Design of Electronic Voting System for Visually Impaired Persons Using Arduino Mega 2560

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Abstract

People with visual impairment, even if they are availed to voting, they do not have the privilege to vote confidentially, because of their physical disability. Therefore, a user-friendly and confidential voting system is necessary for visually impaired people. In this paper, we build anelectronic voting system for visually impaired people is a user-friendly device which can help those group of people vote independently with sound. The system is built on an Arduino Mega 2560 microcontroller board, a SD card module, an LCD module, several buttons, a buzzer, GSM SIM 900A and a headset. The system has a special voice feature stored in SD card to familiarize them with names of candidates. Also, the voice is passed through a headset for secrecy. In addition, a control unit of the system for polling officials is designed separately from a voting unit for the smooth election procedural. Once user votes, a buzzer is turned on and the system cannot accept the voting. If a control button is pushed, the buzzer is turned offand the system accepts voting. This mechanism is to avoid double voting. A result button is implemented to display final votes for each candidate and store them in the SD card. GSM SIM900A is interfaced with Arduino Mega 2560 to disseminate final results. We can encourage mass participation equally in democracy through the system electronic voting system.

Key words – *electronic voting, visually impaired people, Arduino Mega 2560, headset,SD card, GSM*

Introduction

The concept of liberal democracy has proven to be the best ruling form of government in the world. It is based on that promise of ensuring everyone with right to choose our own leaders upholding the fundamental values of human rights, liberty and freedom of expression. The active participation in election could greatly determine the systematic organization of the society. For this, general public from every walks of life should be encouraged through mass awareness programs to be part of procedural. The election system should be robust to avoid unethical and variety of fraudulent behaviours.

An election is a public group decision-making process by which a population chooses an individual to hold official position in the legislature and for regional and local government. InBhutan, the first election to the National Assembly of Bhutan was held in 2008 (Dalrymple, 2008) . In general, voters choose by marking a ballot or write the names of their candidates ona ballot in a jurisdiction using a paper system.

In general, the right to vote through the secret ballot is given to every individual in the democratic world. However, such privilege is not there for those eligible visually impaired voters to vote in secrecy as they were escorted to the polling booth by their family members, trusted friends and even by the polling officials. Disabled Persons' Association of Bhutan (DPAB) called on Election Commission of Bhutan (ECB) to come up with an alternative votingsystem, but nothing had change till now (Dargay, 2018). The seeking of guidance to vote without secrecy is a matter of concern on their humanitarian ground.

According to DPAB's annual report on Data Registration of People with Disability in Bhutan2015-2016, there are 1238 people living with some kind of visual impairment, of which 51.90% consist of male and 48.10% consist of female. If one vote could make a difference, we would get to appreciate the difference this large number of 1328 is going to make.

Thus, we developed an electronic voting system with secrecy for visually impaired people. Thesystem is composed of an Arduino Mega board, a SD card module, an I2C LCD module, twelvebuttons, a buzzer, a speaker and a headset. Visually impaired people can identify

candidates with voice stored in the SD card by pressing a replay button allocated for each candidate. Then, the voice is passed through a headset for secrecy. Once they vote by pushing a ballot button, a buzzer is turned on and the system cannot accept the voting. If a control button is pushed by anelection inspector, the buzzer is turned off and the system can accept voting again. This mechanism is to avoid double voting. A result button is implemented to display final votes foreach candidate and store them in the SD card. The system can accommodate maximum of fivecandidates. The proposed system will guide them to vote independently and confidentially byaccessing audio feature embedded which will read out names of the candidate.

Literature Review

According to the news from Times of India, during the Lok Shaba elections in India 2019, visually impaired voters are provided with braille voter slips (The Times of India, 2019). The braille enabled voting facility encouraged them to vote independently. But we have another issue to be looked upon for those illiterate ones.

The visually impaired people in Israeli went to polls without assistance for the first time to vote independently using visual aid attached to the side of the spectral frame. This unique system iscalled MyEye developed by OrCam and its artificial vision can read ballot printed with candidate's name (Leichman, 2019). For our country where technology is still paving its way,this method is too hi-tech and with our potentiality and ability we can build our own which canmake a great difference in their lives.

System Architecture

Figure 1 is a block diagram executing the overall schematic representation of "Electronic Voting System for Visually Impaired People" with Arduino Mega board as the main component. The main component of the system i.e., Arduino Mega is interfaced with various components like a GSM SIM 900A module, a SD card module, buttons, a buzzer and a headset.The system comprises of two parts mainly to e mphasis swift procedural of election and for discreet and fair election.

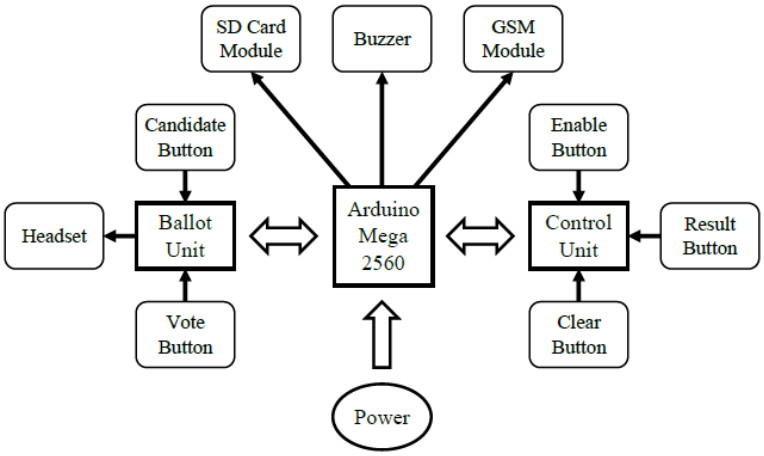

Fig 1 Block Diagram

The system comprises of two parts mainly to emphasis swift procedural of election and for discreet and fair election ballot unit houses audio and ballot buttons. This unit is meticulously designed for the friendly usage owing to the special facility required for them. Each candidate is designated with individual compartments to avoid identity misinterpretation of candidates. By pressing the audio buttons, voters can read out names of the candidates privately passed through the headset. The voters can independently cast their ballot upon his desired choice simply by pressing the ballot button aligned next to the audio button.

Control Unit

The control unit is solely for the handy usage of the controller or polling officials. It remotely controls the ballot unit farther encouraging

independent voting for voters. All the buttons for enabling the ballot unit for voters, erasing memories from SD card to reset the system and result button to display the final result on LCD are fixed on this unit. It also houses main modules like Arduino and GSM SIM 900A. The *result* and *reset* buttons are sealed with durable shutterto avoid consequences in case of unethical misconduct. The GSM module can send final result through SMS to concerned authorities for the final dissemination of result. Through the control of this unit, the system becomes robust enough to withstand fraudulent behaviours.

Circuit Design

The Arduino Mega 2560 board is adopted as a microcontroller board, because it has a wide array of I/O devices and its programming language is easy (Elprocus, n.d.).

Both the Arduino board and the SD card module have SPI (Serial Peripheral Interface). The SPI bus is composed of four logic signals: MISO (Master In Slave Out), MOSI (Master Out Slave In), SCK (Serial Clock) and CS (Slave Select). These signals are located in pins 50, 51, 52 and 53, respectively on the Arduino Mega 2560 board. Therefore, the SD card module is connected to these pins on the Arduino board.

The I2C LCD module is adopted as a display, because its interface with the Arduino board is simpler than that of a standard LCD module. Only two pins of the I2C LCD: SDA (Serial Data) and SCL (Serial Clock) are connected to analogue input pins A20 and A21 on the Arduino board.

Twenty-three pins connected with the push buttons are configured as inputs with the internal pull-ups on the Arduino Mega board. Thus, the input pin is in a LOW state when the push button is pushed. On the other hand, the input is HIGH when the push button is released.

Finally, the buzzer and the speaker are simple digital output devices same as LED. Therefore, the digital output pins on Arduino Mega 2560 are connected to the input pins of the buzzer and the speaker.

The above-mentioned circuit design is done on Proteus Design Suite

8.1. Figure 2 shows the system circuit designed by Proteus Design Suite 8.1.

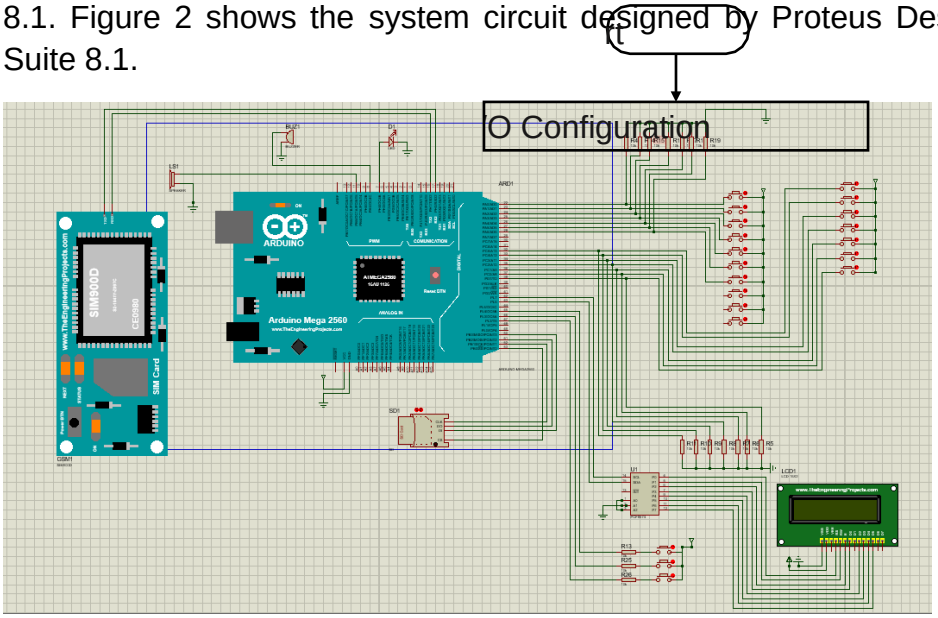

Fig.2 Circuit diagram.

Software Development

The Arduino IDE (Integrated Development Environment) is used as main tool in this design of electronic voting system for all programming and compilation. Figure 3 shows a flowchartfor the code.

After I/O configuration, first the program confirms one of the replay buttons is pushed or not.If one of the replay buttons is pushed, the corresponding candidate name is replayed with the headset speaker. Next, the program confirms one of the vote buttons is pushed or not. If one of the vote buttons is pushed, the number of votes to the corresponding candidate is incremented. Then the buzzer is on until the control button is pushed. Finally, the program confirms the result button is pushed or not. If the result button is pushed, the number of votesto each candidate is displayed on the I2C LCD and stored on the SD card. Otherwise, the process returns back to the confirmation of the reply buttons.

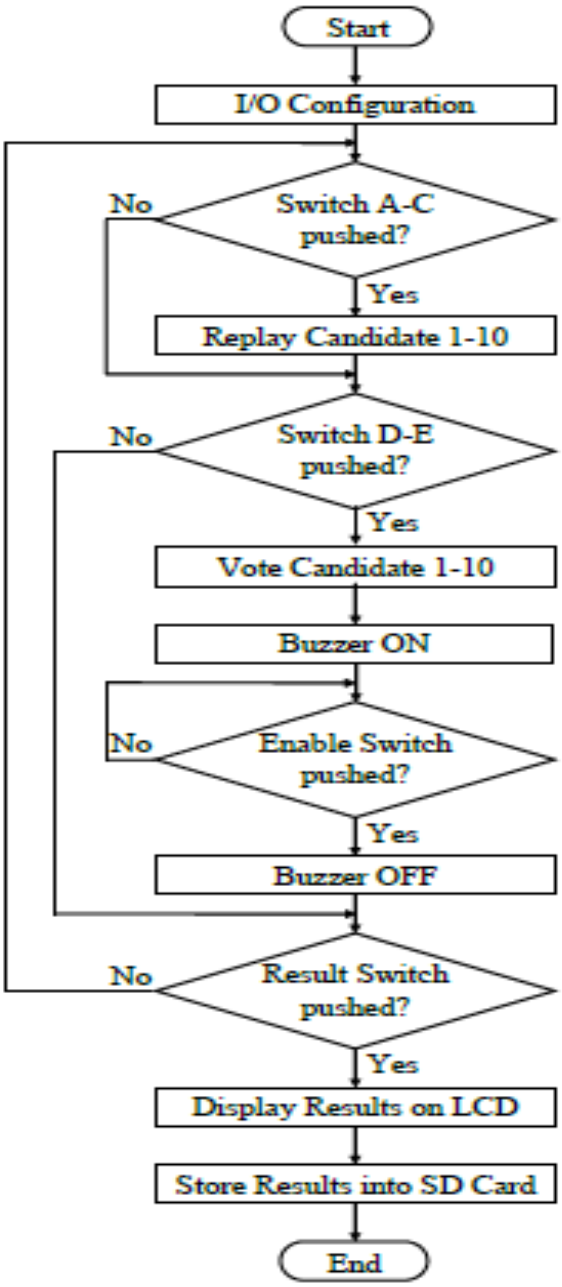

Fig.3 Flowchart for the program code.

Prototyping

In order to test each component, audio files are necessary to read out names of the candidates. We generate audio files as .WAV audio format by the use of an online audio converter, where samples per second is 16 kHz, channel is set to mono and the sampling rate is 8 bits.

After doing final testing of components, designing and fabrication of the electronic voting system is done. Testing and demonstrations of the electronic voting system are carried out after the fabrication to match the expected outcome outline. Figures 4 and 5 show the outlook of our developed system. The control unit controls ballot unit remotely.

Fig.4 Control unit.

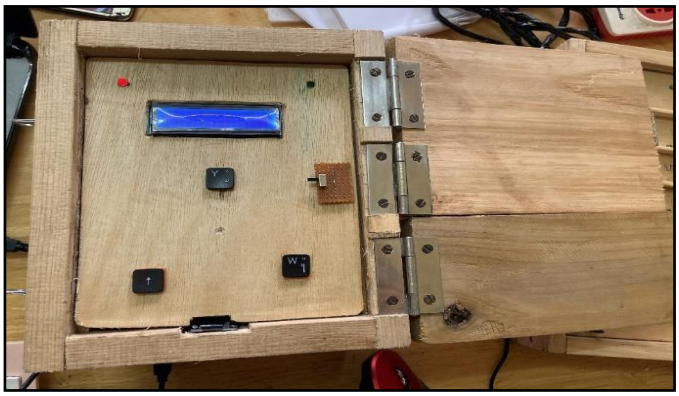

Fig.5 Ballot unit.

Output

The total number of votes for all candidates can be displayed serially on the I2C LCD by pressing the result button sealed inside the ballot unit. The winner of the election is declared. Figure 6 shows the final result displayed on I2C LCD.

Also, the results are sent via SMS (Short Message Service) using GSM SIM 900A module. They are received by three registered cellular mobile numbers of concerned authorities from Election Commission. Figure 7 shows the message received.

Fig.6 Results.

Fig. 7 SMS received by registered number.

Critical Analysis

The system is powered by the AC power adapter that converts the incoming AC current to DCcurrent. It can be alternatively powered with 9V rechargeable battery in case of power shut down and operations in far-flung areas without electricity line.

The total current required including all the components interfaced in the system sums up to 103mA and the capacity of 9V battery is 500 mAh. Thus, the time to last up by 9V battery is

$$\frac{\text{capacity of the battery}}{\text{Current drawn by interfaced devices}} = \frac{500\ mAh}{103\ mA} = 4.8\ hours \qquad (1)$$

We can power GSM SIM900A separately by another 9V battery because it has higher power consumption. It requires current of 400 mA.

The main drawback is that the buzzer must be turned off by an election inspector manually andthere is a delay in GSM module due to requirement of stable mobile network.

Conclusion

By using the Arduino Mega 2560 board, we developed a prototype of a secured, convenient and economic electronic voting system for visually impaired people. Then, we confirmed the system was working well. In the near future, we will extend the system to an IoT (Internet of Things) platform. Namely final votes for each candidate will be stored in a database server through the Internet.

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