

B.Sc. in Computer Science and Engineering Thesis

Development of an Online Mobile Voting System for Conducting an Election

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CANDIDATES' DECLARATION

This is to certify that the work presented in this thesis, titled, **“Development of an Online Mobile Voting System for Conducting an Election”**, is the outcome of the investigation and research carried out by me under the supervision of Mr. Abu Wasif.

It is also declared that neither this thesis nor any part thereof has been submitted elsewhere for the award of any degree, diploma or other qualifications.

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CERTIFICATION

This thesis titled, “**Development of an Online Mobile Voting System for Conducting an Election**”, submitted by me as mentioned below has been accepted as satisfactory in partial fulfillment of the requirements for the degree B.Sc. in Computer Science and Engineering in January 2020.

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ABSTRACT

An online mobile voting system has been developed, which may prove superior to the traditional voting system and the electronic voting machines. Here, the voters are registered with the Election Commission with their mobile phones, and on the day of voting, they cast their votes from their respective mobile phones by sending a voting SMS along with their national ID number, candidate code and password. It has been tested that the developed online mobile voting system performs its intended tasks successfully under the ideal conditions, where a voter does not make any mistake in writing the voting SMS. The developed voting system may be considered as the skeleton or the building block for developing any subsequent practical mobile voting applications. It has the advantages of being highly economic, less involving, safe, simple, and less time consuming, free from chaos, vandalism, fraud, corruption or any voting irregularity over the traditional voting system and the electronic voting machines.

Chapter 1

Introduction

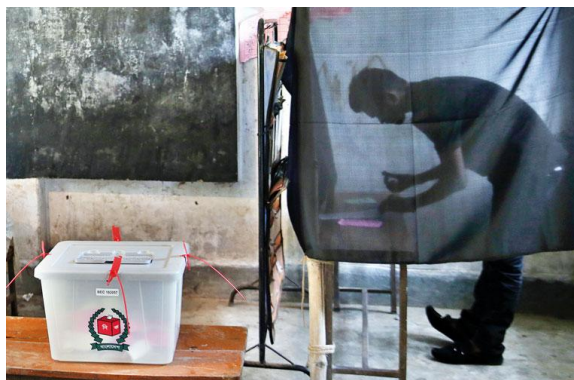
This chapter introduces us to the need for an election, which is used by almost all the democratic countries of the world for selecting their representatives from some local areas by the inhabitants of the locality. This chapter first describes the traditional voting systems, their limitations in brief and then it goes on to propose a new system, an online mobile voting system, which can eliminate all the major drawbacks of the traditional voting systems. This chapter also describes the motivation for the current work, the main objectives of the work, and finally, it enumerates the contents of the thesis.

1.1 The Traditional Voting Systems

An election is a way people can choose their candidate or their preferences in a representative democracy or other form of government. Most democratic countries hold new elections for their national legislature every few years. What elections do is, select representatives for the local areas. These are called MPs (members of parliament) in the British parliamentary system. Parliamentary systems may have a head of government and a head of state, but sometimes the two posts are held by the same person. The legislature chooses the government, usually by majority vote in the legislature. Some democracies elect a president, who then selects the government. Many democratic countries also have regional, provincial or state elections [1].

There are different ways to organize an election in different countries. Voters might vote for an individual, or they might vote for a political party. This is because different countries use different voting systems. Countries that are not democracies can also hold elections. This is usually done to let the people choose a local representative (like a Mayor).

It should be noted here that Bangladesh Election Commission is an independent authoritative body to conduct any national level election, like election for selecting the members of the parliament (MPs), Mayors of the city corporations etc. Fig. 1.1 shows two traditional election booths in two different election centers of Dhaka, Bangladesh.



(a) A male voter putting stamp on his chosen candidate's name/symbol in the private corner.



(b) A female voter putting her ballot paper into the ballot box (vote box), in front of the polling officer.

Fig. 1.1: The traditional election booth.

Here, a polling officer first verifies the identity of a voter with the voters register. Then he/she is given an official ballot paper. The voter takes it to the private area (inside a hung

curtain, refer to Fig. 1.1), where he/she puts a stamp on his/her chosen candidates name/symbol, folds the paper and puts it inside the ballot/vote box.

To simplify the traditional voting process, recently electronic voting machines (EVM) have been introduced by the Election Commission of Bangladesh [2]. There will be more than one candidates competing for each post. In this system, instead of ballot papers, the voters are given a simple electronic voting machine (EVM) with some keys to be pressed. For each post one EVM unit is provided. If there are 3 posts to be voted, 3 EVMs are kept in the private corners for selecting one person for each of the 3 posts. Fig.1.2 shows the EVM machines.



(a) Single EVM – voting for a single post



(b) 3 EVMs – voting for 3 posts

Fig.1.2: Electronic Voting Machines (EVM).

The names and symbols of the candidates are displayed on the display screen of the EVM, and by the side of each candidate, there is a white key. First, the voter selects his/her chosen candidate, by pressing the white key by the right hand side of the candidate's name and symbol. Then if he/she presses the green key at the bottom, the vote is cast.

It has some advantages over the traditional voting system. Here, the voters are identified first by matching the fingerprints with the national finger print database, which ensures the authenticity of the voter and then the EVM is made ready for casting a vote. However, it inherits the same disadvantages, which exist with the traditional voting system. These disadvantages are the results of malpractice by the supporters of the political parties.

1.2 Limitations of the Existing Voting Systems

The traditional voting system and the recently introduced electronic voting machines (EVM) are being used in Bangladesh. However, there are many complaints of irregularities against the traditional voting systems. In this system, people have to visit the election centers on the day of election and they have to stand in long queues, as shown in Fig. 1.3.

It has many other disadvantages, which are mainly related to the particular social contexts of Bangladesh. Fig. 1.4 shows pictorial examples of some of the voting irregularities. This issue is further discussed in Section 5.8 of Chapter 5.



(a) Male voters



(b) Female Voters

Fig. 1.3: Long queues in an election centre on the day of election.

(a) Ballot-boxes stolen and abandoned.



(b) Illegal vote casting.

Fig. 1.4: Examples of some voting irregularities.

1.3 Motivation for the Current Work

Elections keep a democratic country functioning, as they give people the right to select their own government. The former US President Abraham Lincoln defined democracy elegantly. According to him: “*Democracy is the government of the people, by the people, for the people*” [3]. The process of election plays a pivotal role in materializing democracy in a country or in selecting honest, sincere and righteous leadership. However, if the process of election is not free and fair, the selection by election does not work, and the country is deprived of the able- and good leadership. We know, if our leaders are not good, the government, and all its institutions will fail. Therefore, if we can eliminate the disadvantages and limitations of the existing voting systems, and can make the election/voting process free and fair, the whole process would be appreciated by every quarter.

In this thesis, we propose an online mobile voting system, where voters can cast their votes from their mobile phones. Now-a-days, almost every household in Bangladesh owns a mobile phone, even the maid-servants and the beggars own mobile phones and they are able to use it conveniently. If people can vote from their own place and if the authenticity can be ensured, it would be highly desirable by and acceptable to everyone. Some countries of the world are trying to implement this system for online mobile voting [4–5]. The proposed online mobile voting system would be a viable alternative to the existing voting systems, both traditional and EVM. This is why there is ample scope to develop the mobile voting system for conducting an election in our country. This may be used to conduct any election, be it a national level or a local government election or be it a government or private organization, institution or club etc.

It has been reported in the news media that, in the recent city corporation polls, voters belonging to some parties were not allowed by the musclemen to enter into the election centers for casting their votes. If that is the case, the proposed online mobile voting system

would be a possible solution for overcoming this sort of problems, where a voter can cast vote from his/her mobile phone by being at home or at work place.

1.4 Objectives of the Current Work

The objectives of the current research are as follows:

- (a) To develop a new online mobile voting system, where people would use it to select their leaders by voting from their mobile phones at home or at work place.
- (b) To ensure the authenticity and privacy of the voters.
- (c) To adopt all measures in the system to hold an economic, fair and peaceful election by avoiding chaos and anarchy, and
- (d) To make the election process free from all irregularities.

1.5 Contributions of the Thesis

An online mobile voting system has been developed successfully. At first, an algorithm for the basic steps in the voting process has been developed and implemented. In this process, the flow diagrams are drawn, followed by writing the codes in Java programming language. Appropriate hardware interface has been formulated and designed. Necessary codes were also built in this regard to achieve the serial communication. Routines are developed in JAVA programming language, which can successfully read the voting SMS from the SIM memory of the GSM modem, which are sent by the voters from their mobile phones, and can extract the vital information from the sent SMS. A colorful and relevant graphical user interface (GUI) has also been designed to run the developed online mobile voting applications package. Finally, its proper operation has been tested using real life casting of votes by the voters from their respective mobile phones.

1.6 Organization of the Thesis

The first chapter gives the introduction to the need for an election, the traditional and the recent EVM voting systems. Then it goes on to identify the disadvantages and limitations of the existing voting systems. It then proposes a new alternative, where the voters will cast their votes by using the mobile phones. Then Chapter 2 describes the proposed online mobile voting system. Chapter 3 goes on to describe the hardware and software setup for the online mobile voting system. The implementation of the online mobile voting system is described in Chapter 4. Chapter 5 describes the results of the development and includes discussions on the results. Conclusions are drawn in Chapter 6. This chapter also includes suggestions of some topics for future work on the online mobile voting system. The references are included next, followed by the Appendices at the end of this thesis, which includes the necessary installation guides for various hardware and software setups, and Java codes needed for the online mobile voting system.

Summary

This chapter has described what an election is, the need for an election, the traditional voting systems, their limitations, the motivations for and objectives of the current research and development. It has also described the topics of each chapter in the thesis. The next chapter will discuss the features of the proposed online mobile voting system.

Chapter 2

The Proposed Online Mobile Voting System

The traditional voting systems were discussed in Chapter 1 and a new online mobile voting system was proposed. This chapter will describe the features and requirements of the proposed online mobile voting system.

2.1 The Online Mobile Voting System

Fig. 2.1 depicts a generic voting system, where the basic requirements are highlighted.

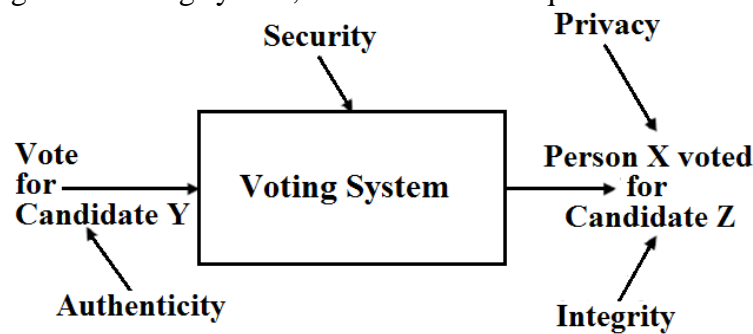


Fig. 2.1: A generic voting system.

Authentication: The voters list using the pre-stored mobile phone number and/or the pre-assigned password may be used for authentication.

The database file or the **Voters_List** table containing the **NID No.**, **Mobile Phone No.** and **password**, once finalized, will be closed and will be marked as a **read only** file. Provision should be kept in the developed software so that each voter may cast his/her vote only once, and the **first attempt** will be **accepted** and **no subsequent attempt** will be **entertained**.

Security: The voting SMS data from the mobile phones of the voters may be encrypted before transmitting the SMS for voting, and at the receiving end (that is at the Election Commission), the data will then be decrypted.

Privacy: For each post, voted information for all the candidates should be stored in a corresponding separate database file, where the information regarding the mobile number of the voters or the passwords will not be stored. Thus, no one could know who has voted for whom. This is how privacy will be ensured.

Validation: Appropriate validation scheme should be ensured by the logics set forth in the software so that no voter can vote for candidates other than that/those permitted as per the rules set forth.

When voting closes at the end of the scheduled time, the voted files should be automatically closed by the software. Integrity should be ensured by not allowing anyone to edit the candidates' voted tables and the result table.

2.2.3 Installation of Necessary Hardware Drivers and Software Packages for the Election Commission Server

The following tasks are to be accomplished sequentially for meeting the hardware and software requirements of the Election Commission Server (a Laptop/desktop PC).

1. Install **Windows 7/Windows 10** in the Laptop/PC to be used as the **EC Server**.
Next, we have to perform the following important **tasks** to **get** the **hardware working** and then move on to **develop** the **Mobile Voting Applications Software**.
2. **Install** driver for USB to TTL Converter (**CP210x/Here CP2102** for Windows **7** and **PL2303HXD/ PL2303HTA/Latest Converter** for Windows 10) after inserting it in an empty USB slot. Identify the COM port from **Device Manager** and **Ports (Com & LPT)** submenu.
3. **Install** the HyperTerminal/ Equivalent Software say, **RealTerm**, in PC. Then configure it as per the need of the USB to TTL converter.
4. **Test** the **Functionality** of the **Modem** by Performing the **Loopback Test**.
5. The next task is to **connect** the **GSM modem** with the USB to TTL converter. Connect the appropriate **DC power supply** to the **GSM Modem**. We use the **HyperTerminal/RealTerm** software and the **AT** (Attention) commands to communicate with the **GSM Modem**.
6. **Perform** the **Tests** on the **GSM Modem** by using **AT** Commands
7. **Insert** the SIM **01521253557** in the empty slot and request the voters to cast test votes by sending **SMS**.

Then using the HyperTerminal software, we read the **SMS** sent [9] and try to study its contents so that we can extract the vital information from the sent **SMS**, like the **National ID No.** of the voter, the **Mobile Phone No.** from which he/she has cast the vote, the **Candidate Code (CC)** who he/she has voted for, and also the **Time Stamp** as to when the vote was cast.

8. Next, we have to **throw AT commands** [10] from our **codes** to read and extract the **SMS** from the **SIM memory** of the **GSM modem**.

We shall be using the **Java programming language** for developing the online mobile voting system.

Summary

This chapter has described the features and requirements of the proposed online mobile voting system. The next chapter will discuss the hardware and software setup needed for implementing the online mobile voting system.

Chapter 3

Hardware and Software Setup for the Online Mobile Voting System

Chapter 2 described the main features of the proposed online mobile voting system and the necessary hardware and software requirements for its implementation. This chapter describes how the hardware and software are set up for the actual implementation of the online mobile voting system.

3.1 Hardware Setup

In this voting system, the voters will send their voting SMS to a specific mobile no. (in our case it is **01521253557**), the SIM of which will be inserted into the empty slot of a GSM modem. The modem needs a stable 5V DC power supply for its proper operation. On the day of the election, once the voting SMS reaches the SIM memory of the modem, it has to be quickly read by the online voting software package from the SIM memory. Next, the system will extract the vital information from the SMS for authentication and it will cast the vote in favor of the voter's chosen candidate. To make a connection of our server PC/Laptop with the GSM modem, we need to design a hardware interface. A modem uses TTL logic for its serial communication, but a PC does not have a serial port, it has a USB port. Therefore we need to insert a USB to TTL converter into the USB port of a Laptop/PC and make proper connection of its terminals to the corresponding GSM modem terminals. Fig. 3.1 shows how to connect the 5V DC adapter terminals to the GSM power supply input terminals.

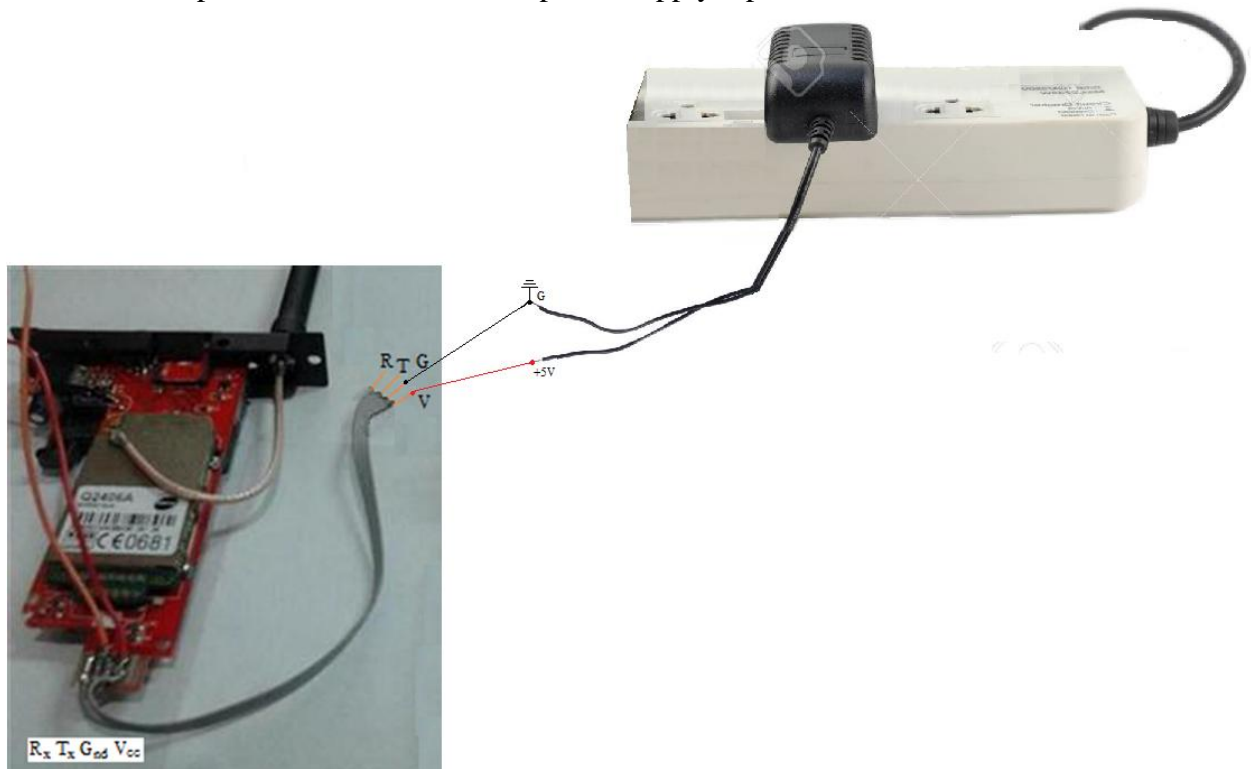


Fig. 3.1: GSM modem terminals and the 5V DC power supply (adapter) connection.

```

C:\Windows\system32\cmd.exe - mysql -h localhost -u saad -p
mysql> select * from modu;
+-----+-----+
| Cast_Name | Time_Stamp |
+-----+-----+
0 row in set (0.00 sec)
mysql>

```

Fig. 3.15: The “modu” table before vote casting.

```

C:\Windows\system32\cmd.exe - mysql -h localhost -u saad -p
mysql> select * from canv;
+-----+-----+
| Cast_Name | Time_Stamp |
+-----+-----+
0 row in set (0.00 sec)
mysql>

```

Fig. 3.16: The “canv” table before vote casting.

```

C:\Windows\system32\cmd.exe - mysql -h localhost -u saad -p
mysql> select * from result;
+-----+-----+-----+-----+-----+-----+-----+
| raam_res | sham_res | jodu_res | modu_res | vote_canc | tot_cast | comments |
+-----+-----+-----+-----+-----+-----+-----+
0 row in set (0.00 sec)
mysql>

```

Fig. 3.17: The “result” table before vote casting.

Summary

This chapter has described the hardware and software setups required for implementing the online mobile voting system. The next chapter will discuss the details of the actual implementation.

Chapter 4

Implementation of the Online Mobile Voting System

The previous chapter described the necessary hardware and software setups for implementing the online mobile voting system. This chapter goes on to elaborately describe the software codes required, their development using Java programming language and its actual functioning according to the flow diagrams designed. It also discusses how the voting information, received in the GSM modem from the voters, are read and the vital information like National ID No., Mobile Phone No., candidate code (CC), password etc. are extracted, followed by the actual casting of votes in favor of the candidates.

4.1 Flow Diagrams of the Developed JAVA Classes

The following java classes are needed to implement the whole process.

ECDhakaMenu.java	To invoke ECDhakaFrame.java class to display the menu buttons as shown in Fig. 2.3. It will be used as the Main class .
ECDhakaFrame.java	To include the buttons and call for the specific execution codes corresponding to the click on a button .
CANDFrame.java	To display the Pictures and Short Descriptions of the Candidates .
DispVLFrame.java	To display the Voters List in a Tabular Form .
SMSReader.java	To initiate reading sms from the memory of the GSM modem through the Receiver.java file to collect voted information and voter information validation.
Receiver.java	To receive the sms initiated by the SMSReader.java , then read all the other sms , cast vote, and store results.
CalcVoteStat.java	To compute the vote counts, validate with the result table and produce relevant statistics for the candidates .
ResultFrame.java	To display the result and the picture of the winning candidate in this frame.
ResultSetTableModel.java	To obtain the info. from the database table by sending Query using the JDBC connector.
SerialParameters.java	To set the parameters of the serial communication ports in JAVA. ©
SerialConnection.java	To establish communication with the serial port in JAVA. ©
SerialConnectionException.java	To catch the exceptions thrown by the SerialConnection.java. ©

Out of the above **12** java classes, codes for the first **9** classes have been written by myself from the scratch, and the last **3** of the classes were taken from codes developed by Sun Microsystems [16], © 1998; which has provided royalty free license to use.

The overall flow pattern or the functional connectivity of each class is shown in Fig. 4.1.

The command in DOS mode for updating the specific columns of the individual Voter's table is as follows:

```
INSERT INTO raam VALUES ('raam', sTS );
```

where sTS is a string variable that has stored the time stamp=19:18:57

However, to execute the above command from Java codes is a bit tricky. The following two methods of writing a statement are possible in the JAVA codes before updating a candidate's table:

First Method : Writing statement and executeUpdate
Second Method : Writing Prepared Statement and executeUpdate

Example of the First Method: Writing a statement and then using executeUpdate

```
insraam = "INSERT INTO raam VALUES ('raam', ' "+ sTS + " ' )";
raamCount = stmt.executeUpdate(insraam);
```

Example of the Second Method: Writing a Prepared Statement and then using executeUpdate

```
PreparedStatement prep = connection.prepareStatement (INSERT INTO raam (Cast_Name,
Time_Stamp) VALUES (?, ?));
// Set values for corresponding variables
prep.setString(1, 'raam');
prep.setString(2, sTS);
// Now execute the update process
prep.executeUpdate();
```

Summary

This chapter has described the final implementation of the online mobile voting system by writing JAVA codes. The next chapter illustrates the results and makes fruitful discussions on the findings.

Chapter 5

Results and Discussions

The previous chapter described as to how the online mobile voting system was developed and executed by writing JAVA codes. This chapter will show the results by actually running the application using real life SMS votes cast by 12 different voters from 12 different mobile phones. This chapter also compares the advantages and disadvantages of the proposed online mobile voting system with the traditional ones.

5.1 GUI Design and the 5 Menu Bars

A background picture has been designed for displaying the menu bars on, which is shown in Fig. 5.1.



Fig. 5.1: A background picture designed to show the menu bars on.

The 5 menu bars are then displayed on the background picture for performing the specific tasks by clicking on the menu bar. The 5 menu bars are shown in Fig. 5.2 on the next page.

5.2 Display Voters List

If the authoritative person likes to have a look at the main database file or table, which is the **Voters_List** table in the **EC_Dhaka** database, he/she has to click on the “**Display Voters List**” menu bar. When clicked on the said menu bar, it displays the Voters_List table on the screen. This is shown in Fig. 5.3 on the next page.



Fig. 5.35: In manual vote counting cheating is possible if the polling agents of some parties are not allowed in.

On the contrary, in a mobile voting system, the votes will be counted and the results will be processed by the developed software packages by computers. Therefore, **almost instantaneous counting of votes** is possible and **no counting errors** and **cheating** will take place.

Electronic voting machines are a better option compared to the traditional voting system. However, in case of a finger print mismatch, a voter cannot cast his/her vote in this system. The mismatch of finger print may occur for the workers, day laborers or those who have substantial involvement in the kitchen and use their hands frequently. Although technically it is not possible for casting illegal votes in EVMs, still there are reports that voters were deprived from entering into the election centers in the recently held city corporation polls on 30 January, 2020. In the developed online mobile voting system, as the voters do not have to go to the election center, this may be one of the best possible and a viable alternative to the traditional voting systems and the electronic voting machines. In the proposed system, a voter can cast vote from his/her mobile phone by being at home or at work place.

Summary

This chapter has described the results of the final implementation of the online mobile voting system by executing the codes. It has been found that under the ideal conditions, the system functions its intended tasks properly, without any error. It has also pointed out the major drawbacks of the traditional voting systems, including the EVMs, and highlighted the advantages of the proposed online mobile voting system over the traditional ones. The next chapter draws conclusions of the findings and offers some suggestions for future work.

Chapter 6

Conclusions and Suggestions for Future Work

The previous chapter discussed the results obtained from the developed online mobile voting system. This chapter concludes the findings on the developed online mobile voting system, and highlights its major advantages over the traditional voting systems. It also suggests for some work to be carried out in future as an extension to the existing work.

6.1 Conclusions

I shall next draw the major conclusions on what I could achieve in designing the Online mobile voting system and highlight some of its advantages over the traditional voting system and the electronic voting machines (EVM).

6.1.1 Major Conclusions

The following are the conclusions of my research and current development on the online mobile voting System.

A basic online mobile voting system has been developed successfully. At first, the necessary algorithms are developed, then the flow diagrams are drawn, followed by writing the codes in Java programming language and finally its proper operation has been tested using real life casting of votes by the voters from their mobile phones.

An algorithm for the basic steps in the voting process has been developed and implemented.

After receiving an SMS from a voter in the SIM memory of the GSM modem, the following algorithm or strategy is followed:

No matching National ID: Simply ignores the vote and deletes the read SMS.

Matching NID No. but no Matching Mob. No.: Vote is cancelled and SMS is deleted.

Matching NID No. and Mob. No, but Wrong candidate code (CC): Vote is cancelled and SMS is deleted.

Appropriate hardware interface has been formulated and designed. Necessary codes were also built in this regard to achieve the serial communication.

A colorful and relevant graphical user interface (GUI) has also been designed to run the developed online mobile voting applications package.

Out of the needed **12** java classes, codes for **9** classes have been written by myself from the scratch, and **3** of the classes were taken from codes developed by Sun Microsystems, © 1998; which has provided royalty free license to use.

6.2.4 Modification of the Algorithm for Realistic/Practical Voting Applications

We have tested the developed software routines without using the password in the voting SMS. Inclusion of password is also necessary to guarantee the authenticity of a voter. The algorithm and the developed software routines should be modified accordingly to incorporate the 6-digit password.

The Election Commission should send the password to each voter by post and/or by sending SMS. It may also send the password by SMS from a Message Casting Server, well ahead of the election-day. Also, any other changes have to be incorporated in the developed routine as per the requirements of conducting a particular election.

6.2.5 Performance Evaluation of the Developed Mobile Voting System

Rigorous tests have to be carried out on the developed mobile voting system, before the actual deployment of this system in practical use.

Real-life scenario may not allow us to obtain various types of voting mistakes for testing purposes, and it is not also possible to obtain a huge number of SMS data from a huge number of valid voters. However, as we know what the correct format of the SMS would be after reading it from the SIM memory of the GSM modem, we can fabricate such data in a huge volume by writing them in a database file and then reading the message by a slightly modified “Receiver.java” class. Instead of reading the actual SMS from the GSM modem, this modified “Receiver.java” class will read those data from the database file (which contains the fabricated votes) and then cast the votes on a usual manner.

That way, the test can be simulated for a huge number of artificial, but realistic votes.

6.2.6 Inclusion of Data Encryption and Decryption Option

As the time was limited for the undergraduate project, the data encryption and decryption option was not incorporated. This option can also be implemented as a future work.

6.2.7 Result Seeking from the Mobile Phones from the Election Commission Server

The option for result seeking from the mobile phones by sending SMS was not implemented. Therefore, arrangement can be made so that result(s) may be known from the finally processed database file by sending SMS Query to the Message Casting server from any mobile phone using a predefined command in the SMS text.

6.2.8 Database for Practical Applications of the Mobile Voting System

It should be noted here that for **actual voting**, **Oracle database** shall be used instead of MySQL.

Summary

This chapter has described the conclusions and suggestions for the list of work that may be carried out in future. References are included next, followed by the Appendices, which include the necessary hardware and software installation guides and JAVA codes.

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Appendices

Appendix A–1: Installation Guide for Necessary Hardware Setup

Installing Driver file for the USB to RS232 TTL Converter Module (Model No. CP2102x)

Before we install the driver file, we should go to the **Device Manager** from the **Control Panel (/System)** folder of the Laptop/PC. Then if we expand the category '**Ports**', it will show all the ports currently connected to the PC/computer. However, in our laptop, as there was no ports connected to it, it did not show the **Ports** category on the list of devices (refer to Fig. A1.1 below).

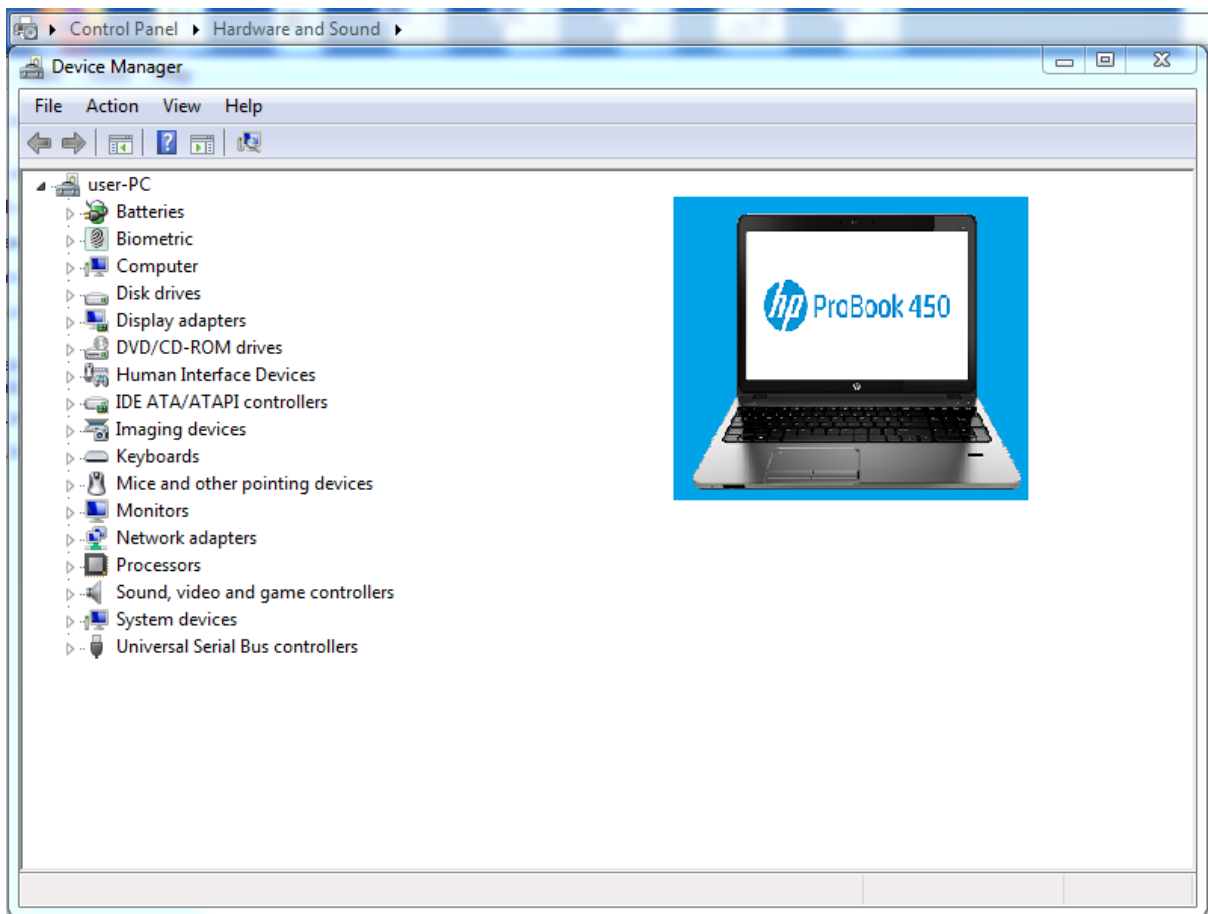


Fig. A1.1: The port is not shown on the list of devices under the Device Manager sub-folder.

First, we have to download the appropriate driver file from the Internet and copy the driver file in a directory in the hard disk. Then we connect the CP2102 converter module to one of the USB ports of the PC. If connected properly, a red LED will lit up. If not, we have to fix it by properly placing the converter module with the USB slot of the PC. If inserted properly, the PC will ask for the device driver. We should **cancel** the request and go to the directory where the device driver was copied. We then **install the driver file** by double-clicking on the setup file and then follow the subsequent steps.

Once the driver file is installed and the **USB to RS232 TTL Converter Module** is connected to a USB port, we again go to the **Device Manager** from the **Control Panel (/System)** folder. Then we expand the category '**Ports**', it will show all the ports connected to the computer.

Appendix A–2: Installation Guides for Necessary Software

Steps for Installation of Various Software Packages for the Election Commission Server

1. Install Windows 7/Windows 10 in the laptop.
2. Install driver for USB to TTL Converter (**CP210x**/Here **CP2102** for Windows 7 and **PL2303HxD**/ **PL2303HTA**/ for Windows 10) after inserting it in an empty USB slot. Identify the COM port from **Device Manager** and **Ports (Com & LPT)** submenu.
3. Install HyperTerminal/Realterm software in PC. Then configure it as per the need of the USB to TTL converter.
4. Connect the USB to TTL converter, open HyperTerminal/RealTerm. Short circuit the RxTx terminals of the USB to TTL converter using suitable means (Jumper Wire or Connector).
5. Do the loop-back test to see if it works.
6. The next task is to connect the GSM modem with the USB to TTL converter. Connect the appropriate DC power supply to the GSM Modem. Use the HyperTerminal/RealTerm software and use AT (Attention) commands to communicate with the GSM Modem.

The following AT commands may be used:

AT
AT+

7. Finally, we have to throw appropriate AT commands from JAVA codes to the GSM modem to read the received SMS as the voters cast their votes, that reaches the modem as an SMS. Mobile Number for the GSM Modem used is: **01521253557**.

How to Install/Copy the Serial Communication Files in Java

In the Java Codes, the following files are to be installed or copied to specific locations to achieve serial communication in JAVA.

At first, collect the appropriate serial communications Java Library files: **comm.jar**, **javax.comm.properties** and **win32com.dll** from the Internet [17] and then insert into appropriate directories to achieve serial communication in Java programming.

- (a) Copy **comm.jar** to **C:\Program Files\Java\jdk1.6.0_11\lib** directory and also to **C:\Program Files\Java\jdk1.6.0_11\jre\lib\ext** directory
- (b) Copy **win32com.dll** to **C:\Program Files\Java\jdk1.6.0_11\bin** directory, to **C:\Program Files\Java\jdk1.6.0_11\jre\bin** directory and to **C:\Windows\System32** directory
- (c) Copy **javax.comm.properties** to **C:\Program Files\Java\jdk1.6.0_11\lib** and also to **C:\Program Files\Java\jdk1.6.0_11\jre\lib** directory.

However, all the above files were placed in our Laptop in the sub-directories of: **C:\Program Files (x86)\ ...** directory instead of the **C:\Program Files\ ...** directory.

Appendix A–3: Java Codes for Achieving Serial Communication

A-3.1: SerialConnection.java

```

package javaapplication2;
import javax.comm.*;
import java.io.*;
import java.awt.TextArea;
import java.awt.event.*;
import java.util.TooManyListenersException;

/**
A class that handles the details of a serial connection. Reads from one
TextArea and writes to a second TextArea.
Holds the state of the connection.
*/
public class SerialConnection implements SerialPortEventListener,
                                   CommPortOwnershipListener {
//    private SerialDemo parent;

/*    private TextArea messageAreaOut;
    private TextArea messageAreaIn;
    */

    private SerialParameters parameters;
    private OutputStream os;
    private InputStream is;
    private KeyHandler keyHandler;

    private CommPortIdentifier portId;
    private SerialPort sPort;

    private boolean open;

    private String receptionString="";

    public String getIncommingString(){
        byte[] bVal= receptionString.getBytes();
        // System.out.print("Content is:"+ new String (bVal));// saif added for test
        receptionString="";
        return new String (bVal);
    }

/**
Creates a SerialConnection object and initilizes variables passed in
as params.

@param parent A SerialDemo object.
@param parameters A SerialParameters object.
@param messageAreaOut The TextArea that messages that are to be sent out
of the serial port are entered into.

```