THE DESIGN OF AN ELECTRONIC VOTING MACHINE WITH A GSM MODULE

By

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Abstract

The main objective of this project was to design a cost effective and efficient electronic voting system interfaced with a GSM module. There is need to replace the conventional voting system based on paper in Zimbabwe and many African countries by electronic voting machines which are cheaper, more secure and less cumbersome.

Voting is when societies or a particular group of people come up with decisions based on choice and or preferences hence the need for a cheaper, more secure, reliable, transparent and less cumbersome system.

A voting system of this nature will significantly reduce the draining of the much needed resources of the Zimbabwean economy and many other African countries. Costs linked to time, personnel, accommodation, food, stationery and transport are significantly reduced.

Declaration

I, **Ignatio Mangwayana (R14641M)** hereby declare that I am the sole author of this dissertation entitled "The design of an Electronic Voting System with GSM module". I authorize Midlands State University to use this dissertation only for purposes of scholarly research.

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Approval

This dissertation entitled “The Design of an Electronic Voting System with a GSM module” by **Ignatio Mangwayana** meets the regulations governing the awarding of Bachelor of Science Honours in Telecommunications Engineering at the Midlands State University.

Supervisor…………………………………………

Date………………………………………………..

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Abbreviations

GSM-Global System for Mobile Communication

USB-Universal Serial Bus

PIC-Programmable Interface Controller

OS-Operating System

IDE-Integrated Development Environment

GPS-Global Position for Satellite

TV-Television

PCB-Printed Circuit Board

AC-Alternating Current

DC-Direct Current

GND-Ground

PWM-Pulse width Modulation

AREF-Analogue Reference

LED-Light Emitting Diode

TX-Transmit

RX-Receive

IC-Integrated Circuit

UART-Universal Asynchronous Receiver Transmitter

I/O-Input/Output

EEPROM-Electrical Erasable Programmable Read only Memory

GPRS-General packet Radio Service

LCD-Liquid Crystal Display

SIM-Subscriber Identification Module

BSC-Base Station Controller

MS-Mobile Station

MSC-Mobile Switching Centre

VLR-Visitor Location Register

EIR-Equipment Identifier Register

NSS-Network Subsystem

OSS-Operations and Support System

SMS-Short Message Service

EVM-Electronic Voting Machine

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CHAPTER 1:
INTRODUCTION /LITERATURE REVIEW

1.1 Introduction

A vote is a formal expression of an individual's choice in voting, an individual can vote for or against some motion or idea, for a candidate of choice or preference, a political party, any organisation be it social or economic and so on.

Voting is when individuals, societies or a particular group of people come up with decisions based on choice and or preferences. It is way of choosing someone or something. The people of the United States choose their leaders by voting. Some leaders run towns, cities and states. Sometimes people vote for projects that will help their cities and towns. They also vote against projects that will hurt their city or town. For example if the people of a town vote “yes”, the town will build a new road and if the same people vote “no”, the town will not build the new road.[2] A secret ballot has come to be the practice to prevent voters from being intimidated and to protect their privacy.

Zimbabwe and many other African countries use the conventional voting system based on paper. This system is slow, expensive, less secure, not reliable, cumbersome and not very transparent. It is this background of study that has motivated the design of an Electronic voting system interfaced to a GSM module which is much cheaper hence saving a lot of resources for Zimbabwe. The fact that Zimbabwe is a poor third world country means that the budget and the economy are small and elections usually dent both the budget and economy in a big way.

1.2 Background

1.2.1 Brief voting background

The idea of voting was motivated by the fact that most of the times people do not think alike and they have different choices, societies do not behave in the same way. Imagine if people were supposed to discuss and come with an agreement on every topical issue, some decisions could not have been made on time. Voting enabled people to have a stake in society.

It evolved from the time voting was done by voice, standing up or sitting down, show of raising of hands up to the time when it was done by written ballot. In the late nineteenth century in

America parties printed ballots on coloured paper so that it was still possible to determine who had voted for which candidate. [1]

The reasons why voting systems are being changed or upgraded all the time are that, there is need to have a secure, cheap, reliable, less cumbersome and transparent voting system.

A long time ago In America leading colonists associated democracy with disorder and mob rule and believed that the vote should be restricted to those who owned property or paid taxes. Only these people in their view were committed members of the community thus they had the right to vote and this made the whole system insecure. [1]

1.3 Dissertation overview

1.3.1 Research goals

This section outlines the aim of the dissertation. It clearly sets the objectives to be undertaken to meet the overall project goal of designing a cost effective, secure, less cumbersome, transparent, reliable and efficient Electronic voting system based on a GSM module so that it can send results from the polling station to the monitoring station via a mobile telephone network. There is need to replace the conventional voting system based on paper by electronic voting machines. The benefits of implementing the project for Zimbabwe, other African countries, business organisations, sporting organisations and social organisations are clearly articulated in **1.6**.

Voting can be done for political, social, economic, and educational reasons.

a) Political

   Under political reasons voting can be categorised into national, regional, and local elections

b) Social

   Individuals or societies vote for or against an opinion, for example the best dressed male or female, the best radio or Television presenter, soccer star of the year.

c) Economic/Business

An example of voting done in this regard is when individuals, societies or companies vote for the most influential company executive.

d) Educational/Research

When you are carrying out feasibility studies for a particular project voting can be used to determine public opinion, stakeholders' opinion and so on. Voting of a local school board is another example.

1.4 Aim and objectives of project

The project aims to design a cost effective, secure, less cumbersome and efficient Electronic voting system based on a GSM module.

Objectives

- To come up with an electronic design of the circuit.
- To show the principles of operation of the system
- To develop the software to run the system
- To interface the GSM module and the Arduino
- To show how cheap, secure and less cumbersome the system is
- To test and trouble shoot for any flows

1.5 Problem Statement

There is need to replace the conventional voting system based on paper by electronic voting machines which are cheaper, more secure, reliable and less cumbersome

1.6 Benefits of study

The project's key result area is to design an electronic voting system based on a GSM module and the voting system will be cheap, more secure, less cumbersome, transparent and reliable.

- ***Security:*** Any voting system must be secure as far as the candidates, voters and stakeholders are concerned. Candidates should not sniff into the results or tamper with them before, during and after voting. Voters should not vote more than ones and each voter is entitled to privacy. Secure voting systems bring about quality decisions that are not based on external influence or fear. [3]
- ***Cost:*** The electronic voting system is cheap. It has lower costs due to automated means. [8] Cost considerations are very important when coming up with a decision on the choice of a voting system. The conventional paper voting system is very expensive be it to the country or private organisation intending to use it. Huge costs are incurred on staff, food, accommodation, transport and the time taken to count and validate the votes.
- ***Reliability:*** A reliable voting system should have minimum or no errors and this enhances the quality of the system as well as the voting so this makes the electronic voting system better. [3]
- ***Less Cumbersome:*** If a voting system has too many processes, this will increase room or chances for errors to occur. Paper based voting systems have too many human managed processes increasing chances for error.
- ***Faster results and building trust:*** For other countries, particularly large ones like Brazil, India and the Philippines, electronic voting and electronic counting means that people can get official election results within hours, instead of weeks. Again, this builds trust. [7]
- ***Trees and forests conservation:*** Electronic voting uses very little paper so trees and forests are conserved. [7]
- ***Scalability:*** The electronic voting machine has potential to be enlarged in order to accommodate growth in amount of work.
- ***Better accuracy:*** This is due to the fact that the negative factor of human error is minimised. [8]

1.7 Literature review

The dynamism of technology has caused new ideas and devices to be launched onto the market frequently and this market is broad. It covers areas like Politics, Business, Social, Academic and Sporting.

This project aims to facilitate voting using electronic means based on a GSM module. There are a number of designs that have been done earlier and some of them are described below:

From April 2014 to December 2015 Vaibhav Bhatia and Rahul Gupta designed a GSM based Electronic voting machine with voter tracking. This machine is based on the microcontroller PIC 16F877A. [3] The Programming language used on this PIC is embedded C. Embedded C is an extension to C programming language that provides support for developing efficient programs for embedded devices. It is not a part of the C language. C is a widely used general purpose high level programming language mainly intended for system programming. In this project the Arduino Uno was chosen instead of the PIC 16F877A because it does not require too much wiring. The objective of the Arduino was to make it easy for artists and designers to work with electronics, by abstracting away the often complicated details of electronics so they can focus on their own objectives.[4] It provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages C and C++ For programming the microcontrollers,

C and C++ languages are simpler than the embedded C. Normal C language can also use the resources of a desktop computer like memory, OS etc. Embedded C is closer to assembly language whereas Normal C is closer to user language like English thus the embedded industry needs requires good C programming professionals. The other reason why the Arduino was used in this project is because **Arduino** is an open-source project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. [5] This implies that it is a platform that keeps developing.

The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analogue input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers.

On the other hand the Global System for Mobile communications (GSM) is the most widely used mobile networking standard not just for mobile telephony, but for also other mobile applications that exploit the mature GSM infrastructure. [6] It operates at either the 900 MHz or 1800 MHz frequency bands and this the reason why a GSM module was used for this project.

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[6] H. M. Sidqi, “ International Journal of Emerging Trends and Technology in computer Science (IJETTCS),” Volume 3, Issue 4, July-August 2014

[7] http://www.smartmatic.com

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CHAPTER 2:
THEORETICAL ASPECTS

2.1 Arduino Controller

Arduino controller was chosen for this project because of its low price, wide range of application, high quality and easy availability. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a huge variety of Arduino-based projects. [3] Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control objects in the physical world. [1] Massimo Banzi helped invent the Arduino, a tiny, easy-to-use open-source microcontroller that has inspired thousands of people around the world to make gadgets that range from toys to satellite gear.

For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on the Processing project, which includes support for the **C** and C++ programming languages. [1] [5]

2.1.1 Physical Characteristics

The maximum length and width of the Arduino Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins. [2]

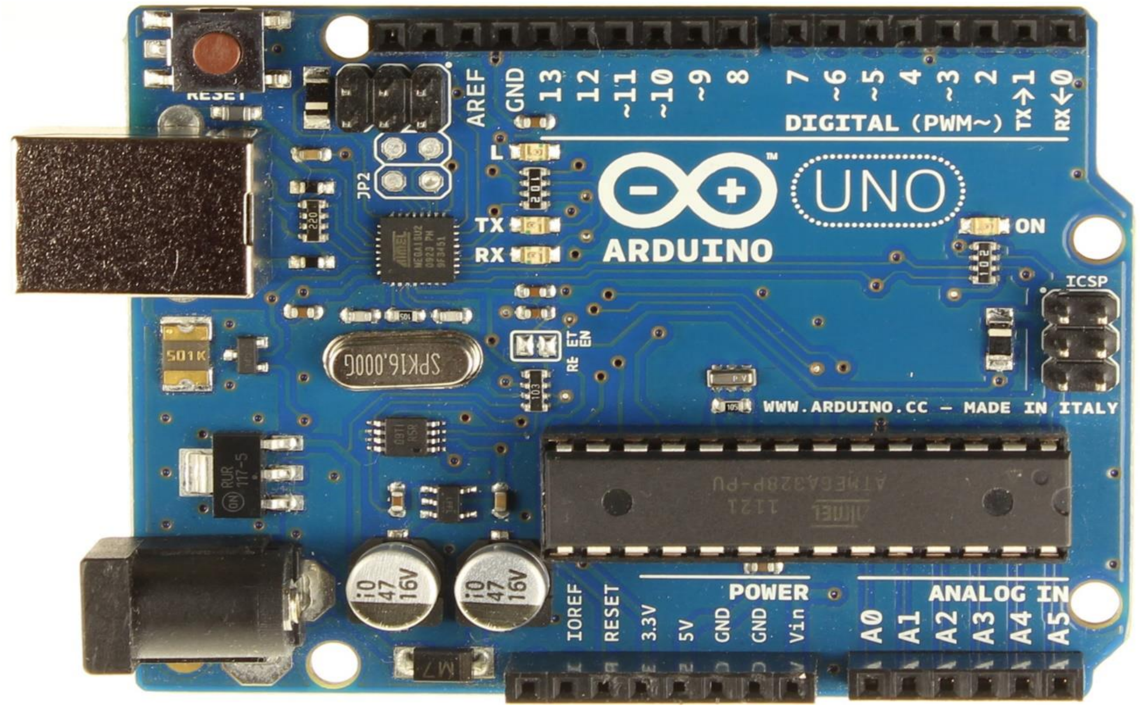


Figure2.1 Arduino image.[4]

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, 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 an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. [4]

There are many varieties/versions of Arduino boards and they can be used for different purposes. Some boards look a bit different from the one below, but they have the majority of these components in common:

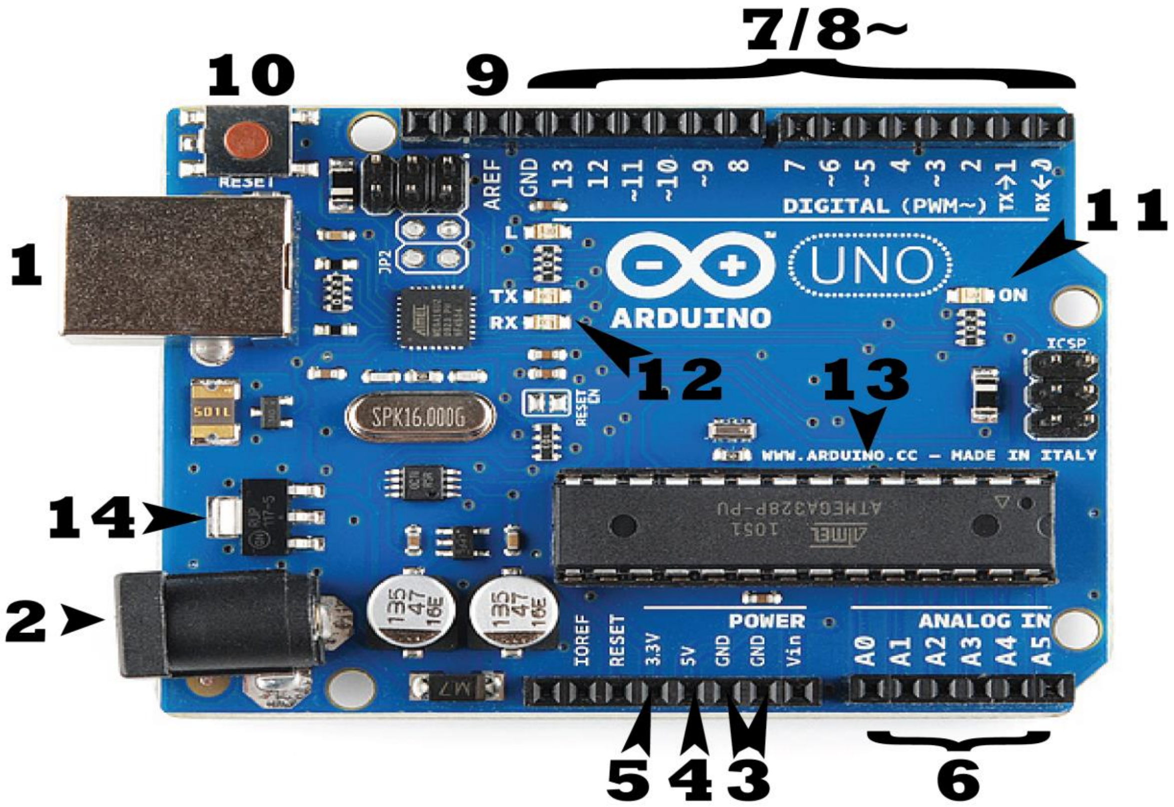


Figure2.2 Arduino image. [3]

(i) Power (USB / Barrel Jack)

The Arduino UNO can be powered from a USB cable coming from your computer or an external power supply that is terminated in a barrel jack. In the picture above the USB connection is labelled **(1)** and the barrel jack is labelled **(2)**. [3] External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. [2]

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. [2]

The USB connection is also used to load code onto the Arduino board.

(ii) Pins (5V, 3.3V, GND, Analogue, Digital, PWM, AREF)

Wires used to construct a circuit are connected on the pins on the Arduino probably in conjunction with a breadboard. They usually have black plastic ‘headers’ that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labelled on the board and used for different functions. [3]

- ***Ground (GND) (3):*** There are several GND pins on the Arduino, any of which can be used to ground your circuit. [3]
- ***5V (4) & 3.3V (5):*** As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run well on the 5V supply or 3.3 volts supply. [3]
- ***Analogue (6):*** The area of pins under the ‘Analogue In’ label (A0 through A5 on the UNO) are Analogue In pins. These pins can read the signal from an analogue sensor (like a temperature sensor) and convert it into a digital value that we can read. [3] Each pin 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function.
- ***Digital (7):*** The digital pins are from (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED). [3]
- ***Pulse-Width Modulation (PWM) (8)****:* You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM).These pins are able to simulate an analogue output (like fading an LED in and out). [3]
- ***Analogue Reference (AREF) (9):*** Most of the time this pin is left out but it is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analogue input pins. [3]

(iii) Reset Button

The Arduino has a reset button **(10)**. Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn't repeat, but you want to test it multiple times. [3]

(iv) Power LED Indicator

On the Arduino UNO circuit board, there's a tiny LED next to the word 'ON' **(11)**. This LED should light up whenever you plug your Arduino into a power source. If this light doesn't turn on, there's a good chance something is wrong. [3] The circuit needs to be diagnosed.

(v) Trasmit and Receive (TX & RX) LEDs

These pins are responsible for serial communication. There are two places on the Arduino UNO where TX and RX appear – by digital pins 0 and 1, and a next to the TX and RX indicator LEDs **(12)**. These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (like when we're loading a new program onto the board). [3]

(vi) Main Integrated Circuit (IC)

This is the one labelled **(13)** on the Arduino circuit board above in Figure 2.2. It is the brains of the Arduino. Different Arduino board types have slightly different main ICs but they are usually ATmega line of ICs from the ATMEL Company. It is important to know the IC type and the Board type before loading a new program from the Arduino software. This information is usually written on the top side of the IC.

(vii) Voltage Regulator

The voltage regulator **(14)** controls the amount of voltage that is let into the Arduino board. It has its limits, so the Arduino must not be connected to anything greater than 20 volts.

2.1.2 Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 Receive (RX) and 1 Transmit (TX).

ATmega16U2 firmware on the board channels allows serial communication over USB is and this 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, an .info file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino 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). [2]

2.1.3 Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the **Tools** > **Board** menu (according to the microcontroller on your board). More details, are found in the reference and tutorials. [2]

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). [2]

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header. The C or C++ language is used to program the Arduino.

2.1.4 Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. [2] The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. [2] This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following halfsecond or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. [2]

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line. [2]

2.1.5 USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed. [2]

2.1.6 Technical specifications of Arduino

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16MHz[3]

2.1.7 The Arduino was chosen for this project because of the following reasons:

- ***Inexpensive*** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50.[1]

- ***Cross-platform*** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.[1]
- ***Simple, clear programming environment*** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well.[1]
- ***Open source and extensible software*** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.[1]
- ***Open source and extensible hardware*** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.[1]

2.2 GSM2 Click Modem

This is a GSM modem and it connects wirelessly to the GSM network. GSM Click is an add-on board in mikroBUS™ form factor which is a perfect solution for adding GSM/GPRS communication layer to your device. It is interfaced to the Arduino Microcontroller and whatever information that is received or transmitted by the Arduino passes through the GSM modem to or from the GSM network. The GSM modem features the Quetctel M95 FA GSM/GPRS module which supports GSM850MHz, GSM900MHz, DCS1800MHz or PCS1900MHz quad band frequencies with 85.6kbps GPRS data transfer. The board contains an SMA antenna connector, quadruple audio/microphone jack and as well as the SIM card socket. The GSM2 click modem communicates with the target microcontroller via seven microBUS lines (RX, TX, INT, PWM, CS, RST and AN). The board is powered by 5V or 3.3V power supply and I/O voltage levels. LEDs indicate the presence of power supply. [6]

2.2.1 Applications

GSM Click™ with its Telit GL865-QUAD IC is ideal for mobile devices. [6]

2.2.2 Key features

- Supports GSM/GPRS protocol stack 3GPP.

- Supports GSM/GPRS 850/900/1800/ 1900 MHz Quad-band frequency.
- On-board antenna connector as well as 3.5mm quadruple earphone/microphone jack.
- SIM card socket integrated at the bottom side of the board.

2.2.3 Key Benefits

The GSM click 2 modem was chosen for this project because the GSM mode of communication is a mature sytem which is now being used all over the world. The other reasons for choosing the GSM click modem are listed below: [6]

- mikroBUS™ form factor enables easy integration.
- Supported in all mikroElektronika compilers.
- Ready-to-use examples save development time.
- Very compact design and affordable price.

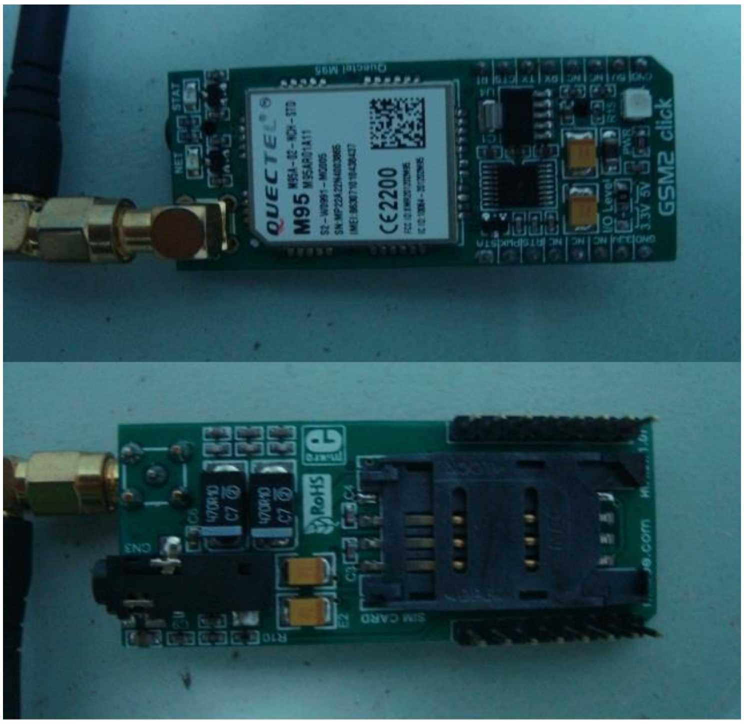


Figure 2.3 GSM2 click modem. [6]

2.3 Liquid Crystal Display (LCD) (20*4)

It is an electronic display system. The liquid crystal display(LCD) has become the display device of choice for microcontrollers. An LCD features low power, ful ASCII character displays of one to four lines, from 16 to 40 characters per line and low cost. A 20*4 LCD is a 20 column and 4- row LCD. It means it can display 20 characters per line and 4 such lines are available. The advantages of LCD’s are that, they are economical, easily programmable, display a number of characters, compact, light and have low power consumption.

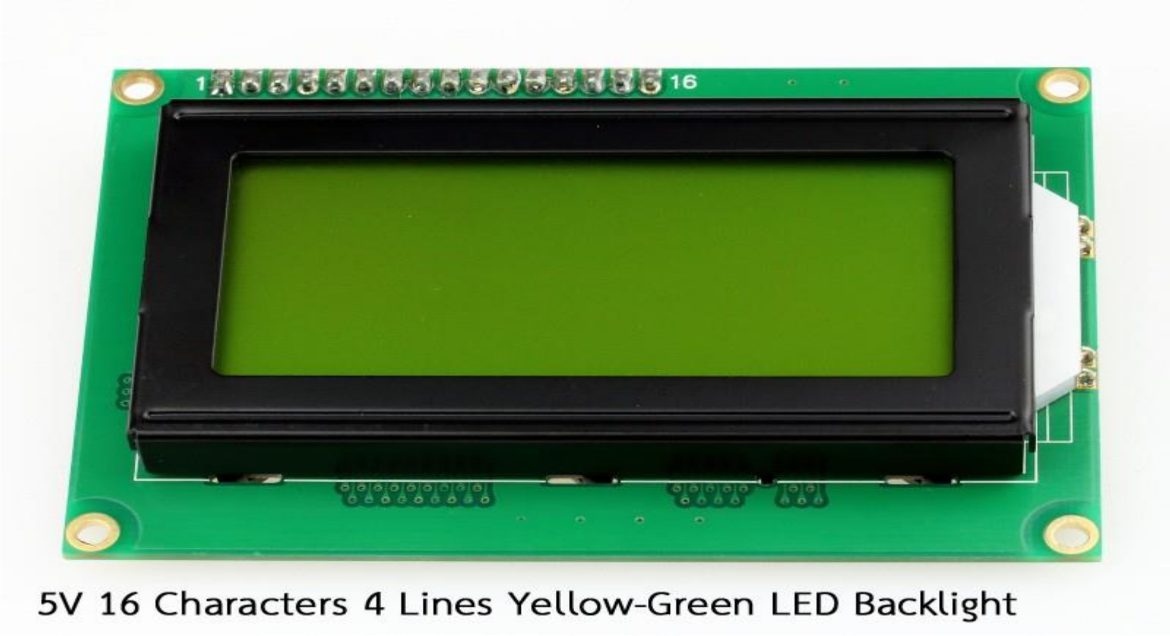


Figure 2.4 (20*4) LCD. [7]

2.3.1 LCD Pin connections and Explanations

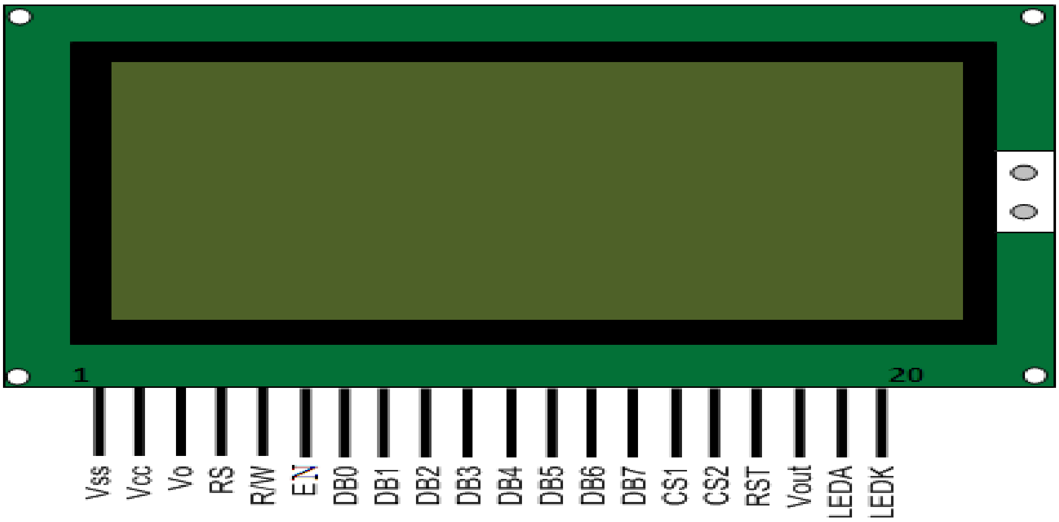
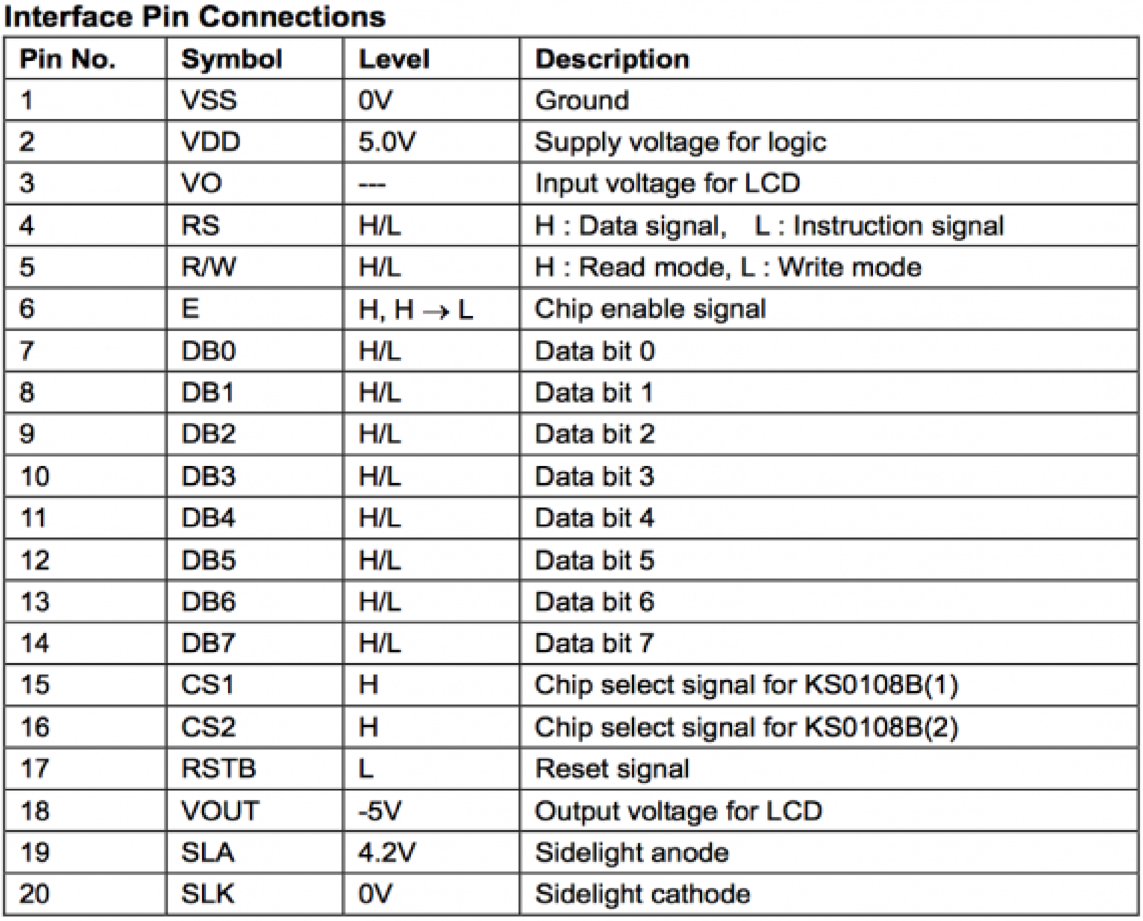


Figure 2.5 (20*4) LCD Pin Connections. [7]



Interface Pin Connections

Pin No.	Symbol	Level	Description
1	VSS	0V	Ground
2	VDD	5.0V	Supply voltage for logic
3	VO	---	Input voltage for LCD
4	RS	H/L	H : Data signal, L : Instruction signal
5	R/W	H/L	H : Read mode, L : Write mode
6	E	H, H → L	Chip enable signal
7	DB0	H/L	Data bit 0
8	DB1	H/L	Data bit 1
9	DB2	H/L	Data bit 2
10	DB3	H/L	Data bit 3
11	DB4	H/L	Data bit 4
12	DB5	H/L	Data bit 5
13	DB6	H/L	Data bit 6
14	DB7	H/L	Data bit 7
15	CS1	H	Chip select signal for KS0108B(1)
16	CS2	H	Chip select signal for KS0108B(2)
17	RSTB	L	Reset signal
18	VOUT	-5V	Output voltage for LCD
19	SLA	4.2V	Sidelight anode
20	SLK	0V	Sidelight cathode

Table 2.1 Pin explanations

8-Data pins carries 8-bit data or command from an external unit such as microcontroller.
Their are two registers in every LCD
(i) Command Register
(ii) Data Register

Command Register

When we send commands to LCD these commands go to Command register and are processed there. When RS=0 Command Register is Selected.

Data Register

When we send Data to LCD it goes to data register and is processed there. When S=1Data Register is selected.

EN (Enable Signal)

When you select the register(Command and Data) and set RW(read - write) now it is time to execute the instruction. The instruction can be the 8-bit data or 8-bit command present on Data lines of LCD. This requires an extra voltage push to execute the instruction and EN (enable) signal is used for this purpose. Usually EN=0 and when we want to execute the instruction we make it high EN=1 for some milli seconds. After this we again make it zero (low) EN=0. [8]

2.4 Polling Switches

Polling switches are used in the system to cast votes for the candidates. By pressing the switch a vote is given to the desired candidate. The switches can be configured to work as normal when open or closed depending on the design.

2.5 Power Supply

A power supply is an important part of any electronic circuit. It powers all the active and passive components of an electronic system.

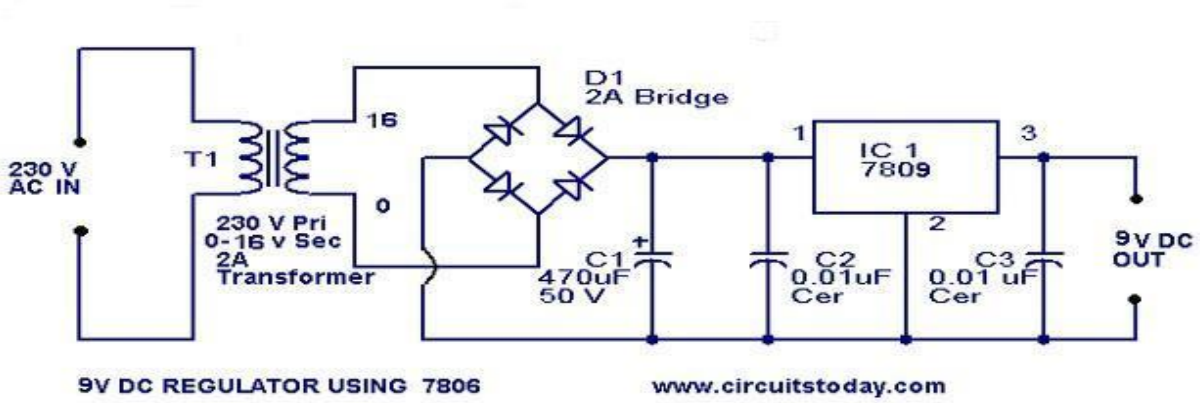


Figure 2.6 Power Supply Circuit Diagram

The transformer will step down AC input from 230V to about 12V AC and the full wave rectifier will rectify the 12V AC to DC. The output DC voltage will then be smoothened first by the 470uF 50V capacitor (C1). The smoothened output is also further smoothened by the 0.01uF Ceramic capacitor (C2), and any AC voltage in the output is short circuited (filtered out) by this capacitor. Stabilisation of the output is done by the LM 7809 integrated circuit. Further smoothening and filtering out of any AC in the output is done by the 0.01uF capacitor (C3) and a stable 9V DC is outputted at the output terminals

2.6 Structure of the GSM network

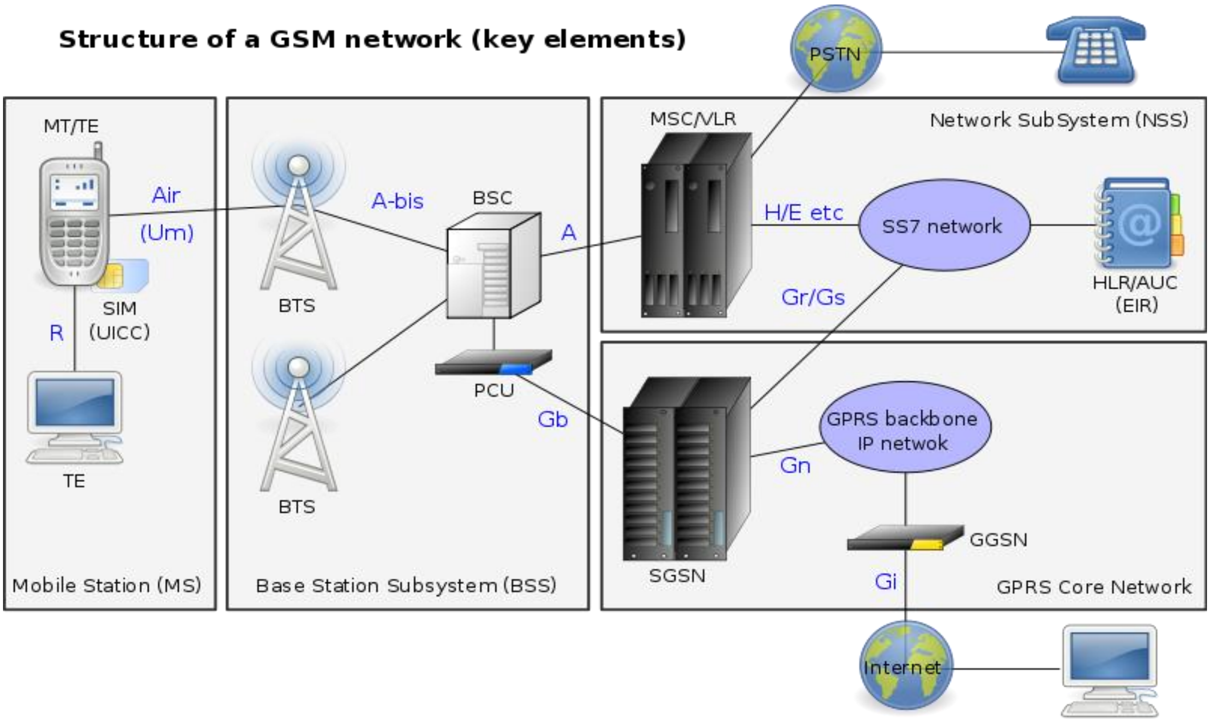


Figure 2.7 (GSM Structure)

The structure is composed of different sections that work together and these are:

(a) The mobile station (MS) and Mobile terminal (MT) – These are user interfaces.
(b) The Base Station Subsystem (BSS)-composed of the base stations and the base station controllers (BSCs).
(c) The Network Switching Subsystem- composed of the Mobile switching centre (MSC) and that is where registers such as VLR, HLR, AUC, EIR are found. Interconnection with other GSM MSCs or PSTN, ISDN, PSPDN, CSPDN Networks is done here.
(d) GPRS core network- This is where packet based internet connections are done
(e) The Operations and support System (OSS) - meant for monitoring and maintenance of the network.

2.7 Short message Service (SMS)

This is a service that is of particular interest to this project because messages are going to be sent from the GSM module connected to the Arduino to a programmed Telephone number at the Monitoring Station via the GSM mobile network.

This is a service used for sending or receiving sms' at very low costs from user user. All the mobile operators in Zimbabwe provide the sms service. A limit of 160 alphanumeric characters are allowed to be sent at any instance via the Short Message Service centre (SMSC). SMS service can be from one user to another user, One user to many users (Broadcasting) or many users to one user (updating). The SMSC receives a message and then directs it to the appropriate device. The SMSC does this by sending an SMS request to the Home Location Register (HLR) in order to find the customer and once the HLR receives the request it the responds to the SMSC with the Subscriber's status for example inactive, active or where the customer is roaming. The SMSC then purges the device and if it responds the message gets delivered. Verification is then sent to the SMSC that the end user has received the message then this message will be categorised as sent so that an attempt to send it again will not be made.

2.8 Monitoring Centre

This is where all the voting results are going to be sent by the GSM module via the GSM network using Short Message Service. Results of the voting or election process are going to be announced from the monitoring centre.

REFERENCES

[1] https://www.arduino.cc/en/guide/introduction (accessed October 7 2016)

[2] http://www.farnel.com/datasheets/1682209.pdf (accessed October 7 2016)

[3] https://learn.sparkfun.com/tutorials/what-is-an-arduino

[4] http://www.digital.csic.es/bitstream/120261/127788/7/D-C-Arduino uno.pdf (accessed October 7 2016)

[5] https://www.arduino.cc/en/main/software (accessed October 7 2016)

[6] http://www.mikroe.com/click/gsm2 (accessed October 7 2016)

[7] G. J. Lipovski, "Single and Multi-Chip Microcontroller Interfacing," University of Texas, Academic Press 1999

[8] www.microcontroller-project.com/16*2 LCD (Accessed October 9 2016)

[9] www.wisegeek.org/what-is-an-infrared-sensor.html

CHAPTER 3

RESEARCH METHODS AND TECHNIQUES

3.1 Introduction

This chapter describes in detail the tools used for example software used, the architectural design of the project, the development steps, techniques and method used to integrate all the parts (subsystems) in this project. The Waterfall project development method was used for this project. It is a stage by stage system and the advantage of this system is that it is possible to return to the previous stage or stages whenever a hiccup or error arises. Trouble shooting is easy when using this method.

3.1.1 Step 1- Literature survey

Surveys for all the information needed for this project were done at this stage. This included outlining the objectives of this project and then discussing with the project supervisors and constant consultation was done as the project was progressing in order to keep the project in line with the objectives and aim. The other sources of literature were books, the internet and discussions with fellow students.

3.1.2 Step 2- Conceptual design

With all the needed information now at hand flow charts and block diagrams were designed. Components were sourced and the project was divided into small tasks in order to reduce the complexity. Some of the components were found at the University’s Department of Physics and Telecommunications Laboratory and some were sourced outside. Availability of programming software was also confirmed.

3.1.3 Step 3- Building stage

This is the stage were all the components were put together to build one complete system thus making it the critical stage of the project. Components like the Power supply, Arduino Uno, GSM module, polling switches, LCD, Buzzer and programming software were put together at this stage.

3.1.4 Step 4- Testing

Any system that is designed needs to be tested in order to verify if the design is performing according to the required standards. At this stage the whole system was powered, software was loaded and test runs were carried out. Software bugs, mechanical faults, electrical faults and electronic faults were all cleared.

3.1.5 Step 5- Results

All the results are documented and a proper analysis of them is made to check if the objectives were met and if so then the project was a success. If the results do not tally with the expected results then troubleshooting has to be done. Scalability of a system will always depend on the present success of a system so even if results show that the objectives were met there will be still room for improvement of the system in order to meet new and bigger demands.

3.1.6 Step 6- Documentation

Documentation is a very important component of any project because documents are used as future reference. Documents are used for fault finding, improvement of the system, knowledge transfer and budget formulation. A system with proper documentation will surely pass the test of time

3.1.7 Methodology

The Waterfall Model was used for this project. It is also referred to as a **linear-sequential life cycle model**. It is very simple to understand and use. In a waterfall model, each phase must be completed fully before the next phase can begin. This model was used because the project is small. At the end of each phase, a review took place to determine if the project was on the right path and whether or not to continue or discard the project. In **waterfall model phases** do not overlap. [1]

Advantages of waterfall model:

- This model is simple, easy to understand and use.
- It is easy to manage due to the rigidity of the model – each phase has specific deliverables and a review process.
- In this model phases are processed and completed one at a time. Phases do not overlap.

- Waterfall model works well for smaller projects where requirements are very well understood. [1]

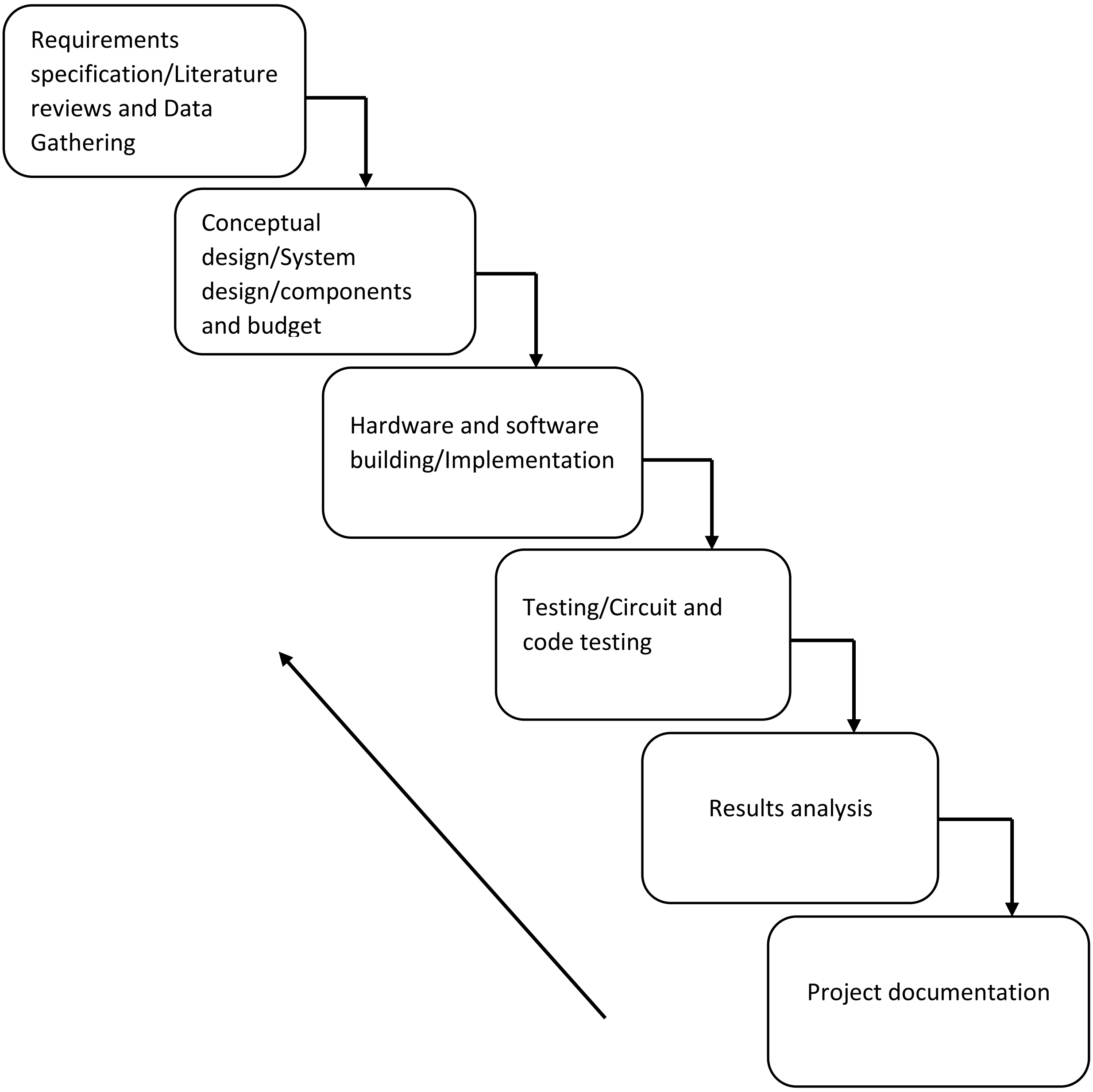

Requirements specification/Literature reviews and Data Gathering
Conceptual design/System design/components and budget
Hardware and software building/Implementation
Testing/Circuit and code testing
Results analysis
Project documentation

Figure 3.1 Methodology flow block diagram

3.2 Overview of system design

This section shows the basic layout of the system design. It shows all the components used in a system block diagram.

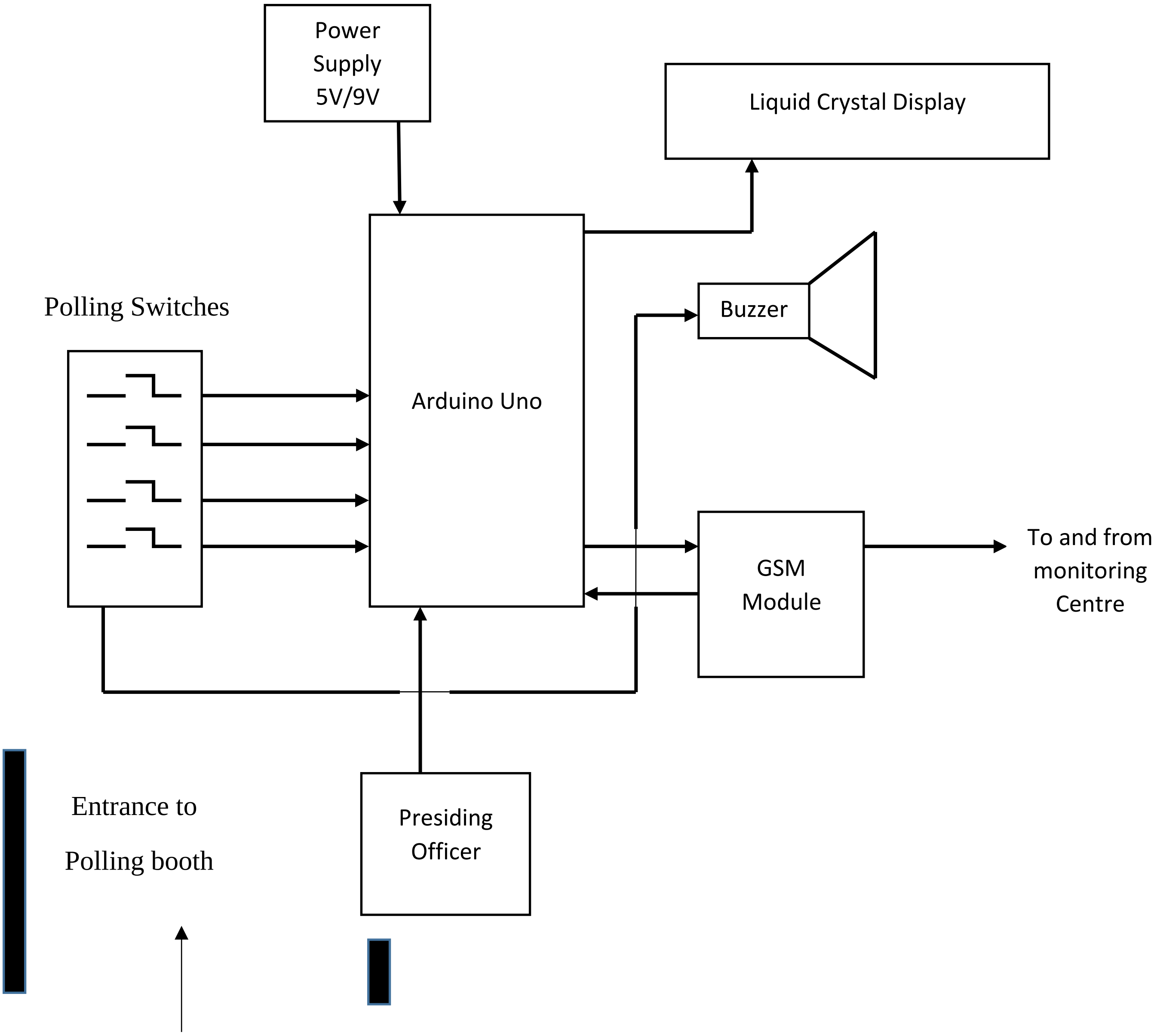


Figure 3.2 System block diagram

3.2.1 Main parts of the voting system

The voting system is composed of three main parts and these are the voting unit, counting unit, communication unit and the control unit (Arduino Uno, Led's and buzzer). The microcontroller controls the other three units. [2]

(i) Voting Unit

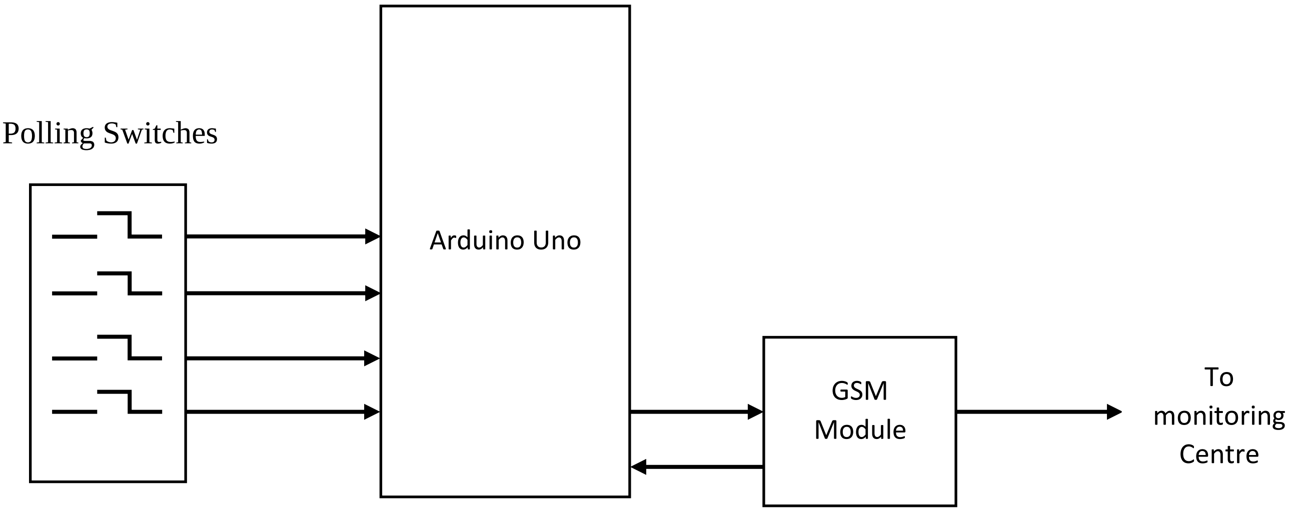


Figure 3.3 voting unit block diagram

(ii) Counting Unit

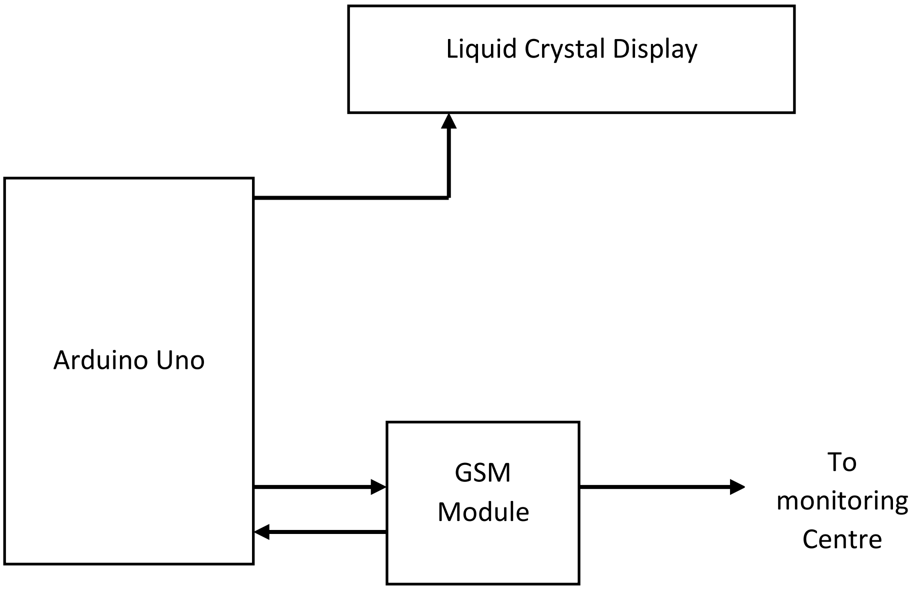


Figure 3.4 counting unit block diagram

(iii) Communication Unit

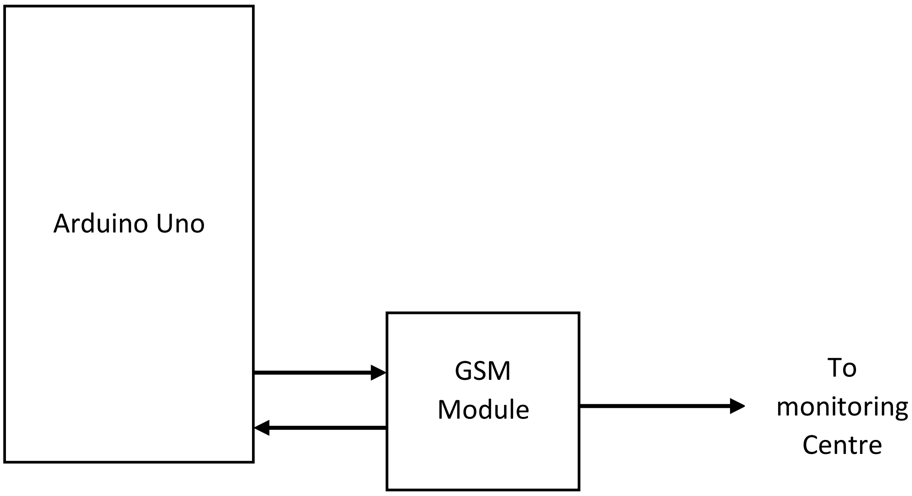


Figure 3.5 Communication Unit Block Diagram

(iv Control Unit

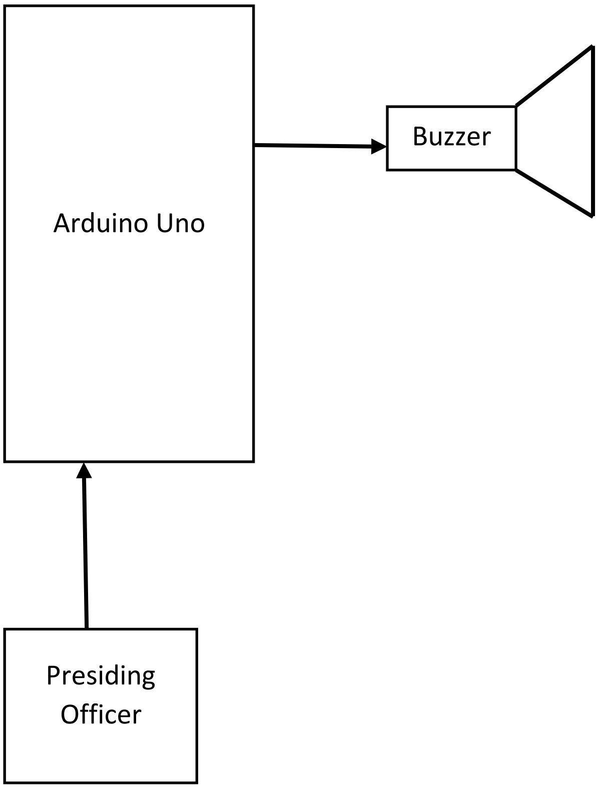
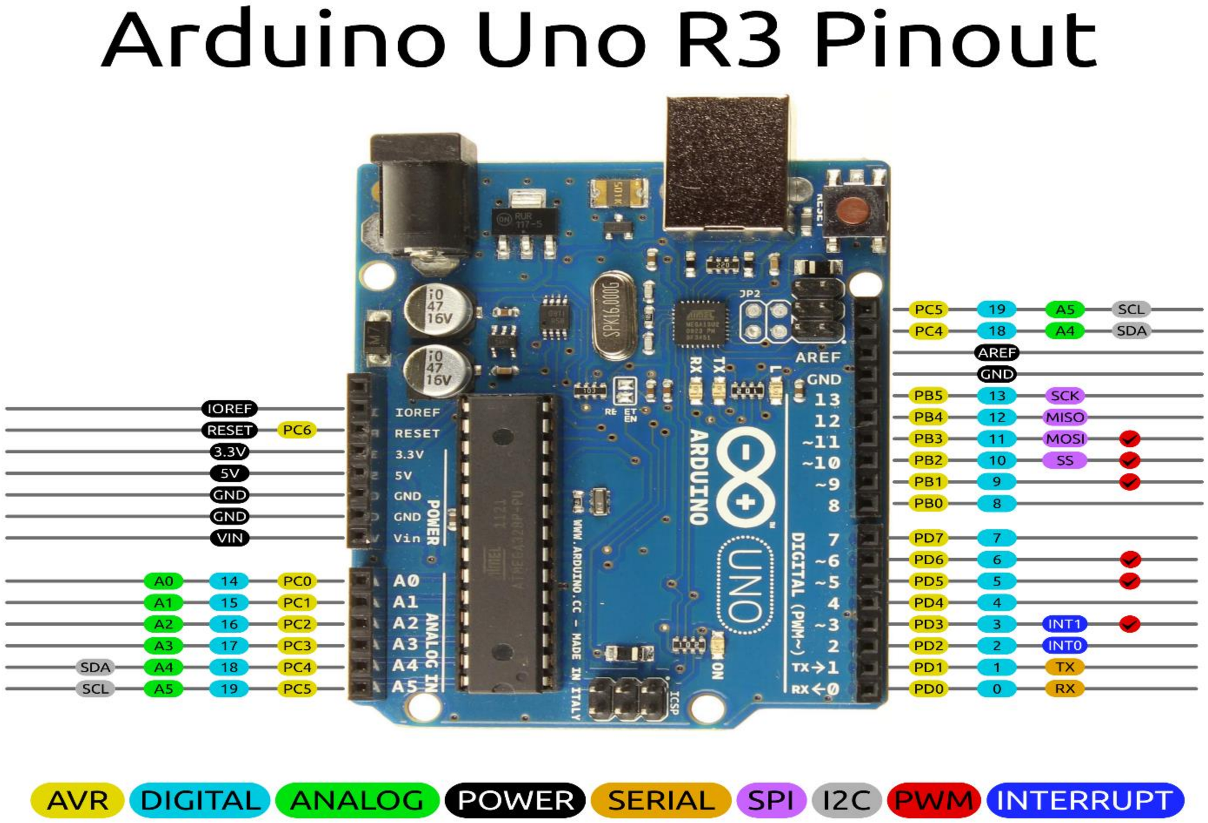


Figure 3.6 Control Unit Block Diagram

3.3 Interfacing Hardware

Interfacing is very important in any electronic project and this section of the project is going to look at hardware interfacing. An interface is a shared boundary across which two separate hardware components exchange information. The exchange can be between peripheral devices, humans and combinations of these. A hardware interface is described by the mechanical, electrical and logical signals at the interface and the protocol for sequencing them (sometimes called signalling). Hardware interfaces can be parallel with several electrical connections carrying parts of the data simultaneously, or serial where data is sent one bit at a time. Interface analysis verifies that the requirements for the complex electronics interfaces with other hardware, software, users, and other systems are correct, consistent, complete, accurate, and testable. [3]

3.3.1 Arduino pin out



2014 by Bouni
Photo by Arduino.cc

Figure 3.7 Arduino pin out. [4]

*3.3.2 Interfacing 20*4 LCD to Arduino uno*

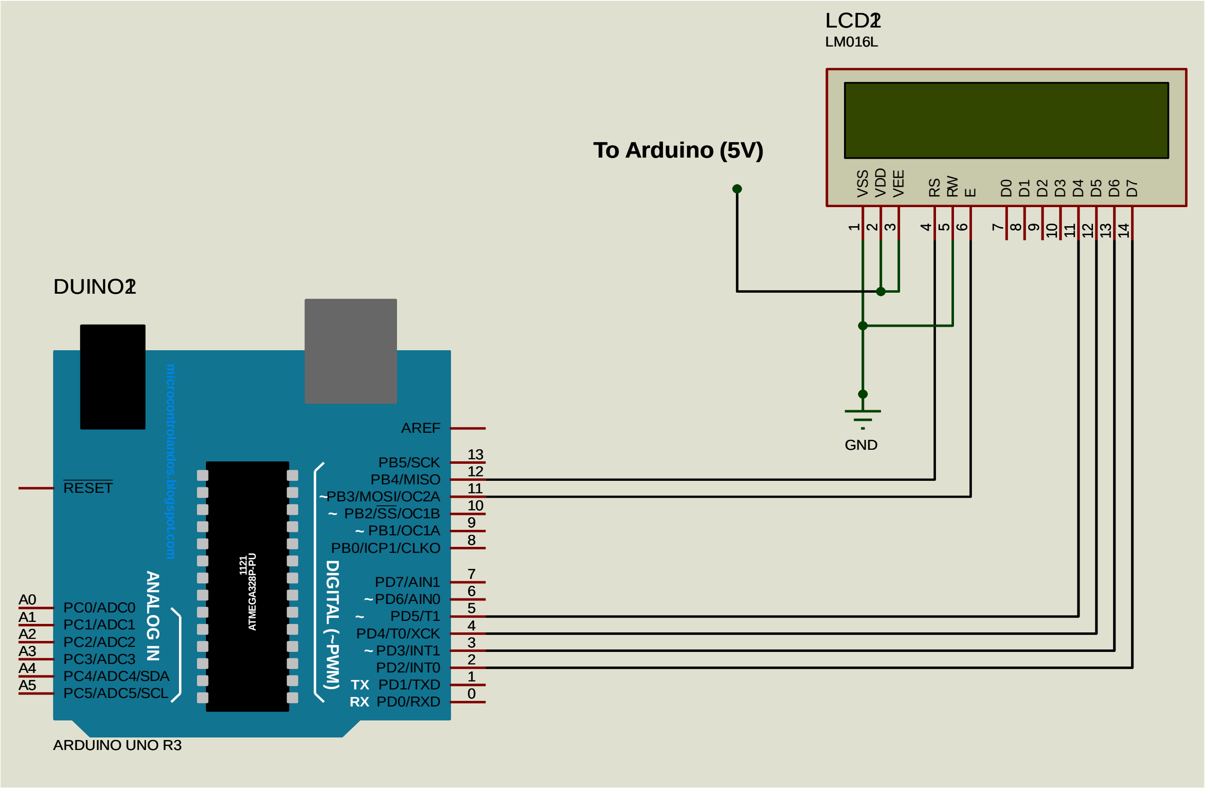


Figure 3.8 20*4 LCD to Arduino. (Proteus 8 Professional Schematic)

3.3.3 Interfacing GSM 2 Click Modem to Arduino

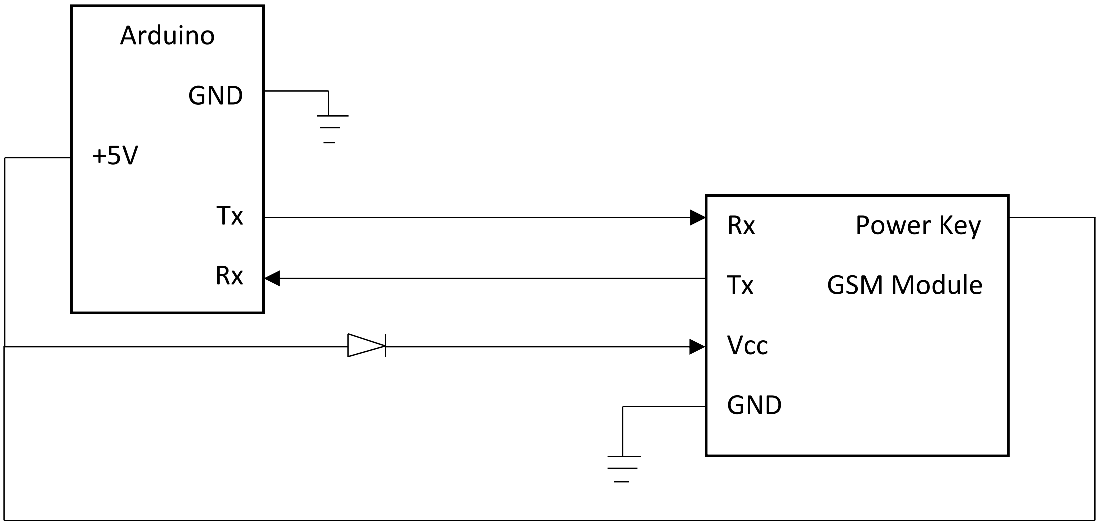


Figure 3.9 GSM module to Arduino

3.3.4 Interfacing Polling Switches to Arduino

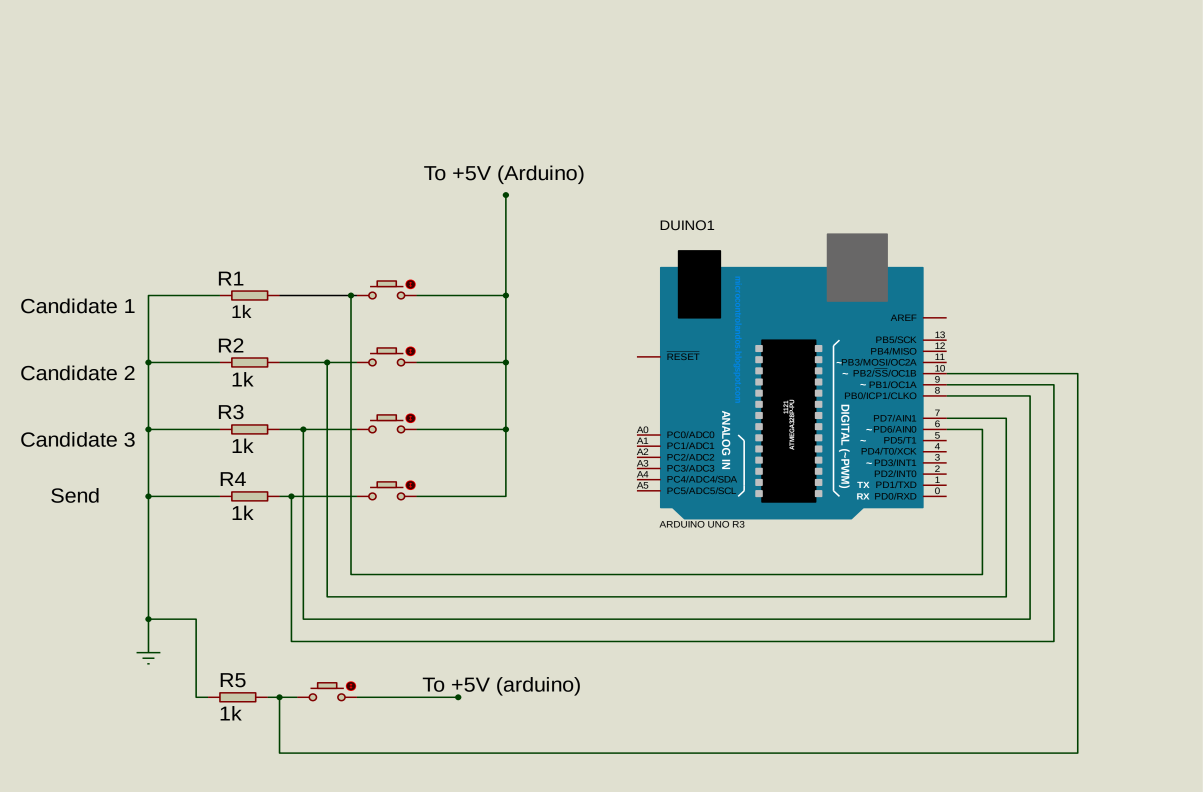


Figure 3.91 Polling Switches and Arduino (Proteus Schematic)

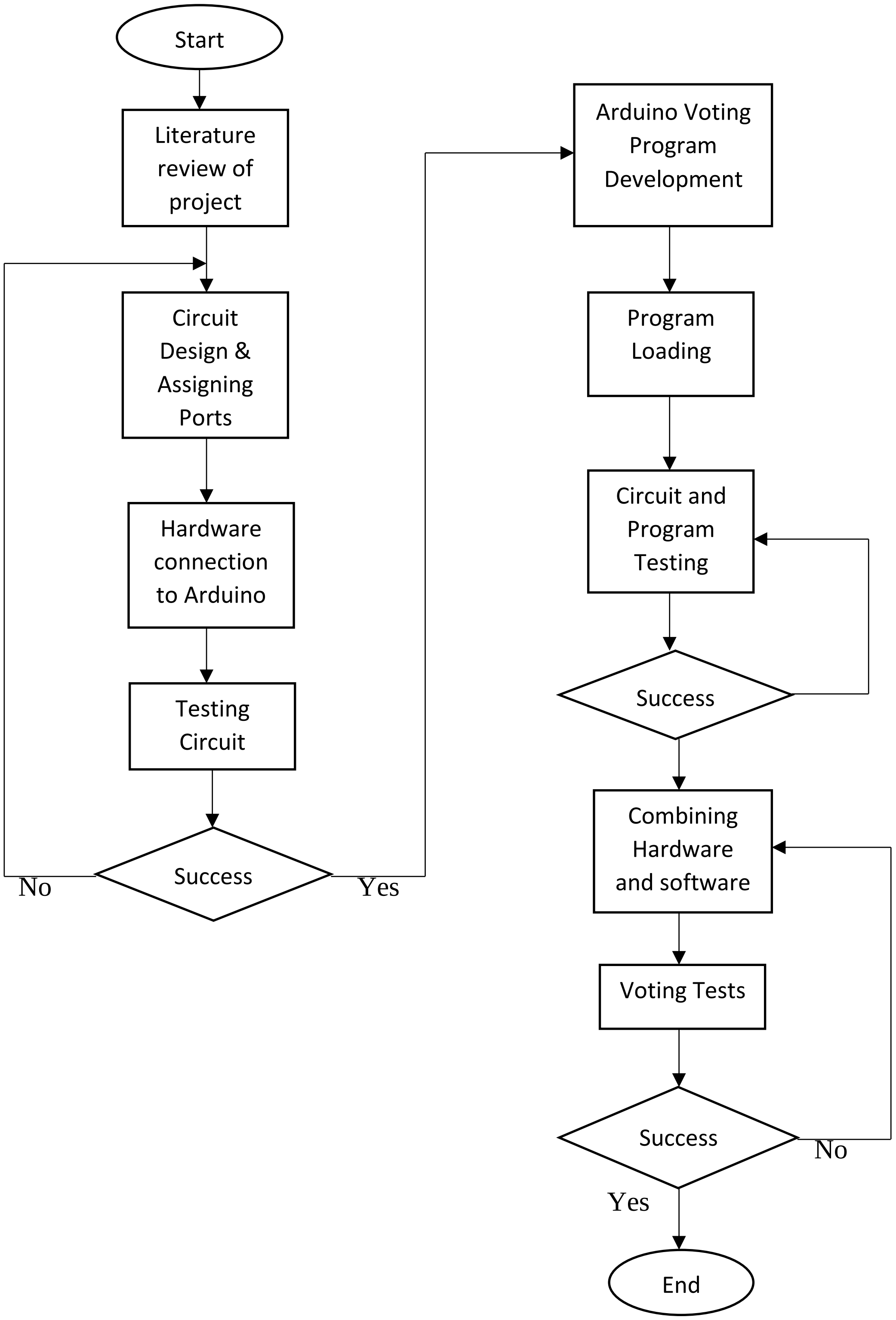
3.3.5 Buzzer

The buzzer is connected between the one Kilo Ohm resistors from the Polling switches and the earth. It simply gives an indication that the voter has voted or the Presiding Officer has send the voting results via the GSM module to the Monitoring centre.

3.3.6 LED

The LED simply shows that the presiding officer has given permission to someone to vote.

3.4 Software Design and development



Start
Literature review of project
Circuit Design & Assigning Ports
Hardware connection to Arduino
Testing Circuit
Success
No
Yes
Arduino Voting Program Development
Program Loading
Circuit and Program Testing
Success
Combining Hardware and software
Voting Tests
Success
No
Yes
End

Figure 3.92 System Flowchart

The software program was written in C language using the Arduino Integrated Development Environment Language. Proteus 8 Professional was used to draw most of the Circuit diagrams.

3.5 Performance Evaluation and testing

After building the whole hardware system, the software program was uploaded onto the system. The whole system was tested and results started showing and this was a great motivation. The system was showing votes for each candidate and the total votes which were then sent to the monitoring center.

REFERENCES

[1] istqbexamcertification.com/what-is waterfall-model (accessed October 14 2016)

[2] P.Diponker, R.KSobuj " apreview on Microcontroller Based Electronic Voting Machine," International Journal of Information and Electronics Engineering, Volume 3. Number 2, March 2013

[3] www.hq.nasa.gov/complex electronics/interface-analysis.htm

[4] https://github.com/Bouni/Arduino-Pinout

[5] www.hobbytronics.co.uk (accessed October 21 2016)

[6] www.vishay.com/docs/37306/lcd016n004b.pdf (accessed October 23 2016)

[7] https:www.arduino.cc/en/uploads/tutorial/lcd-bsae-bb-fritz.png

CHAPTER 4

RESULTS AND ANALYSIS

4.1 Introduction

This Chapter gives results obtained from the prototype. A number of voting sessions were carried out and these were just meant to test the system and see if the objectives of the project were met. Carrying out these numerous tests was also a way of stress testing the system. The first result to be obtained was the actual completed Electronic Voting Machine with a GSM module prototype

4.2 Electronic voting machine outlook

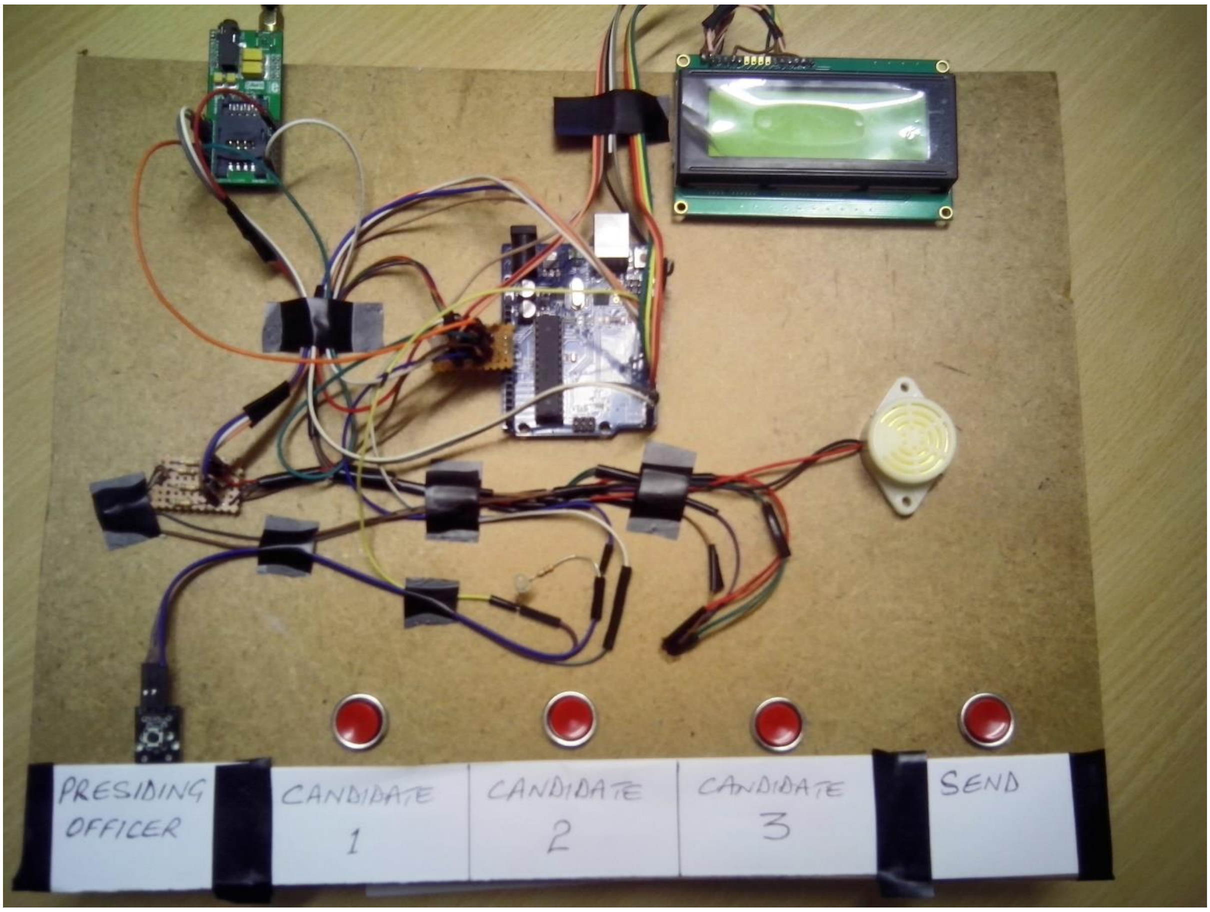


Figure 4.1 Prototype outlook

4.2.1 LCD before voting

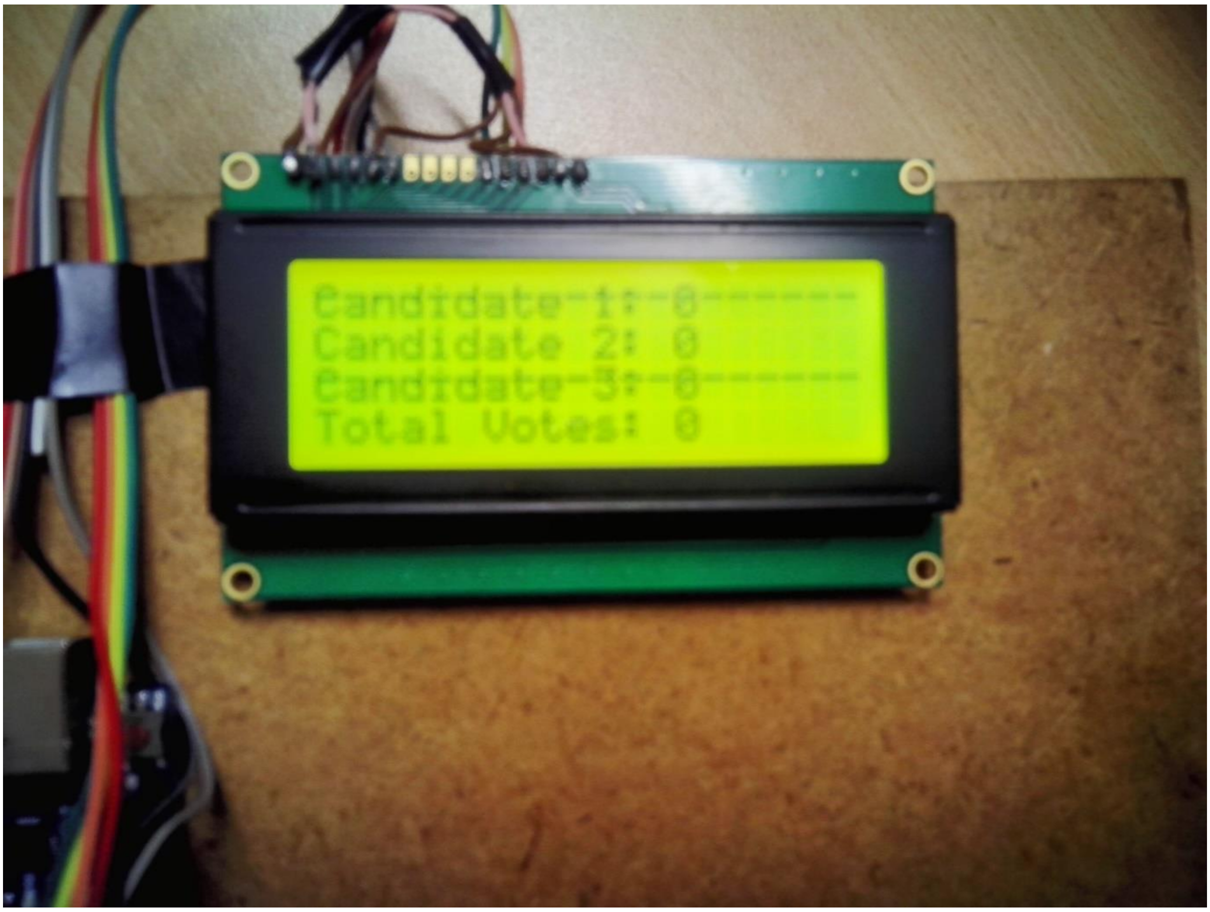


Figure 4.2 LCD before voting

The counters for Candidates one, two and three are still showing Zero and this is the reason why the total votes are also zero. When voting is in progress the total votes counter will increase in tandem with the votes being casted for the candidates.

4.2.2 LCD After voting

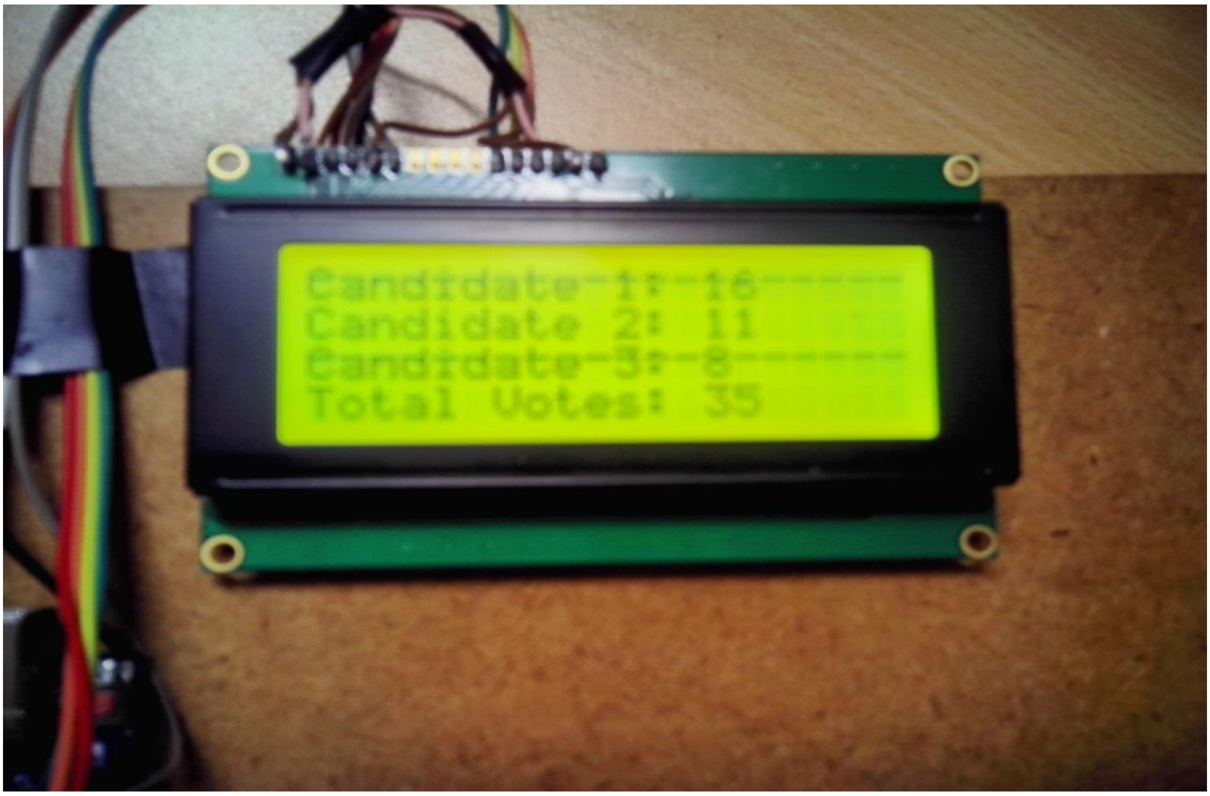


Figure 4.3 LCD after casting votes

As the voting goes on the total votes counter also increments one vote at a time in tandem with every vote being casted for any of the candidates. Voting is done using the buttons marked Candidate 1, 2 or 3. The presiding officer gives the permission to vote and the voter is unable to vote twice whilst in the voting booth. During or after voting the presiding officer can send the voting results to the monitoring center as texts via the GSM module.

At the monitoring center the voting results will appear as below

Results of Elections are as follows

Candidate ONE: 21; Candidate TWO: 12; Candidate THREE: 7; Total Number of Voters: 40

Received: 23:08

There will be a date and time stamp on the message. The mobile number that will have sent the message is also shown, this means polling stations can be identified by their Telephone numbers.

The frequency of sending the results can be a negotiated and agreed upon position amongst the interested stakeholders. It can also be in accordance to the laws of the country, organization, board or even the voters. As the system was being tested results were recorded and stored at the monitoring Centre in the way shown below

Duration(hrs)	**Candidate 1**	**Candidate 2**	**Candidate 3**	**Total number of votes**
1	15	20	8	43
2	22	31	14	67
3	28	33	17	88
4	37	35	29	101

Table 4.1 Hourly Election results

The last row to be recorded shows the final or current results because all the other preceding figures are included in the last row. The above table can also be represented as below

Duration (hrs)	1	2	3	4	5	6	7
Candidate 1	15	22	28	37			
Candidate 2	21	31	33	35			
Candidate 3	8	14	17	29			
Total number of votes	43	67	88	101			

Table 4.2 Hourly Election results

From the above results in tables 4.1 and 4.2 pie charts, bar graphs and ordinary graphs can be drawn for further analysis. These results can also be analyzed by Region or locality for future use.

REFERENCES

[1] https://www.reference .com/math/tabular-data-presentation (Accessed October 30 2016)

CHAPTER 5
CONCLUSIONS

5.1 Introduction

The main objective of this project was to construct a very simple low cost Electronic Voting System with a GSM module and this objective was achieved. This chapter looks at the conclusion and recommendations for this prototype project.

5.2 Recommendations

Electronic Voting System with a GSM module is the way to go because of the following reasons

(a) It is very simple and of low cost, thus it serves resources

(b) The GSM Technology is a widely used and mature Technology

(c) If properly implemented it leaves very little room for errors

(d) Precious time is also saved by using this EVM

(e) The EVM is scalable, thus it can meet future demands or workloads

(f) Modern Technologies are taking over in many spheres of life thus the EVM is a sure way of tracking technology.

5.3 Conclusion

The aims and objectives of the project were met in the developed prototype. The Saving of resources is now of paramount importance in any given economic setup and the Electronic Voting Machine is one sure way of saving resources be it in sports, education, social, politics and business. The EVM also builds voter confidence.

APPENDIX A

SOFTWARE CODE FOR THE SYSTEM

```
// include the library code:

#include <LiquidCrystal.h>


#define SENDTONUMBER   "+263774222134"


long int candidate1 = 0;

long int candidate2 = 0;

long int candidate3 = 0;

long int totalVotes = 0;


const int vote1Pin = 6;     // the number of the pushbutton pin

const int vote2Pin = 7;     // the number of the pushbutton pin

const int vote3Pin = 8;     // the number of the pushbutton pin

const int countAndSMSPin = 9;     // the number of the pushbutton pin

const int SensorPin = 10;     // sensor


int vote1PinState = 0;

int vote2PinState = 0;

int vote3PinState = 0;

int countAndSMSState = 0;

int SensorPinState = 0;
```

```
String mssg = "";

unsigned long debounceTime = 300;

const int ledPin =  13;      // the number of the LED pin to show if vote has been added to
candidate
bool voteEnableFlag = false;

// initialize the library with the numbers of the interface pins
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

void setup() {

    Serial.begin(9600);
    // set up the LCD's number of columns and rows:
  lcd.begin(20, 4);

  // put your setup code here, to run once:
 pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(vote1Pin, INPUT);
  pinMode(vote2Pin, INPUT);
  pinMode(vote3Pin, INPUT);
  pinMode(countAndSMSPin, INPUT);
```

```
   pinMode(SensorPin, INPUT);
}


void loop() {
  // put your main code here, to run repeatedly:
  vote1PinState = digitalRead(vote1Pin);
  vote2PinState = digitalRead(vote2Pin);
  vote3PinState = digitalRead(vote3Pin);
 countAndSMSState = digitalRead(countAndSMSPin);
 SensorPinState =  digitalRead(SensorPin);


totalVotes = candidate1 + candidate2 + candidate3;


  dispOnLCD();
if(SensorPinState == LOW){
  delay(debounceTime);


  voteEnableFlag = true;
  Serial.print("Vote Enable Flag = ");
  Serial.println(voteEnableFlag);
   }
  if(voteEnableFlag == true){
                    if (vote1PinState == HIGH) {
                 digitalWrite(ledPin, HIGH);// turn LED on:
```

```
    delay(debounceTime);



  candidate1++;

  delay(250);

  voteEnableFlag = false;

  digitalWrite(ledPin, LOW);


}

 if (vote2PinState == HIGH) {

  digitalWrite(ledPin, HIGH);// turn LED on:

    delay(debounceTime);


  candidate2++;

  delay(250);

  voteEnableFlag = false;

  digitalWrite(ledPin, LOW);


}

 if (vote3PinState == HIGH) {

  digitalWrite(ledPin, HIGH);// turn LED on:

    delay(debounceTime);


  candidate3++;
```

```
               delay(250);

               voteEnableFlag = false;

               digitalWrite(ledPin, LOW);


              }


         }

          if (countAndSMSState == HIGH) {

           digitalWrite(ledPin, HIGH);// turn LED on:

               delay(debounceTime);




           mssg = "Results of Elections are as follows\n";

           mssg += "Candidate ONE: ";

           mssg += String(candidate1);

           mssg += ";  Candidate TWO: ";

           mssg += String(candidate2);

           mssg += ";  Candidate THREE: ";

           mssg += String(candidate3);

           mssg += ";  Total Number Of Voters: ";

           mssg += String(totalVotes);




           sendSMS(mssg, SENDTONUMBER);
```

```
    delay(100);

    digitalWrite(ledPin, LOW);


  }



}


void sendSMS(String message, char mobile_number[14]) //function to send sms, takes message and phone number as arguments

{

 delay(1200);

Serial.print("AT");

delay(1200);

bool bOK = false;

while (Serial.available() > 0)

{

char inChar = (char)Serial.read();

bOK = true;

}


if(bOK)

{

int index = 0;

Serial.println();
Serial.println("AT+CMGF=1"); // sets the SMS mode to text

delay(100);

delay(1200);

bool bOK = false;

while (Serial.available() > 0) {

//Serial.write(Serial.read());

char inChar = (char)Serial.read();

bOK = true;

}

if(bOK)

{

Serial.println();

Serial.print("AT+CMGS=\""); // send the SMS number

Serial.print(mobile_number);

Serial.println("\"");

delay(1000);

Serial.print(message); // SMS body


delay(500);


Serial.write(0x1A);

Serial.write(0x0D);

Serial.write(0x0A);
}

}

}


void dispOnLCD(){


    // Print a message to the LCD.


  lcd.setCursor(0, 0);

  lcd.print("Candidate 1: ");

  lcd.setCursor(13, 0);

  lcd.print(candidate1);




  lcd.setCursor(0, 1);

  lcd.print("Candidate 2: ");

  lcd.setCursor(13, 1);

  lcd.print(candidate2);




  lcd.setCursor(0, 2);

  lcd.print("Candidate 3: ");

  lcd.setCursor(13, 2);

  lcd.print(candidate3);
  lcd.setCursor(0, 3);

  lcd.print("Total Votes: ");

  lcd.setCursor(13, 3);

  lcd.print(totalVotes);


  }


  void clrLCD(){

  delay(2000);

    lcd.begin(20, 4);

  // Print a message to the LCD.

lcd.print("                    ");

 lcd.setCursor(0,1);

 lcd.print("                    ");

 lcd.setCursor(0,2);

lcd.print("                    ");

 lcd.setCursor(0,3);

 lcd.print("                    ");


  }
```