COMP4801 Final Year Project
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E-voting platform

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Abbreviations:
Direct recording electronic (DRE)
voter-verified paper audit trail (VVPAT)
precinct count optical scanning system (PCO)
Optical mark recognition (OMR)
Electronic ballot printers (EBPs)
1. Background

1.1 Introduction

E-voting is a big trend throughout the Internet era. It is partially implemented in some countries and areas such as the US, India, Hong Kong etc. However, some e-voting platforms may face some technical issues like double voting, identity verification and the security of the user data. This project plans to find a suitable e-voting system for Hong Kong, and build an e-voting platform with suitable methods for identity verification and secured data storage.

1.2 Problem statement

In the age of well developed technology, it is inevitable that many things are being electronic. The voting procedure is one part of this process, the voting procedure is changing from face to face to be the electronic format gradually.

Most e-voting platform can divide into the following four types (IDEA, 2011):

1) Direct recording electronic (DRE) voting machines. Voter-verified paper audit trail (VVPAT) which is used to provide physical proof of the votes cast can be used or not used in DREs.

2) Optical mark recognition (OMR) is a machine with scanners to recognize the choices of the voters made on the special machine-readable ballot papers. Precinct count optical scanning systems (PCO) in OMR will mark voters’ choices in the papers.

3) Electronic ballot printers (EBPs). The devices can make a machine-readable paper or electronic token include the choices of the voters. The token will be put into a separate ballot scanner and the scanner can do the vote count automatically.

4) Internet voting systems. Voters can connect to a centralized system or platform through the Internet. Voters can vote by using public computers or from Internet-connected devices

E-voting or internet voting usually used DRE and PCO to do the voting process. Using a suitable voting system is essentially important for an e-voting platform. It may relate to the convenience and performance of a server.

E-voting is a substitution way of the traditional voting method. It is a lot more convenient, e.g. for the disable person, or just like the current circumstance, the outbreak of COVID-19 etc. On the other hand, e-voting can accelerate the process of vote counting, so it saves a lot of time and public resources like public funds.
However, e-voting does contain some weaknesses. The main concerns of the voters using the e-voting platform are about data security and how to ensure the fairness of the voting system like ensuring that everybody enjoys the same opportunities to vote (Rana, Zincir and Basarici, 2015).

In order to eliminate the above concerns, an e-voting platform should strengthen the level of privacy or data security to prevent cyber attack for stealing personal information, the data or record should also be trackable. The voting process or record should be checkable by the voters to prevent modifying by hackers or people with malicious intentions. On the other hand, the methods of identity verification should also be taken into account during the development process in order to prevent double voting.

In light of this situation, this project aims to choose a suitable e-voting system to build an e-voting platform with appropriate identity verification measures and reliable database.

1.3 Previous work

There are many examples of e-voting systems. Recently, the 2020 Hong Kong pro-democracy primaries were held in July 2020. The Hong Kong Public Opinion Research Institute provided a voting platform which is in an electronic way. The voters needed to go to designated polling stations with their phone and proof of identification or residency. After they scanned the QR code, they could cast the ballot using the smartphones. There are around 60 thousands voters in total and most of them used electronic voting instead of the traditional one (Wong, 2020). Although the voting process is not entirely electronic, it represents that the e-voting is becoming more common nowadays. However, there were some accidents indicating that e-voting development is still not mature. Since the voting results were leaked by the media beforehand, the system might be hacked or some insiders disclosed the results to the public (Wong, 2020).

Actually, the Public Opinion Programme at The University of Hong Kong has developed an e-voting app or platform called PopVote. However, there are some problems when this platform is released, like some fraud websites to pretend PopVote and cyber attack. It is a good example for us to take it as a reference.

On top of that, many countries have started to make voting be electronic. Estonia, Australia, US and Spain are some of the examples, but most of the e-voting systems are not completed and suffer from different kinds of problems.
2. Scope and objective

This project aims to find out the most suitable method of e-voting system in Hong Kong and implement it. Since the e-voting platforms still have a lot of problems and issues in the present, we are going to try to make a more complete system which fits the situation of Hong Kong. In 2020, there are around 4460000 registered electors, so the database of our e-voting platform should be large enough.

To prevent the issues mentioned above, we have to set some requirements to ensure the quality of the platform. They can be divided into several aspects (Wu, 2020).

1. Verifiability
   It means that the e-voting system guarantees that each voter's ballot has been correctly collected, the election outcome correctly represents the collection. Also, the voter can check whether her ballot is correct and tallied as recorded. Each ballot represents no more than a single vote for a legitimate voter, so it is important to find a way to prevent double voting (Wu, 2020).

2. Privacy
   The system should provide anonymity for the votes. No one should learn how a particular voter votes and the voters cannot prove to the others how she voted. The information of voting should be made available to the public and the voters to convince them the votes are correctly cast and recorded. Therefore, a good cryptographic technique should be used to ensure the security and prevent ballot selling, coercion or selection denial of service (Wu, 2020).

3. Accountability
   If some misbehaviors by voters are identified, the judge should set penalty to them to ensure fairness.

4. Accessibility
   The e-voting platform should be accessed by all voters equally, no matter what characteristics of the voters is, such as health, age, abilities, locations.

5. Usability
   The e-voting platform should be efficient and convenient for voters.

6. Proof of security
   We should find a way for the voters to provide the proof of identification. Hence, our goal is to make an e-voting platform that fulfills these requirements.
3. Methodology

In this project, we plan to make an internet voting system. That means the voters can vote by connecting to the system with their electronic devices through the Internet.

3.1 Data collection and Storage - decentralized database

To manage such a big database and guarantee the verifiability, we plan to use blockchain as our way to store the data. During an election through e-voting platform, there are risks of data manipulation and election fraud (Legislation council, n.d.). A decentralized open source blockchain platform which is called Ethereum (Pic1) will be applied. The reason we use it is because it is totally transparent and it would not be interfered by any stakeholders and creators. The concept is similar to a write-once bulletin board. That is all the people can access to the platform and monitor the data of election. All verifiable information is published on the decentralized database (Pic2) after an authenticated voter votes. Once information is published, it cannot be deleted; it is a good way to prevent election fraud (Wu, 2020). As a result, the voters can check the verifiability and credibility of the voting system and report if they find any problem.

Pic 1. Blockchain platform
Also, we may design to choose an algorithm like sha256 to hash the sensitive data and encrypt before storing onto the database. This can protect the data from cyber attacks.

3.2 Platform design (React.js)
For the front-end user interface of the e-voting platform, we plan to use react.js to develop webpages. It is a good design tool which is suitable for making interactive UIs, for example we can show the information of different candidates after the voters click on a particular button. Also, the components inside can be split into independent, reusable pieces, and deal with each piece in isolation. This can make us divide our job and work well together. The main benefit of react.js is that it uses Virtual-DOM which minimizes the manipulation of DOM and optimizes the efficiency. Besides, debugging is easy in react.js since we can use props and state to trace the mistake in the codebase. Therefore, we choose react.js for our platform design.

3.3 Identity verification
One of the important issues is to verify the identity of the voters. It is the main factor to avoid double voting and ensure the verifiability and accountability of the e-voting system. We plan to have two-factor authentication to improve the security. We will first require the voter to upload her identity card or her face and use some software like FastCheck, AppLock or Blippar to verify. After that, a code will be sent to her through SMS or email to make sure her identity further. Also, the information that
we receive will be strictly confidential to protect the privacy of the voters. On the other hand, direct anonymous attestation will also be a selection of identity verification. It enables remote authentication of a trusted computer and preserves privacy of the voters. It is a way that the verifier can verify the credential without attempting to violate the platform’s privacy. However, it requires more processes and techniques, so we are choosing the method of identity verification.

4. Limitation

The challenge or problem during the development process that we cannot solve is still in discussion. The following are the problems we may face during the development.

4.1 Platform Security

E-voting may need to require the voters to enter their personal data into our website or platform. However, ensuring personal data security and preventing cyber-attack may be a challenge.

4.2 Server Capacity

It is not suitable to find places for voters to vote in the physical polling station in this project, so all the voting should be processed through the e-voting platform. In the e-voting platform, the voters will not queue one by one when doing off-site e-voting. Therefore, the server capacity should be large enough to suffer the large amount of users log in or log out from the e-voting platform to prevent server overloaded problems. However, it is difficult to make or build a server that can control or manage the large amount of log in or log out process. If we make a polling and counting station for voting, the places and the efficiency should be considered, since it is totally different to the internet voting method.
### 5. Project Schedule

<table>
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<tr>
<th>Date</th>
<th>Milestones</th>
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<tbody>
<tr>
<td>1 September — 4 October</td>
<td>Deliverables of Phase 1 (Inception)</td>
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<tr>
<td></td>
<td>• Detailed project plan</td>
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<td>• Project web page</td>
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<tr>
<td>11 January — 15 January</td>
<td>First presentation</td>
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<tr>
<td>16 — 24 January</td>
<td>Deliverables of Phase 2 (Elaboration)</td>
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<td>• Preliminary implementation (platform design (React), ethereum database (50%))</td>
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<td>• Detailed interim report</td>
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<tr>
<td>25 January — 18 April</td>
<td>Deliverables of Phase 3 (Construction)</td>
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<td>• Finalized tested implementation (ethereum database (100%), identity verification, finalize the e-voting platform)</td>
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<td>• Final report</td>
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<td>19 — 23 April</td>
<td>Final presentation</td>
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<td>May 4</td>
<td>Project exhibition</td>
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<td>June 2</td>
<td>Project competition</td>
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<td>(for selected projects only)</td>
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6. Conclusion

Designing an e-voting platform should focus on considering the aspects of data security and identity verification. Using hash algorithms to encrypt sensitive data and use blockchain to store the data should be a good solution to solve the security problem. Also, it is a suitable way to send SMS to the voters phone or send Email to handle the verification problem. This project can provide a secured and liable platform for off-site e-voting.

7. Reference