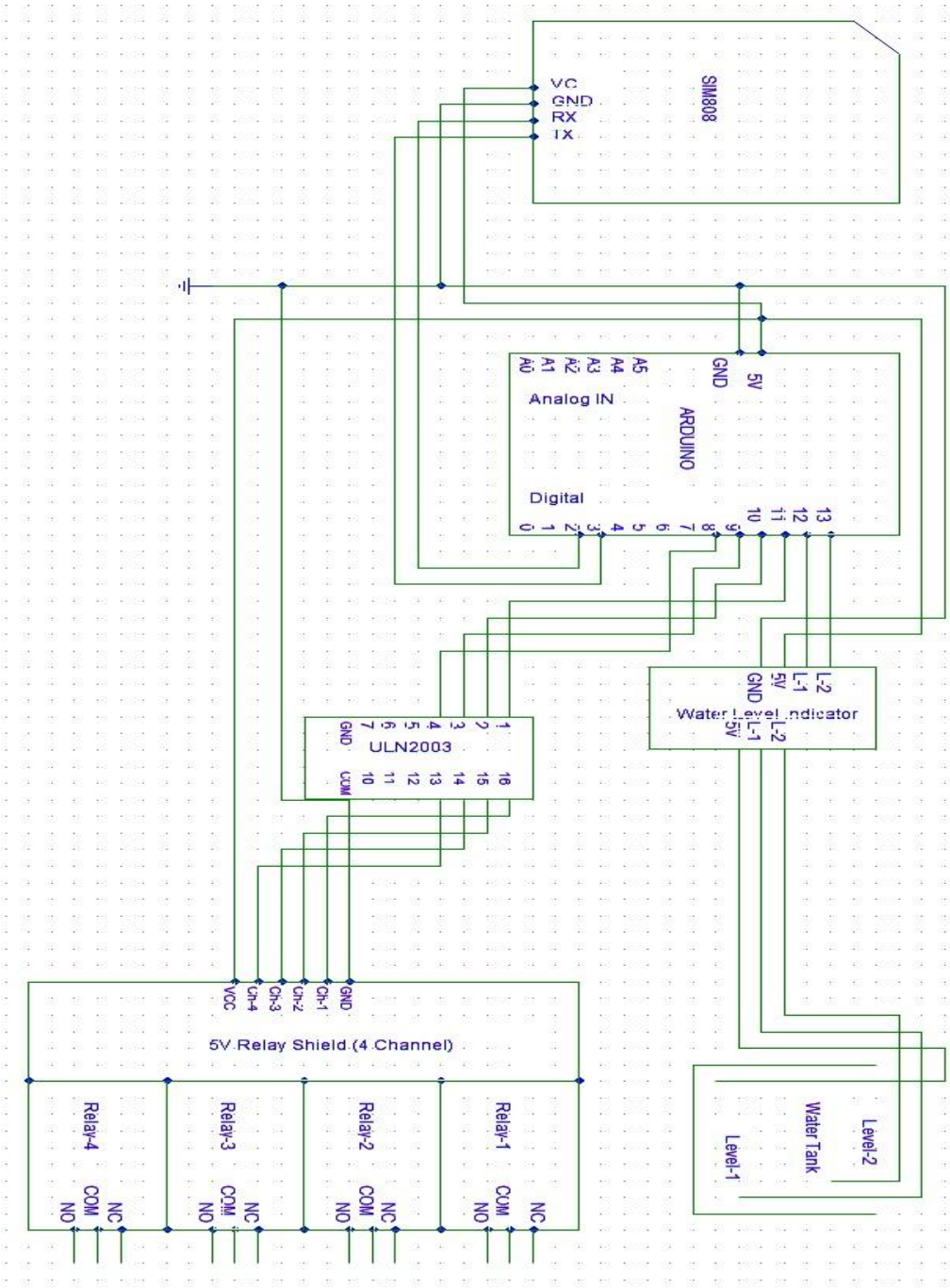


Fig: Circuit diagram

3.1.8 Flow Chart

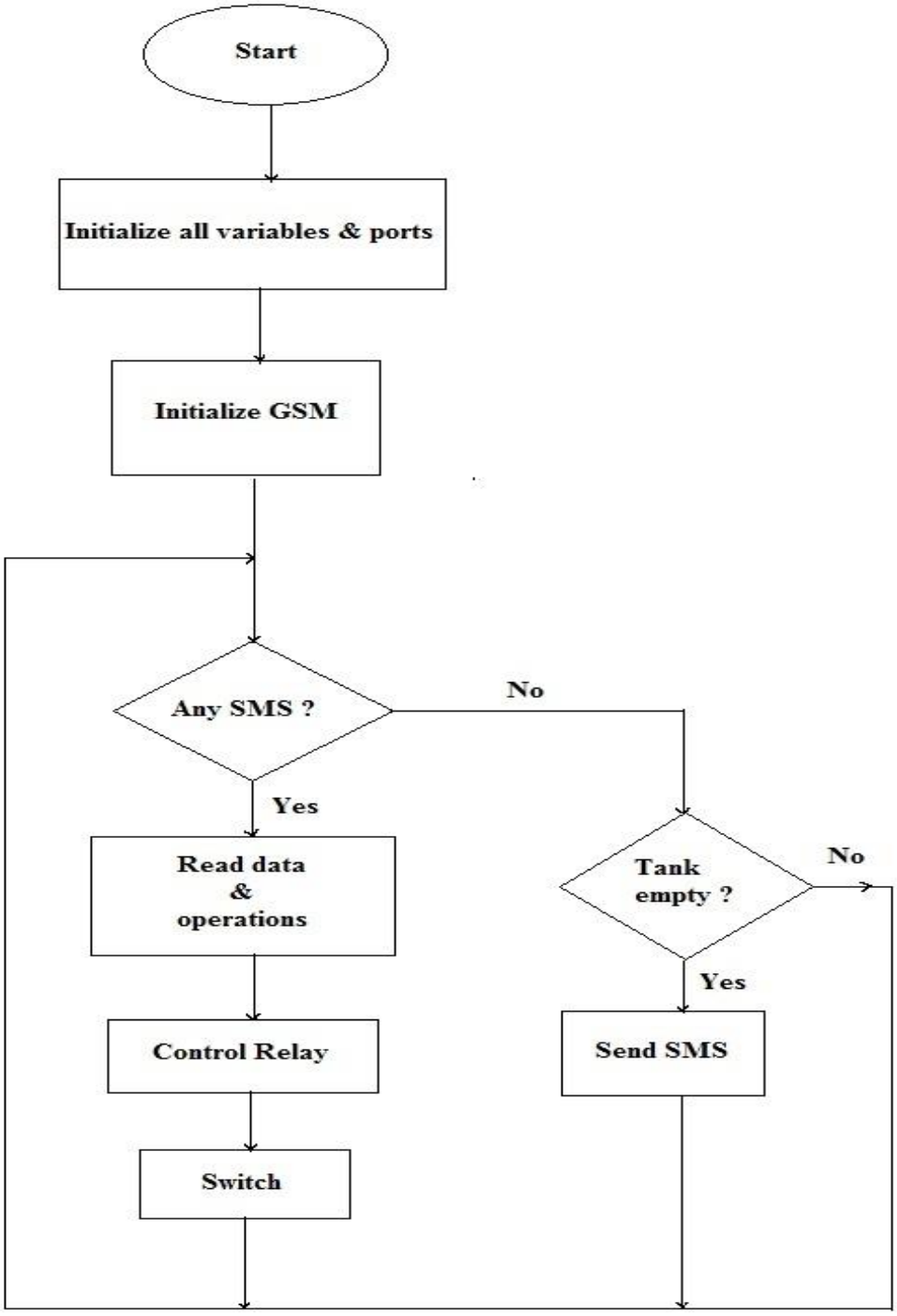


Fig: Flow Chart

3.2 Software

Arduino is an open-source platform used for building electronics projects. The Arduino Integrated Development Environment or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload programs and communicate with them. The Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. The Arduino IDE uses a simplified version of C++, making it easier to learn to program. There are two types of commands – AT command and GSM library

3.2.1 AT Command

These commands are used to control MODEMs. AT is the abbreviation for Attention. These commands come from Hayes commands that were used by the Hayes smart modems. The Hayes commands started with AT to indicate the attention from the MODEM. The dial up and wireless MODEMs (devices that involve machine to machine communication) need AT commands to interact with a computer. These include the Hayes command set as a subset, along with other extended AT commands.

AT commands with a GSM/GPRS MODEM or mobile phone can be used to access following information and services:

1. Information and configuration pertaining to mobile device or MODEM and SIM card.
2. SMS services.
3. MMS services.
4. Fax services.
5. Data and Voice link over mobile network.

3.2.2 GSM Library

GSM library is a default code in Arduino software. The GSM library is included with Arduino IDE 1.0.4 and later. With the Arduino GSM Shield, this library enables an Arduino board to do most of the operations you can do with a GSM phone: place and receive voice calls, send and receive SMS, and connect to the internet over a GPRS network.

The GSM shield has a modem that transfers data from a serial port to the GSM network. The modem executes operations via a series of AT commands. The library abstracts low level communications between the modem and SIM card. It relies on the Software Serial library for communication between the modem and Arduino.

Code for test the modem (SIM808):

```
#include <GSM.h>

// modem verification object
GSMModem modem;

// IMEI variable
String IMEI = "";

void setup()
{
  // initialize serial communications and wait for port to open:
  Serial.begin(9600);
  while (!Serial) {
    ; // wait for serial port to connect. Needed for Leonardo only
  }

  // start modem test (reset and check response)
  Serial.print("Starting modem test...");
  if (modem.begin())
    Serial.println("modem.begin() succeeded");
  else
    Serial.println("ERROR, no modem answer.");
}

void loop()
{
  // get modem IMEI
  Serial.print("Checking IMEI...");
  IMEI = modem.getIMEI();

  // check IMEI response
  if (IMEI != NULL)
  {
    // show IMEI in serial monitor
    Serial.println("Modem's IMEI: " + IMEI);
    // reset modem to check booting:
    Serial.print("Resetting modem...");
    modem.begin();
    // get and check IMEI one more time
    if (modem.getIMEI() != NULL)
    {
      Serial.println("Modem is functoning properly");
    }
    else
```

```
    {
      Serial.println("Error: getIMEI() failed after modem.begin()");
    }
  }
  else
  {
    Serial.println("Error: Could not get IMEI");
  }
  // do nothing:
  while (true);
}
```

3.2.3 Coding

```
//Digital Pin 2 is used as RXD connected to TXD of GSM808
//Digital Pin 3 is used as TXD connected to RXd of GSM808

 // include the GSM library
#include <GSM.h>
// PIN Number for the SIM
#define PINNUMBER ""
// initialize the library instances
GSM gsmAccess;
GSM_SMS sms;
// Array to hold the number a SMS is retreived from
boolean flag =0;
char senderNumber[20];
void setup()
{
  pinMode(8,OUTPUT);
  pinMode(9,OUTPUT);
  pinMode(10,OUTPUT);
  pinMode(11,OUTPUT);
  pinMode(4,INPUT);
  pinMode(12,INPUT);

  // initialize serial communications and wait for port to open:
  Serial.begin(9600);
  while (!Serial) {
    ;
  }
```

```
  Serial.println("SMS Messages Receiver");
  // connection state
  boolean notConnected = true;
  // Start GSM connection
  while (notConnected)
  {
    if (gsmAccess.begin(PINNUMBER) == GSM_READY)
      notConnected = false;
    else
    {
      Serial.println("Not connected");
      delay(1000);
    }
  }
  Serial.println("GSM initialized");
  Serial.println("Waiting for messages");
}
void loop()
{
  char c, msg[10]="ON";
  int i=0;
  //code starts for pump control
  boolean lsl, lsh;
  lsl = digitalRead(12);
  lsh = digitalRead(4);
  //Serial.println(lsl);
  //Serial.println(lsh);

  if((lsl==HIGH) && (flag == LOW))
  {
    //send message
    char remoteNum[20]="+88017XXXXXXXX";  // mobile number to send sms

  //Serial.println("Waiting on the Switch");
  Serial.println(remoteNum);

  char txtMsg[200]="Tank Empty";
  //H readSerial(txtMsg);
  Serial.println("SENDING");
  Serial.println();
  Serial.println("Message:");
  Serial.println(txtMsg);
  // send the message
  sms.beginSMS(remoteNum);
  sms.print(txtMsg);
  sms.endSMS();
  Serial.println("\nCOMPLETE!\n");
  flag = HIGH;

    //end of send message
```

```
}
if(lsl==LOW)flag=LOW;
if(lsh==LOW) digitalWrite(11,LOW);


//up to this for pump control
sms.flush();
  // If there are any SMSs available()
  if (sms.available())
{
  Serial.println("Message received from:");
  // Get remote number
  sms.remoteNumber(senderNumber, 20);
  Serial.println(senderNumber);
  // Any messages starting with # should be discarded
  if (sms.peek() == '#')
  {
    Serial.println("Discarded SMS");
    sms.flush();
  }
  while (c = sms.read())
  {
    msg[i]=c;
    i++;
  }
  msg[i]='\0';
  Serial.println(msg);
  sms.flush();
  if((msg[0]=='1') && (msg[1]=='2') && (msg[2]=='3') && (msg[3]=='4')) // for password
  '

  {
  if(msg[4]=='1')
  digitalWrite(8,HIGH);
  if(msg[4]=='0')
  digitalWrite(8,LOW);

  if(msg[5]=='1')
  digitalWrite(9,HIGH);
  if(msg[5]=='0')
  digitalWrite(9,LOW);

  if(msg[6]=='1')
  digitalWrite(10,HIGH);
  if(msg[6]=='0')
  digitalWrite(10,LOW);
```

```
    if(msg[7]=='1')
    digitalWrite(11,HIGH);
    if(msg[7]=='0')
    digitalWrite(11,LOW);

    Serial.println("\nEND OF MESSAGE");
    // Delete message from GSM memory
    sms.flush();
    Serial.println("MESSAGE DELETED");
    }
  }

  delay(100);
}
```

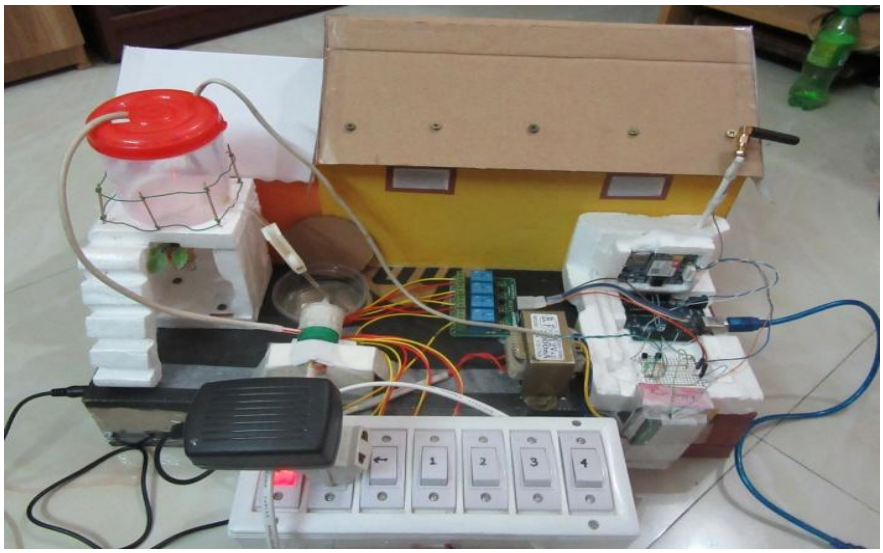
Chapter-4

RESULTS & DISCUSSIONS

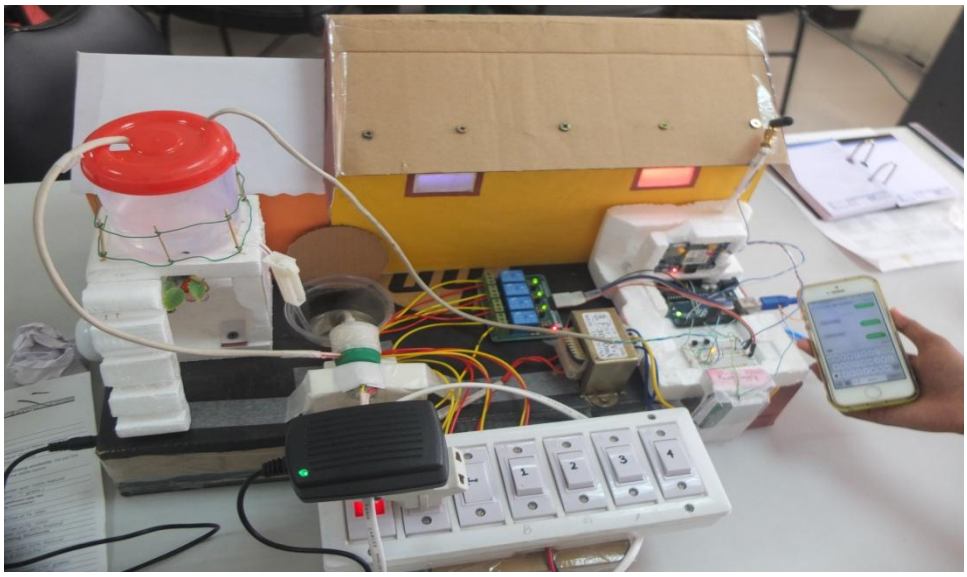
4.1 Hardware Results

The model is designed in bread board and all the components are connected as per the circuit diagram. The figures below shows the hardware connection and the output obtained.

Step 1: When no message is sent



Step 2: When message is sent



4.2 Discussions

SMS based home appliance control system is capable of controlling of the appliances from any place where GSM service is available. The combination of the hardware and software give the final design.

There were some problems encountered in our project development which can be stated as under:

- The modem with our mobile does not support most of the AT Commands.
- Problem with device deployment in laptops with 64-bit Operating System.
- Unavailability of components in the local market.
- We have facing many problems for using GSM SIM 900
- Coding issues also creates some problems.
- Configuration words had to be properly crosschecked for burning the code in the microcontroller.

Chapter-5

CONCLUTION

5.1 Conclusion

In this project a low-cost and simple approach to design an intelligent home system using the concept of mobile-to-machine and machine-to-mobile communication is designed. We develop a general purpose electronic circuit design that can control and monitor a variety of home appliances with interface that can be plugged into GSM modem. The project is successfully developed and met the stated objectives. The system can automatically switch ON and OFF the devices remotely using SMS. In addition, the system is very practical when the user is away from home; through it the user can control the electrical home appliances remotely as long as the mobile phone gets the coverage. The whole control system is protected by password that is why unauthorized users will not be able to control this system.

5.2 Future Work Scope

Smart home technology is one of the emerging technologies in the technological world.

- Face & finger detector door controller using SMS & MMS
- SMS controlled fridge with the consumer interface
- Windows & curtain controller by using SMS
- Adjust/regulate light intensity, fan & AC power using SMS

5.3 Product Commercialization

After completing all the circuit and developing the control system, we connected this control system in a room and we can see that it works properly. Therefore, we can say that our designed and developing control system is ready for commercial uses. We can assure that the setup cost of this control system is reasonable.

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