Modernizing & Developing a Secure Electing System Using Fingerprint, NFC ID card Combination, Voice Aids and Instant Counting System

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Abstract— Voting had always been a guaranteed right for all citizens to choose their representative to speak up by their needs and demands. Thus, many gadgets were invented to facilitate and secure voting process; to make sure to provide the citizen with a transparent & fair elections; fraud and manipulation as free as possible. The proposed system introduces elections with affordable cost, less time consuming, resources saving and reliable results announcement with the least possibility of fraud, manipulation, rigging and human interference. Due to modernization of everyday life that included voting machines, some developments had to be done to secure electing results and providing easy to use system for the voters; by replacing smart chips in ID cards with NFC (near field communication) to benefit from NFC advantages & use it instead of multiple every day's life cards and providing voice aids to guide the voter during the process.

Keywords—Voting, ID cards, NFC, Fingerprint, GPRS, Voice aids, Arduino.

I.   INTRODUCTION

Technology had become a major partner in almost every field of life, including the replacement of traditional methods of voting; to provide the community and the country with fraud & manipulation free elections; passing through multiple stages of manual counting & recounting processes that require cost for manpower fees, printing of non-recycled paper ballots, waste of time in long queues and delay in results announcement in first round and run offs. Many systems and devices were invented before to cooperate in reducing voting problems; which were majorly the fraud, manipulation, rigging, vote exploitation, cost of use, manufacture and maintenance, delay in results announcement, long queues and traffic jams. From secret ballots to punched cards to lever machines to optical mark sense to mail voting to computerized microvote to DRE to fingerprint access devices and I-Voting as in [1] & [2]. Besides having some advantages they shared multiple deficiency problems as in [3].

II.   RELATED WORK

A. Previous Systems

As voting had been a guaranteed right for each citizen in most of the countries, some renovations were made to conquer manipulation and other factors that affects electing results. That's why voting methods through machines and devices were invented and made; Starting from lever machine to DRE and EVM which are systems used nowadays. And here are some previously used systems

1)   Lever machines

They were in a shape of a metal box; with a handle to activate voting process and to save the vote, it also contained number of levers corresponding to the number of candidates, and to choose the wished candidate you have to move the corresponding lever to his name and move the main handle back to the left as in [1]. It was later renovated to have two types: AVM and Shoup voting machine as in [2].

- Advantages: timesaving, easy to be used, privacy and secrecy for voter and over-voting protection as in [3].
- Disadvantages: complexity and costly in maintaining and transporting, unavailability of hardware and spare parts ,in-ability of re-counting of individual ballots, reason for long queues ,complexity in detecting and fixing failures and rigging and manipulation can be caused by technicians who are responsible to fix and maintain it as in [3].

2)   Punched cards

Developed by IBM and still used by some countries as in [3].each candidate is labelled by a number in a separate printed paper ballot as a reference, Voter choose the wished candidate and know its number in the list to punch in the square corresponding to his number or data as in [2] ,[3].

- Advantages: easy to be used, re-checking availability, shorter queues and less time consuming as in [3].
- Disadvantages: no over-voting protection, hanging chad problems, no printed names caused confusion to some people, higher fraud possibility, difficulties in counting and recounting and in some cases more ballots were needed as in [2].

3)   Optical mark sense machine

A machine that scans the marking of a pen to record a vote from the ballot paper as in[1]; voter chooses his wished candidate by colouring the corresponding square to his name as in [2].

- Advantages: individual vote recording, easy recognition and identification of candidates' names, easy to use ballots, time saving, over-voting protection and no long queues as in [2] , [4].
- Disadvantages: sensitivity to some pens and pencils types, some kinds were huge machines which faced difficulties in transportation, difficulties in counting and recounting if the mark wasn't clear and confusion in reading ballots with smudges as in [2] ,[4].

4)   Paper Ballot

This system it was widely used specially in Egypt to cast votes between candidates. The vote signs behind his wishes candidate. It has two types of paper ballot, secret ballot and printed ballot. Also it has two systems to follow, ranking ballot and first-past-to-post as in [1].

- Advantages: it is an easy and traditional way to vote, it gives the ability for recounting and no limited number of voters in one polling station as in [1] , [2].
- Disadvantages: extra human interference which facilitate manipulation and fraud. Also it facilitates void votes, wasted time and consumed man power as in [2].

5)   I-Voting

I-Voting Refers to Internet Voting system which based on a website determined by a government with high database and server; the voters vote via this website according to own username and password as in [5]. This system was widely used in Estonia.

- Advantages: easy to use, the voter can submit his vote from anywhere and it is not necessary to stick to limited time as in [5].
- Disadvantages: anyone can exploit your vote. The administrator can check the voter's name, ID number, phone number and his choice so; there is no secrecy as in [5].

6)   Smart Cards

The voter submits his vote b swiping his smart card on the machine and chooses his wishes candidate from a list as in [6].

- Advantages: it is easy to use and faster than other systems. On the other side it also saves time and man power while sorting, assorting, counting and recounting process as in [6].
- Disadvantages: anyone can exploit your vote which facilitates fraud because anyone can make a copy of this card and use it as in [6].

III.   PROPOSED ALGORITHM

A. Design Components

- Optical fingerprint sensor
- 7" TFT capacitive touch LCD
- Database
- NFC sensor (scanner)
- NFC ID card
- Buzzer
- Voice aid
- Main microcontroller : Arduino Mega ATmega 2560 R3
- GPRS shield

B. Description of proposed algorithm

The main aim is developing a secure, easy to use, affordable and least human interference possibility; for achieving as reliable as possible elections and results. Combining NFC serial and fingerprint as a dual method of identification verification; to make sure that no vote will be exploited and to save the voter's right; also replacing the smart chip card in the ID card with NFC to replace multiple cards by one ID card to be used in many processes in everyday life to be used in health insurance issues, voting, billing, ticketing, attendance, transporting, transit, membership, etc….In case of losses it'll require one call to de-activate all the processes ; also it won't require except one time to extract and pay for; the difference in cost will be noticed in countries with lower currency value than US dollar; which will find it more affordable; as some countries hadn't inserted smart chips in IDs' yet due to some cost problems; so NFC will make a great solution.

TABLE I NFC & SMART CHIPS COMPARISON

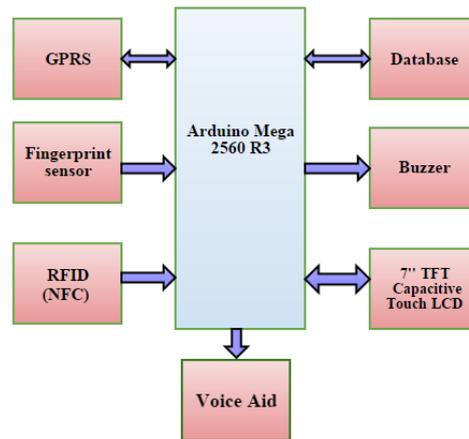|	NFC	Smart Chips
EEPROM	512 bit to 64Kbit	4K-16K
CPU speed	13.56 MHz	3.5-5 MHz
Data Exchange Rate	106 ,212,or 424 Kbits/s	9600bps (~ 1K/s)
Operating Distance	Up to 10 cm	Direct contact to reader
Cost	0.025 $	0.5 $

C. Block Diagram & Specifications

Fig.1 Block Diagram of proposed system

1) Micro-Controller

The main microcontroller is Arduino Mega ATmega 2560 R3

Which is used because it offers suitable features that benefits the proposed system; having: Flash memory of 256 KB, SRAM of 8KB , EEPROM of 4KB, Sufficient number of I/O digital and analogue 54/15 , 4 UART to convert from series to parallel and vice versa , ICSP to add devices without need to add aprogrammable chip, CPU speed of 16 MHZ and Sufficient operating voltage of 5 V or 7-12 V; to operate the touch screen properly and clearly as in [7].

2) Optical fingerprint sensor module for Arduino

It provides accurate scanning for fingerprint, to prevent rigging and make sure to save each vote from being exploited. Through having characteristics of : small size, low power consumption, simple ports, high reliability, small fingerprint template, UART communication port, optical total reflection fingerprint sensor, work volt: DC 3.3V,work current: <100mA ,work temperature: -10 ℃- 60 ℃,work humidity: 20%− 80%and Dimensions: SM12:58*23*22mm as in [8].

3) 7" TFT capacitive touch LCD

To display the candidates list for the voter to choose from and confirm his choice easily ;with characteristics :65K color , 800 x 400 Resolutions ,write images/icons to flash memory via SD card, SSD1963 Controller, Supports 16bit data interface ,4 wires control interface ,40 pins interface and The interface includes LCD bus, SD card bus Touch screen bus and Flash bus as in [9].

4) LCD TFT Arduino Mega Shield

For higher data transmission and saving time, effort and space from using many cables and plugs. And can be used as avoltage regulator for the 7" TFT capacitive touch LCD in our system case; module of 40pin version LCD due to using 7" LCD as in [10].

5) Buzzer

Which beeps when the voter's scanned information don't match the saved ones or the voter is un-qualified to vote; and in cases of trying to unplug the device from power supply or disassemble any part or components.

6) Database

This contains all the built information of combined fingerprint and NFC serial for every ID card; to compare the scanned ones to the saved ones and give the permission of access verification or denial according to rules and regulation of each system; that is located in the main station or center.

7) Voice Aid

Simple circuit to produce sound aids during the voting process to guide the voter and to decrease the human interference to its least; Supports 4 Message segments of fixed duration. Each segment can be controlled by Arduino, The default message duration is 32 second, but can be increased up to 60 seconds, Non-volatile Flash memory technology, No battery backup required, User-friendly, easy-to-use operation for recording and play, Low Power consumption, Operating current: 25 mA, standby current: 1uA, Sample rate and message duration can be changed by replacing a single resistor and Equipped with 0.5 W speaker for playing recorded messages as in [11].There are another components can replace DF Player Mini but we choose this because of low price and simplified output speaker and push buttons or used in combination with an Arduino or any other with RX/TX capabilities. We can control modes via I/O control mode or serial mode. Audio data stored by folder, FD Player can store up to 100 folders.

8) GPRS shield

(General Packet Radio System) is based on transferring the data into packets. By comparing GPRS with GSM, GPRS transfer with a higher data rate with a low cost also, GPRS is used for data transferred but GSM is called for voice calls. If we compared GPRS with Ethernet, GPRS always connective and the serve can reach any place. So, GPRS is the most suitable connection to be used in our proposed system; having: The super capacitor power supply for the RTC. The RTC can work more than 1 day by the power supply of super capacitor. So the SIM900 can keep the time and day when power off, Free serial port connecting, you can select Hardware Serial port(D0/D1) control or Software Serial port(D2/D3) control it, SIM900 all pins breakout. Not just the UART port and debug port be layout, Super capacitor

power supply for the RTC, Not only can use the button for power on, but also can use the digital pin of Arduino to power on and reset the SIM900 module, Quad-Band 850/ 900/ 1800/ 1900 MHz, Control via AT commands, Supply voltage range: 3.1 … 4.8V and Dimension: 68.33x53.09mm as in [12].

9)   NFC module 13.5MHz

Having characteristics of :Small dimension and easy to embed ,Support I2C, SPI and HSU (High Speed UART), easy to change between those modes ,read/write capability ,Support RFID reading , P2P communication with peers, NFC with Android phone ,Up to 5cm~10cm reading distance and On-board level shifter, Standard 5V TTL for I2C and UART, 3.3V TTL SPI as in [13].

10) counting (computing system)

The Counting system to collect vote by vote from poll stations to be calculated instantly to announce the final results and statistics by the exit of the last voter of the day; which is the second part of eliminating human interference. Votes are sent via GPRS to be calculated, as well as the scanned information and the received access permission after comparing.

D. Methodology
1)   Phase I: Access Verification

Step 1: The voter will be asked by the machine to scan his smart card and scan his fingerprint; Combined mean of identity checking.

Step 2: The voter starts to scan his NFC card.

Step 3: The machine will scan the fingerprint of the voter.

Step 4: The combination of NFC serial and fingerprint will be compared with the saved ones in the main database.

Step 5: If the NFC serial and fingerprint belong to the same person,

   If the voter's age is over than 18 years old,

   If he didn't submits his vote before and

   The voter has the right to vote.

He\She will get the access right and the screen displays the welcome note.

Else, the buzzer will beep

End.

2)   Phase II: Voting Process

Step 6: The voter will start to choose his wished candidate.

Step 7: The confirmation message will appear to confirm the voter's choice.

   If the voter presses green and confirms his choice, he\she will be moved to step 8.

   If the voter presses red and doesn't confirm, he\she will return back to step 6 and re-choose.

Else, the countdown will count 30 sec. and the screen will off and the vote won't be sent.

End.

3)   Phase III: GPRS Joining & Calculating System

Step 8: The vote will be submitted and sent to the main station via Ethernet connection.

Step 9: Votes from different unites and different areas will be transmitted to the main station vote by vote and counting system will begin to count and announce the results constantly.
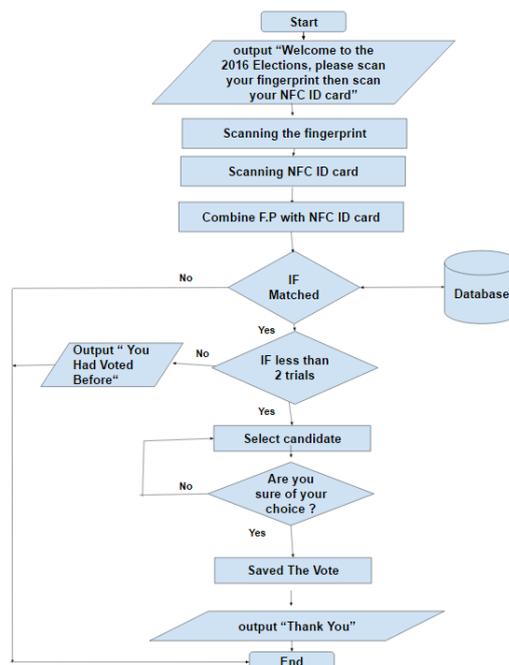
E. Flow Chart

Fig. 2 Proposed System Flow Chart

IV. CONCLUSIONS

The main purpose of the system is to provide community and citizens with a secure and easy to use device to get transparent and fast results, with affordable cost device and fraud, manipulation and rigging free; through combining both fingerprint and NFC serial to an ID card to make sure that no vote will be exploited; and buzzer beeping in case the scanned data doesn't match the saved ones on the data base and in case of unplugging the device or trying to disassemble any part of it; also voice aids are added to guide the voter through his voting process. Using GPRS to constantly send votes and announce the results, instead of having votes on SD cards and the results announced by the end of the day; which caused manipulation from swapping the SD cards by some people as in some current systems as in [14]. Moreover; GPRS distinguished by high data rate because it transfers data into packets with low price and less time comparing to currently used systems ; Besides replacing smart chips with NFC serials in ID cards solved the problem of multiple cards and possibility of losing one of them; as NFC provides higher speed of processing, faster data exchange, can't be spoiled easily by scratching or staining, doesn't require a straight line of sight to be scanned or read and more data capacity as in [15] .Which is useful to use the ID card in billing, transit, transport, ticketing, voting, health insurance, etc…. countries with currency lower than dollar will benefit from the cost difference between smart chips and NFC. Also using one card for multiple processes in our everyday life solves the problem of multiple cards and possibility of losses. Finally; we are working on creating a voting application on android stores and app stores for phones which is supported by fingerprint sensor and NFC.

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