Smart-Vote: Digital Election Ink Based Voting System

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***Abstract*—**In this paper we propose a new voting system based on a digital election ink. This voting system is capable of both, authenticating a legitimate vote, and also digitally inking the finger-nail of the voter. The system primarily comprises of a pulsed laser and a UV reader, in addition to, internal memory and a processor. The advanced version also has a multimodal biometric capture unit and a camera unit. A pulsed laser is used, at a wavelength of 800 nm, to write the data onto the nail. The nail, which is a biological entity, gets discarded in due course of time, thus making the process inherently 'green' and environment-friendly.

***Keywords*—** authentication, pulsed laser, UV Reader.

I. Introduction

IN many countries across the world elections are held using paper ballots/electronic voting machines. After a legitimate voter has voted, election ink is applied. India, being the largest democracy, requires polling at various levels. In 2009, the elections involved an electorate of 714 million [1] (larger than both EU and US elections combined [2]). Currently, a voter is identified using one of the valid photo IDs, and then an indelible ink is applied on the fingernail to mark that the voting has been done. This process needs to be as secure and fail-safe as possible. Currently, Electronic Voting Machines (EVMs) are typically used for casting votes in India. The EVMs are prone to attacks. In [3] the authors demonstrate two kinds of attacks against a real Indian EVM. One attack involves replacing a small part of the machine with a look-alike component that can be silently instructed to steal a percentage of the votes in favor of a chosen candidate. These instructions can be sent wirelessly from a mobile phone. Another attack uses a pocket-sized device to change the votes stored in the EVM between the election and the public counting session, which in India can be weeks later.

The other problem is the voter authentication and recasting of votes. Biometric EVMs already exist [4]. Election ink or electoral stain is a semi-permanent ink or dye that is applied to the forefinger (usually) of voters during elections in order to prevent electoral fraud such as double voting. It is an effective method for countries where identification documents for citizens are not always standardised or institutionalised [5].

There are several known problems with the use of indelible (election) ink [6]. In the Afghan presidential election, 2004, allegations of electoral fraud arose around the use of indelible ink stains, which many claimed were easily able to be washed off. Election officials had chosen to use the more efficient marker pen option; however, regular marker pens were also sent out to polling stations, which led to confusion and some people were marked with less permanent ink.

Critics of indelible ink point out that an individual can theoretically circumvent the security of indelible ink by coating the finger with a temporary, yet transparent glue. The indelible ink would adhere to the glue which could then be washed off leaving the individual available for another round of voting. Sabotaging the finger marking process could cast doubt on the legitimacy of the vote.

In the Malaysian general election, 2008, the election authorities cancelled the use of electoral stain a week before voters went to the poll saying it would be unconstitutional to prevent people from voting even if they had already had their fingers stained. Additionally, they cited reports of ink being smuggled in from neighboring Thailand in order to mark peoples' fingers before they had a chance to vote. Thus, denying them their rights.

During the Zimbabwean presidential election, 2008, reports surfaced that those who had chosen not to vote were attacked and beaten by government sponsored mobs. The mobs attacked those without ink on their finger.

All these problems motivate us to propose an electronic election ink on the voter's fingernail. To the best of knowledge, there is no existing 'electronic election ink' or 'digital election ink'. The paper is organized as follows. Section 2 describes the basic idea behind Smart vote. The functional blocks are described in Section 3. Finally, the paper concludes in Section 4.

II. The Basic Idea

The block schematic for the proposed system is shown in Fig. 1. The system has two cameras that capture the image of the nail and the fingerprint simultaneously. The working of the system is depicted in the flowchart given in the ensuing section. After reading the image of the nail, the Smart Vote System (SVS) verifies the following:

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(a) Whether the nail has election ink
(b) Whether the nail has digital ink (UV)

If either (a) or (b) is found, the intended voter is declared as an 'Invalid Voter'. On the other hand, if the answer to both (a) and (b) is in the negative, the fingerprint image is processed. The processing of the fingerprint image entails checking the person's identity and locating the voter in the database. The UID database may be used for this purpose. If the fingerprint is found to be valid, the SVS uses UV radiation/laser to imprint the date and place of voting on the nail of the voter. It also puts a mark using the election ink. We can use other biometrics in conjunction with the basic authentication system. This modified Smart vote system is shown in Fig. 2. Here, iris is used as an additional biometric.

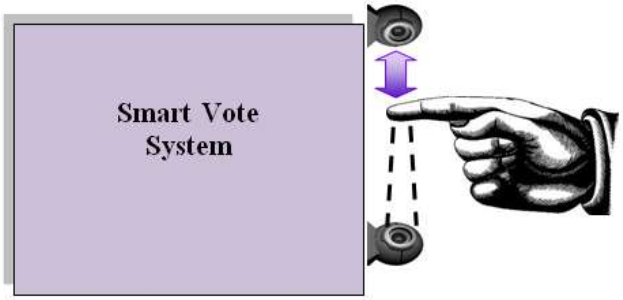

Fig. 1: The Smart Vote System first checks the validity of the voter, and then if found valid, digitally inks the nail.

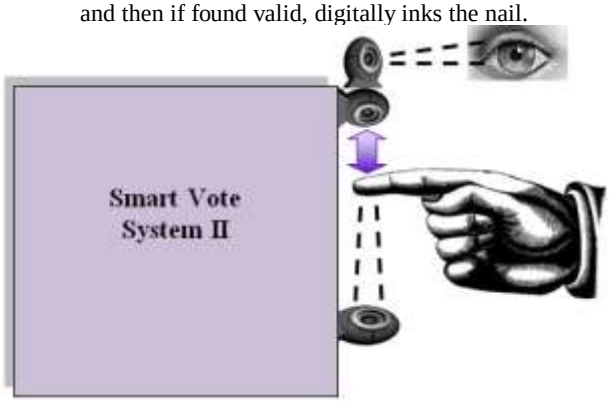

Fig. 2: The Smart Vote System first checks the validity of the voter using multiple biometrics, and then if found valid, digitally inks the nail.

III. Functional Blocks

The block diagram of the Smart vote system is given in Fig. 3. The important blocks consist of a pulsed laser unit, a UV reader, a multimodal biometric capture unit, a camera unit, memory and a processor. Flowchart of the proposed system is given in Fig. 4.

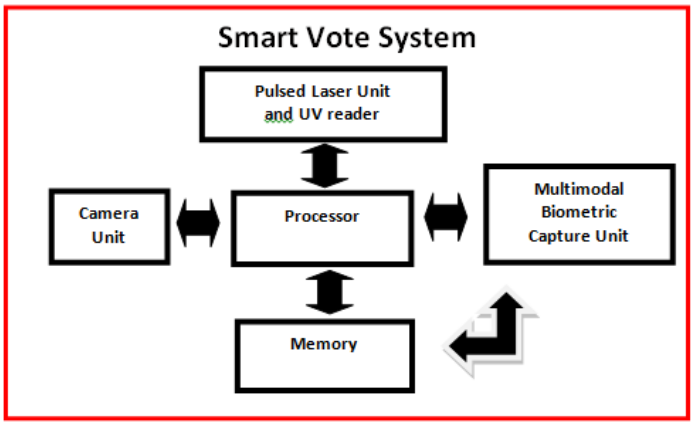

Fig. 3: The sub-blocks of the Smart Vote system.

The main objective of the proposed system is to identify, authenticate and then mark the voter with digital ink. The authentication process for a valid voter involves:

- Checking whether he/she is a legitimate voter
- Checking whether he/she has not already voted
- If found eligible to vote based on the above-two points, ink the person with indelible ink.

The proposed system, which is an authentication-cum-digital inking system, achieves the above-mentioned objectives. The main aim of both the biometric verification block and the digital ink verification block is the same, i.e., authenticate the valid voter. The information stored by digital ink is used to check whether the voter has voted previously. Thus, these blocks are not working independent of each other. In fact, they are acting in conjugation with each other in a new way.

A pulsed laser is used, at a wavelength of 800 nm, to write the data onto the nail. This is a typical wavelength for illustration purpose only. The energy of a single femto-second laser pulse is 1 μJ. The area used for storage is determined by the amount of information being stored. Typically, a 2 mm x2 mm space can be used to comfortably store 128 kilobyte of information. This calculation is based on the fact that the bits can be spaced 0.005 mm apart. Additional information can be stored by increasing the space on the fingernail. It should be noted that if the entire space available for storage is used (say, 5 mm x 5 mm), close to 1 Mb of data can be stored on a single nail.

The impression typically remains for 1-2 weeks. This is sufficient for the electoral process. The nail, which is a biological entity, keeps growing and is eventually cut and discarded. Thus, this 'digital-inking' process is inherently 'green' and environment-friendly. The information which gets imprinted on the finger nail is not readable normally using natural light. In order to read the information, UV light is required. It should be noted that this information imprinted on the finger nail may itself be encoded, and/or distributed over several fingernails for data-safety or security.

UV light of 300 nm to 600 nm can be used**.**

IV. CONCLUSION

In this paper we propose a new Smart-vote system that is capable of authenticating a legitimate voter and also digitally ink the finger-nail of the voter. The important blocks consist of a pulsed laser unit, a UV reader, a multimodal biometric capture unit, a camera unit, memory and a processor. A pulsed laser is used, at a wavelength of 800 nm, to write the data onto the nail. The impression typically remains for 1-2 weeks. This is sufficient for the electoral process. The nail, which is a biological entity, keeps growing and is eventually cut and discarded. Thus, this 'digital-inking' process is inherently 'green' and environment-friendly.

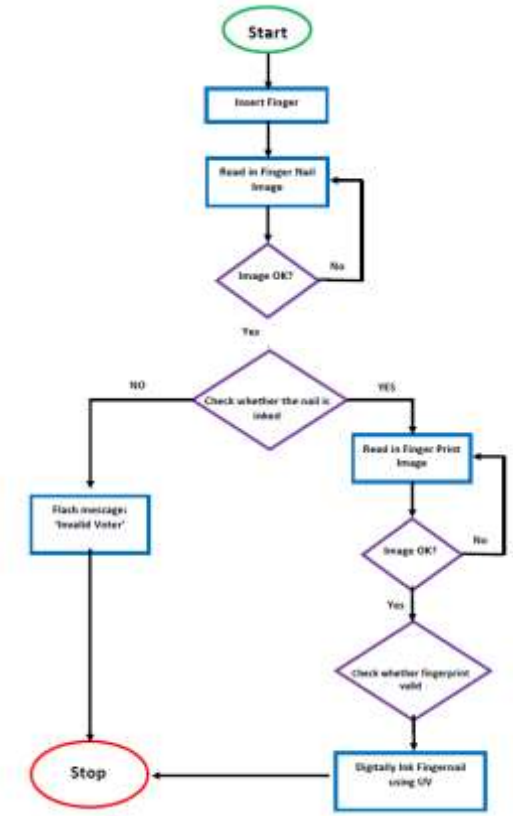

Fig. 4: Flowchart of the proposed system

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