Design and Construction of Enhanced Microcontroller Based Electronic Voting Machine with Digital Display

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Abstract: **This research is justified on the basis of the purpose and importance of voting in democratic dispensation and ways to improve voting process. Enhanced microcontroller based conference electronic voting machine with digital display will ensure a more reliable and efficient way of voting, eradicate rigging, make available vote results at the shortest possible time, eliminate error while counting the votes, maximize the use of computers in the electoral process, save cost and transport of large volumes of electoral materials. Its use will minimize expenditure; eliminate problems associated with the electoral and voting process. It is also eco friendly. The Electronic Voting Machine (EVM) consists of a control unit (CU) and ballot unit (BU), both units are working independently and in collaboration with each other as well. The CU accepts password in voting mode and responds accordingly. When the power of the control unit is turned on, the CU reads the status of the machine from the EPROM into the accumulator. On the basis of the status read from accumulator the CU goes into either the voting mode or the result mode. In voting mode, CU communicates with BU in order to exchange various signals. CU counts the votes for individual candidate and total number of votes cast can be checked at anytime.**

Keywords: **Democracy, Microcontroller, Electronic Voting Machine.**

I.   INTRODUCTION

Democracy has come to be accepted as the most preferred form of political system all over the world. However, the success of a democratic structure is to be judged by the successes that can be solely attributed to this system. There are various challenges facing democracy. These are foundational challenges, challenge of expansion and deepening of democratic principles. All of these are dependent on how the democracy is perceived by people who form the government, participate in formation of government and are benefited by it (9).

Democracy is perceived to be charismatic as it accommodates cultural, regional, economic, social disparities (7). Nigeria follows a federal form of government. It means that governance power is not residing with one authority, but is distributed at various levels. In Nigeria power is distributed between States and Federal government. Nigerian constitution provides every adult above the age of 18 years irrespective of his/her religion, region, caste, creed, color, economic status, education and sex the essential right to vote and elect her/his candidate to represent her/him. Hence voting can be termed as backbone of not just democracy in Nigeria but all around the world. Voting can be done in various ways. In early Roman Empire, voting used to be done by raising hands in favor or against. In board rooms voting is done in similar way, some write their vote down, some choose to speak, some choose to cast vote using latest technology(10).

Voting Techniques:

Elections be it state elections or federal elections, a voter casts his/her vote to his/her favorite candidate by putting the stamp against his/her name and then folding the ballot paper as per a prescribed method before putting it in the Ballot box. This is a long, time-consuming process and very much prone to errors (5, 7). This method wanted voters to be skilled voters to know how to put a stamp, and methodical folding of ballot paper. Millions of paper would be printed and heavy ballot boxes would be loaded and unloaded to and from ballot office to polling station. All this continued till election scene was completely changed by electronic voting machine (4, 6). No more ballot paper, ballot boxes, stamping, etc. all this condensed into a simple box called ballot unit of the electronic voting machine.

The marking system of voting was introduced in 1962 to make it possible for a substantial number of illiterate voters to indicate easily their preferences in choosing their representatives. Over the years, there was a pronounced increase in the volume of work: Scores of ballot papers had to be printed and locks of ballot boxes had to be prepared, transported, and kept in storage; and a great amount of time was taken up by the conduct of elections (8, 9). To overcome these difficulties an electronic voting machine should be introduced (2, 6, 10).

II. METHODOLOGY

Existing System:

Existing electronic voting machine has its disadvantages. These areas of deficiency are not much of a concern to a layman, but for an intelligent voter this must be eliminated for a secure election (1, 3). The few technical disadvantages are given as:

- Microprocessor based design, which requires a no. of supporting components like memory, peripheral interface, etc.

- No security against illegal viewing of results, as presiding officer can view the results without any difficulty.

- Less user friendly due to two seven segment displays

Proposed System:

All these faults motivated us to make this new enhanced EVM. The faults which are eliminated are summarized as follows:

- Microcontroller replaced microprocessor, which made the EVM closer to real time operation making it faster, more reliable and unique.

- Password protection is provided to save data from being accessed by unauthorized personnel. Presiding officer can only conduct voting process, doesn't have any access over results.

- More user friendly and interactive LCD display

General Working:

1. When power of control unit is turned on, the CU reads the status of the machine from the EPROM into the accumulator.

2. On the basis of the status read from accumulator the CU goes into one of the two modes

(A) Voting mode.

(B) Result mode.

3. Let us assume that machine enters the voting mode.

(A)Voting Mode:

  i. Now the LCD displays "VOTING MODE STARTING….." .

 ii. After a few seconds LCD displays "ENTER PASSWORD SIX CHARACTER LONG"

iii. Now the 6-character password needs to be entered through "hexadecimal keypad".

 iv. As the user presses the first key,   LCD displays "*   ".

As the user presses the second key, LCD displays "**   ".

As the user presses the third key,   LCD displays "***   ".

As the user presses the fourth key,   LCD displays "****   ".

As the user presses the fifth key,   LCD displays "***** "

As the user presses the sixth key,   LCD displays "******".

    v.   After that when complete password is entered into the RAM of CU, it is compared with the actual password stored in the ROM memory of CU.

   vi.   If the password is correct, LCD displays "PASSWORD ACCEPTED PROCEED AHEAD".

  vii.   If the password is wrong, LCD displays "WRONG PASSWORD", After that CU moves to step ii again.

 viii.   In case of correct password, after step vi, the status LED on the CU glows to indicate the new vote.

   ix.   Machine waits for the "Ballot Button" to be pressed. As soon as the ballet button is pressed, the CU sends a low "READY SIGNAL" is made "HIGH".

    x.   Now the CU waits for the four-bit code from ballot unit. On the basis of this code, the memory location where the selected candidate's vote count is stored, is accessed and count is incremented. Simultaneously total count is also incremented.

   xi.   After that, CU sends a LOW "vote signal" to ballot unit to turn on vote cast LED and generate buzzer beep, after sometime, "vote signal" is made HIGH.

  xii.   Then program control goes to step viii.

 xiii.   After the voting is complete, i.e. the last voter has cast his/her vote or in case of booth capture, the "CLOSE" button is pressed.

(B) Result Mode:

    i.   Now the LCD displays "RESULT MODE STRARTING…..".

   ii.   After a few seconds LCD displays "ENTER PASSWORD SIX CHARACTER LONG"

  iii.   Now the 6-character password needs to be entered through "hexadecimal keypad".

  iv.   As the user presses the first key,   LCD displays "*   ".

As the user presses the second key, LCD displays "**   ".

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   vi.   If the password is correct, LCD displays "PASSWORD ACCEPTED PROCEED AHEAD".

  vii.   If the password is wrong, LCD displays "WRONG PASSWORD", After that CU moves to step ii again.

 viii.   The LCD displays "CANDIDATE #1 VOTES : _____".

   ix.   Now it waits for the result button to be pressed, the result of next candidate is displayed.

    x.   Step ix is repeated to get result of all the candidates.

TOTAL (Interrupt controlled button):

1. Whenever, the "TOTAL" button is pressed, an interrupt is generated and an Interrupt service routine is called.

2. This ISR retrieves the total vote count from EEPROM and displays it on the LCD.

CLOSE (Interrupt Controlled Button):

1. Whenever the "CLOSE" button is pressed, an interrupt is generated and an ISR is called.

2. The value of status is written in EEPROM to make the machine enter into the result mode, when the machine is powered on next time.
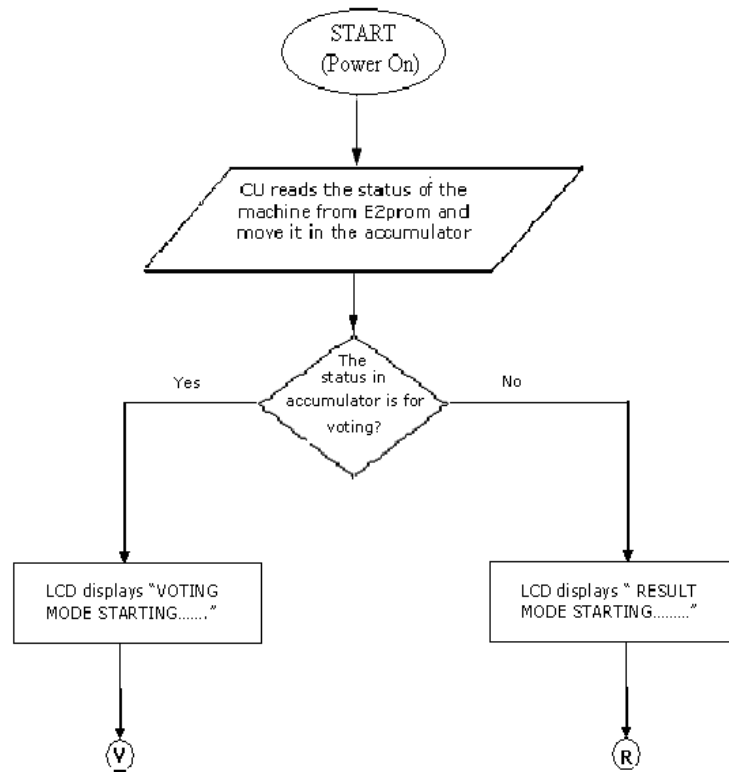
3. The machine goes in "POWER DOWN" mode.

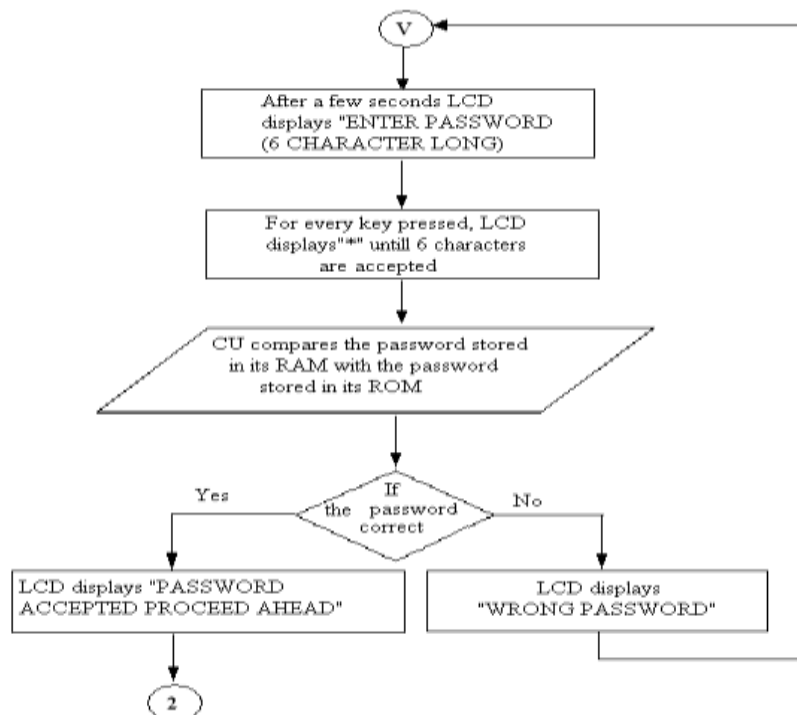**Figure 1: Flowchart to demonstrate program flow/ working of control unit**
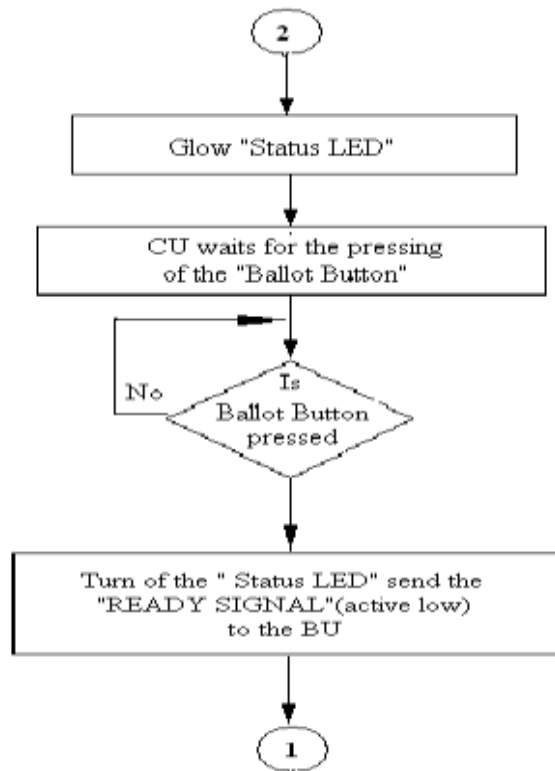

Figure 2 (contd.)…..

Figure 3 (contd.)…..
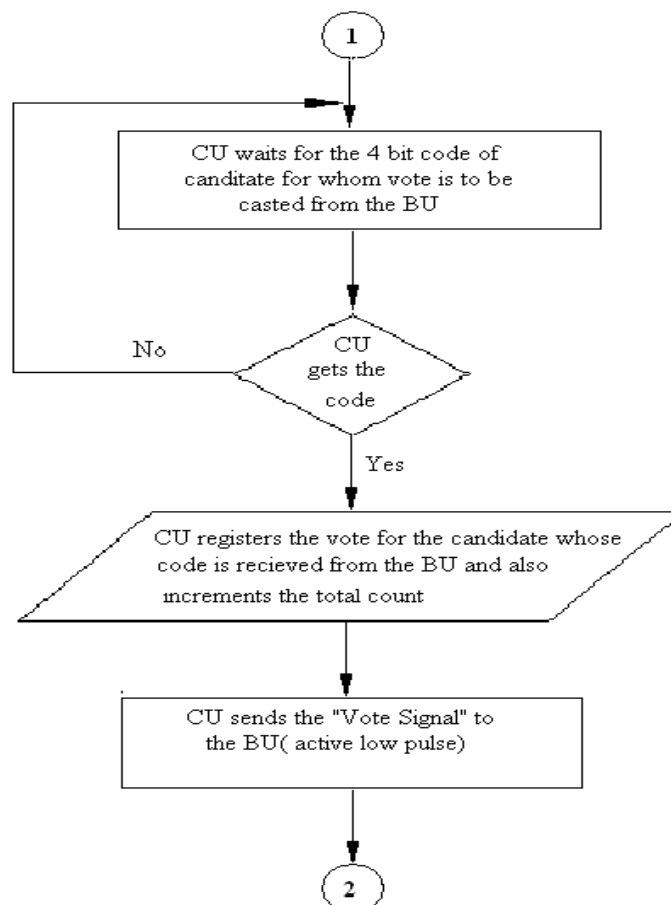
Figure 4 (contd.)…..
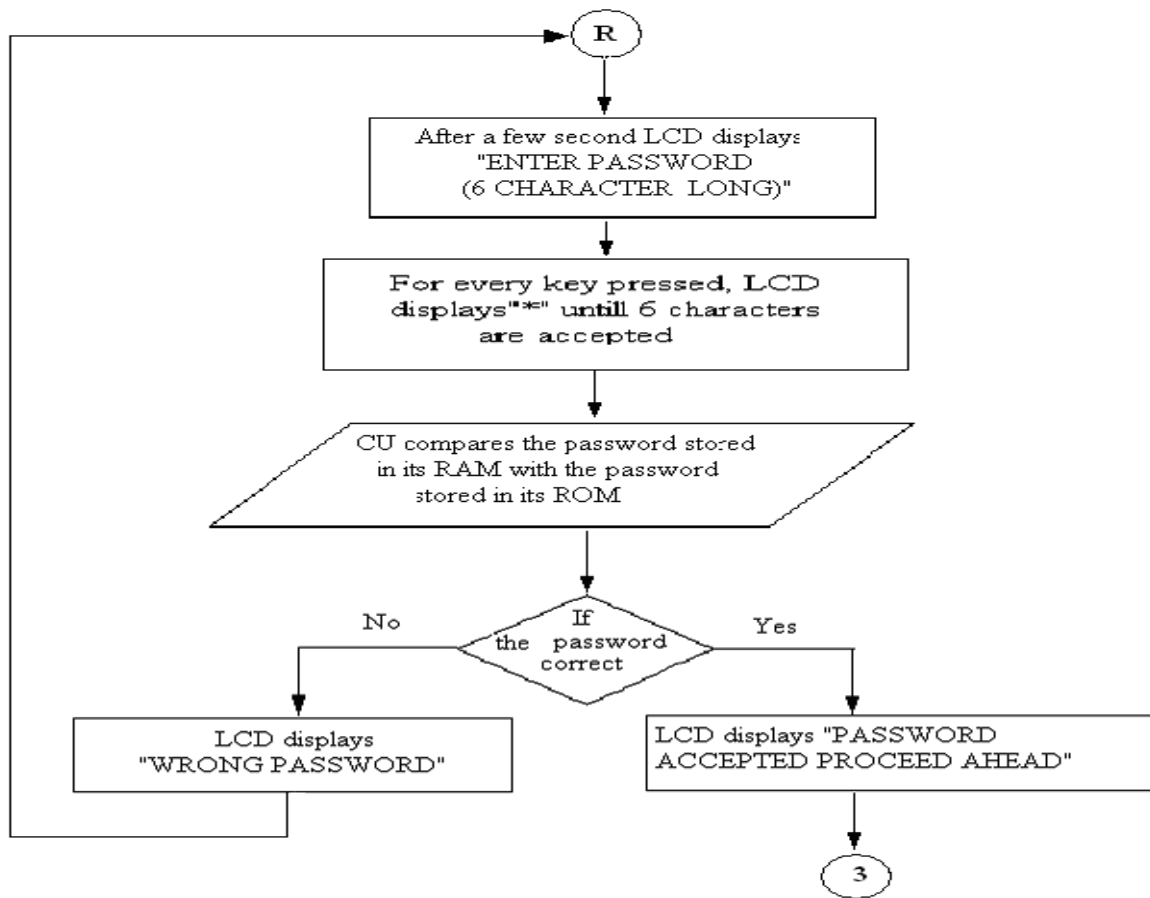
Figure 5 (contd.)…..
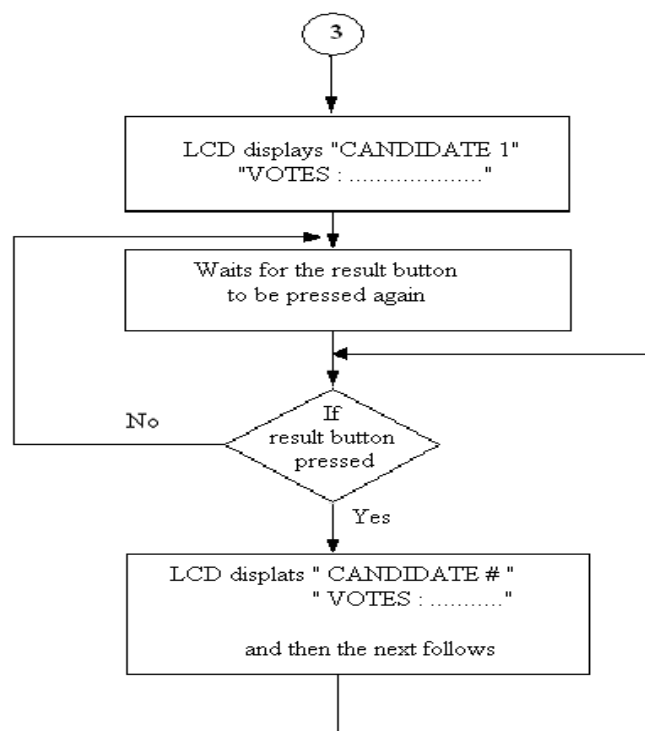
Figure 6 (contd.)…..

Total Button:

START

LCD displays "TOTAL NO OF"
"VOTES : ...."

Return program from where
it was interrupted

Close Button:

START

The status is written into EEPROM
to enter into result mode

CU goes into power down mode

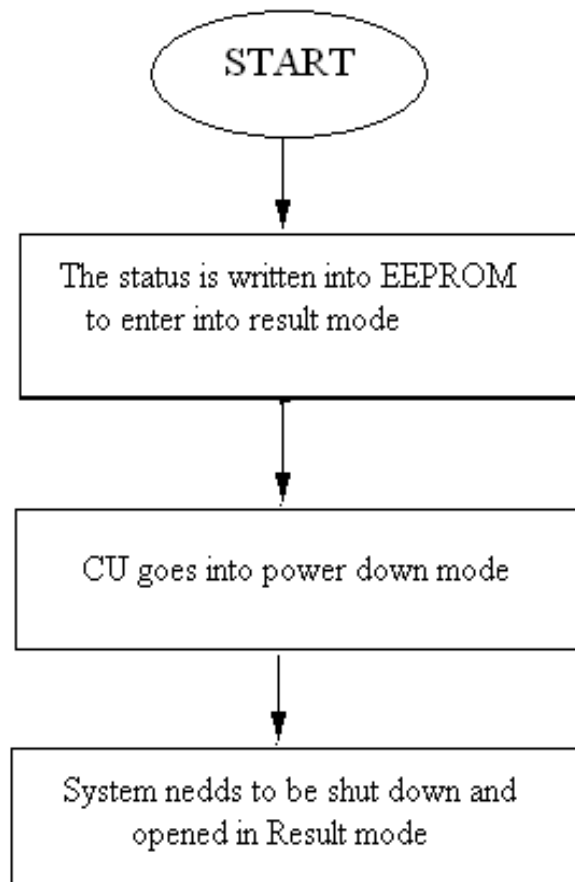System nedds to be shut down and
opened in Result mode
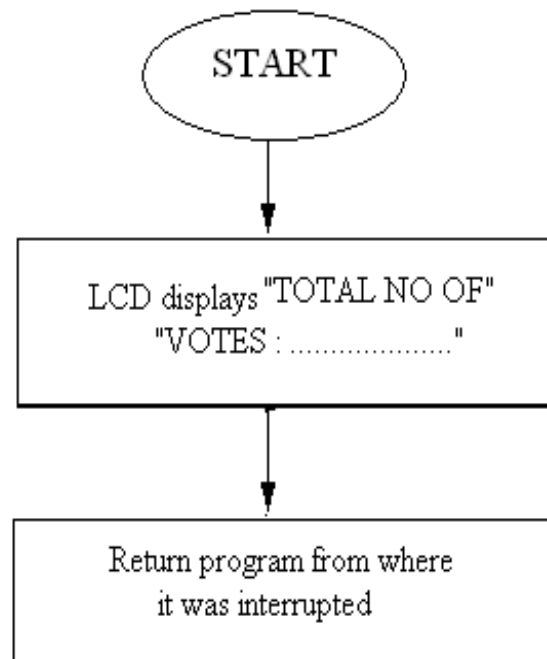
Figure 7 (contd.).....

III. IMPLEMENTATION

Microcontroller Code Development:

The code development is very much the same as for any computer. The microcontroller software development is based around a programming environment which will normally include:

- A text editor to develop the source program code

- An *Assembler* to produce a machine executable program with linked library modules

- Some form of debugging to allow the program to be tested

- Access to a programmer to program the target device.

- The job of the *Assembler* is to convert the *source code* produced by the programmer into an *object code file*. It works by replacing each line of assembly instruction code with the corresponding machine code instruction that will be executed on the target microcontroller.

The *object code file* cannot be executed on the target microcontroller. It needs to be passed through a program called a Linker.

The job of the *Linker* is to take the *object file* produced by the Assembler and link it with standard library modules (that have already been pre-assembled into object files) to produce a complete working *executable file* that can be loaded into the memory of the microcontroller.

Sometimes the *Assembler* and *Linker* are combined into one program so that assembling a source program automatically links it as well. This is the case with the 8051 Assembler.

Figure 8, below, shows the different stages in the production of a program. Note that the only stage that requires a lot of user input is the initial production of the user source code file. The rest of the program production involves using the Assembler and Linker tools.

- 'Filename' is the name of the program that the user is developing, thus the output of the Editor is the source file 'filename.asm'.

- The output of the Assembler is the object file 'filename.obj'.

- The Linker links the 'filename.obj' with any Library object files that the program might use. It will also link any user object files that the user might want to include.

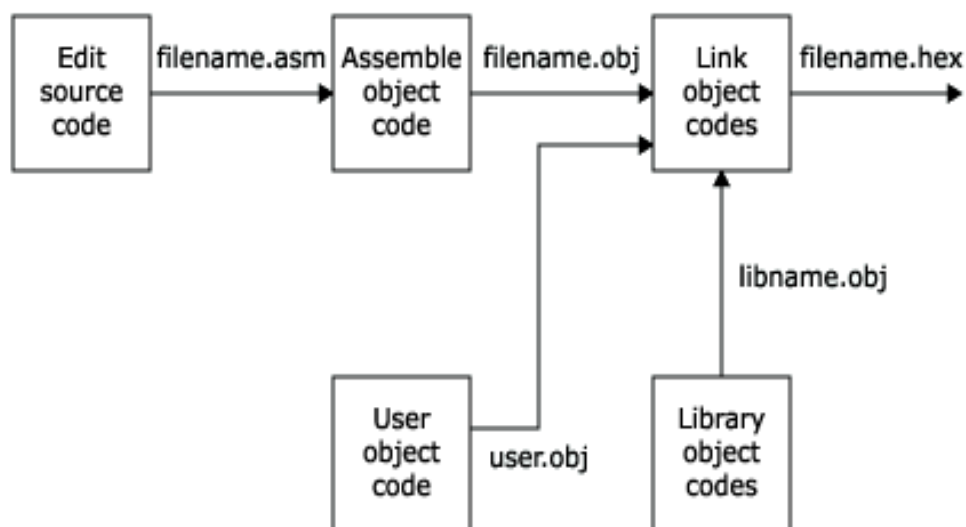- The Linker output is the executable file to run on the target system.

Fig 8: Stages in the Production of the Program

A program called a Loader or a microcontroller programmer takes your executable hex file from the hard disk and loads it onto the target microcontroller.

Using the Electronic Voting Machine:

1. When power of control unit is turned on, the CU reads the status of the machine from the EPROM into the accumulator.

2. On the basis of the status read from accumulator the CU goes into one of the two modes

(A) Voting mode.

(B) Result mode.

3. Let us assume that machine enters the voting mode.

(A) Voting Mode:

xiv.   Now the LCD displays "VOTING MODE STARTING…..".

xv.   After a few seconds LCD displays "ENTER PASSWORD

(SIX CHARACTER LONG)"

xvi.   Now the 6-character password needs to be entered through "hexadecimal keypad".

xvii.   As the user presses the first key,   LCD displays "*   ".

As the user presses the second key, LCD displays "**   ".

As the user presses the third key,   LCD displays "***   ".

As the user presses the fourth key,   LCD displays "****   ".

As the user presses the fifth key,   LCD displays "*****   "

As the user presses the sixth key,   LCD displays "******".

xviii.   After that when complete password is entered into the RAM of CU, it is compared with the actual password stored in the ROM memory of CU.

xix.   If the password is correct, LCD displays "PASSWORD ACCEPTED

PROCEED AHEAD……".

xx.   If the password is wrong, LCD displays "WRONG PASSWORD", after that CU moves to step ii again.

xxi.   The "status LED" on the CU glows to indicate it is ready for polling procedure.

xxii.   Machine waits for the "Ballot Button" to be pressed. As soon as the ballet button is pressed, the CU sends a "READY SIGNAL" which is active low.

xxiii.   Now the CU waits for the four-bit code from ballot unit.

xxiv.   After getting "READY SIGNAL", ballot unit glows its "MACHINE READY LED" indicating that the machine is ready to accept a new vote from its candidate panel.

xxv.   Once the voter presses the button corresponding to the candidate of her/his choice, a four-bit code is generated and sent to the control unit.

xxvi.   "MACHINE READY LED" is turned off by the ballot unit after Accepting the vote and the ballot unit waits for the "vote signal" to become low from control unit,

xxvii.   On the basis of the code received by the CU, the memory location where the selected candidate's vote count is stored is accessed and count is incremented. Simultaneously total count is also incremented.

xxviii.   After that, CU sends a LOW "vote signal" to ballot unit to turn on "VOTE CAST LED" and generate buzzer beep, after sometime, "vote signal" is made HIGH.

xxix. After "VOTE SIGNAL" goes low, the ballet unit glows the "VOTE CAST LED" on the vote cast panel for the corresponding candidate whose vote is being cast.

xxx. At this time, the buzzer also generates a beep sound. This indicates to the voter that her/his vote has been processed.

xxxi. Then program control goes to step viii.

xxxii. After the voting is complete, i.e. the last voter has cast his/her vote or in case of booth capture, the "CLOSE" button is pressed.

CLOSE:

(Interrupt Controlled Button)

1. Whenever the "CLOSE" button is pressed, an interrupt is generated and an ISR is called.

2. The value of status is written in EEPROM to make the machine enter into the result mode, when the machine is powered on next time.

3. The machine goes on "POWER DOWN" mode.

TOTAL:

(Interrupt controlled button):

1. Whenever, the "TOTAL" button is pressed, an interrupt is generated and an Interrupt service routine is called.

2. This ISR retrieves the total vote count from EEPROM and displays it on the LCD.

(B) Result Mode:

xi. Now the LCD displays "RESULT MODE STRARTING…..".

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xix. Now it waits for the result button to be pressed, the result of next candidate is displayed.

xx. Step ix is repeated to get result of all the candidates.

IV.   CONCLUSION

The EVM consists of a control unit (CU) and ballot unit (BU), both units are working independently and in collaboration with each other as well. The CU accepts password in voting mode and responds accordingly. In voting mode, CU communicates with BU in order to exchange various signals. CU counts the votes for individual candidate (8 in number) and total number of votes cast can be checked at anytime. In case of booth capture, the machine can be sealed in such a way that, when powered again, it automatically opens in result mode.

In result mode, the CU is again following the same password detection routine as in case of voting mode. In result mode, the CU displays the votes of individual candidate, in consecutive order, whenever the "Result Button" is pressed. The total number of votes can be checked in result mode in the same way as in voting mode.

In total, the complete system (including all the hardware components and software routines) is working as per the initial specifications and requirements of the research. Because of the creative nature of the design, and due to lack of time, some features could not be fine-tuned and are not working properly. So certain aspects of the system can be modified as operational experience is gained with it. As the users work with the system, they develop various new ideas for the development and enhancement of the research.

REFERENCES

[1] Balzarotti, D., G. Banks, et al. (2010). "An experience in testing the security of real-world electronic voting systems." Software Engineering, IEEE Transactions on 36(4): 453-473.

[2] Chaum, D. (2003). Untraceable Electronic Mail, Return Addresses and Digital Pseudonyms. Secure Electronic Voting, Springer: 211-219.

[3] Keller, A. M., A. Dechert, et al. (2005). A PC-based open-source voting machine with an accessible voter-verifiable paper ballot. Proceedings of the annual conference on USENIX Annual Technical Conference, USENIX Association.

[4] Kohno, T., A. Stubblefield, et al. (2004). Analysis of an electronic voting system. Security and Privacy, 2004. Proceedings. 2004 IEEE Symposium on, IEEE.

[5] Kumar, D. A. and T. U. S. Begum (2011). "A Novel design of Electronic Voting System Using Fingerprint." International Journal Of Innovative Technology & Creative Engineering 1(1): 12-19.

[6] McClure, N. and K. Lohry (2001). Electronic voting system, Google Patents.

[7] Mercuri, R. (2002). "A better ballot box?" Spectrum, IEEE 39(10): 46-50.

[8] Proebstel, E., S. Riddle, et al. (2007). An analysis of the Hart Intercivic DAU eSlate. Proceedings of the USENIX Workshop on Accurate Electronic Voting Technology, USENIX Association.

[9] Qadah, G. Z. and R. Taha (2007). "Electronic voting systems: Requirements, design, and implementation." Computer Standards & Interfaces 29(3): 376-386.

[10] Villafiorita, A., K. Weldemariam, et al. (2009). "Development, formal verification, and evaluation of an E-voting system with VVPAT." Information Forensics and Security, IEEE Transactions on 4(4): 651-661.