

Designing an Information Technology Based Voting Solution for Persons with Visual Impairment in Sri Lanka

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Introduction

- In Sri Lanka, about a million people with visual impairment have the right to vote, which is 5.1% out of the total population [2]
- Sri Lanka currently uses a paper-based voting system for conducting elections.
- According to Elections (Special Provisions) Act [5] in Sri Lanka, it is allowed for a proven person with a disability (an eligible individual adhering to the stated requirements by the act) to be accompanied by someone who is capable of viewing a ballot paper, and mark the choice upon the preference of the voter [6].
- Voters with special needs have to depend on the assistance of another to mark the vote.
- Everyone deserves to vote privately and independently

Research Question

“What are the system and interface design features required to provide a fruitful effective voting experience for the Sri Lankans with visual impairment?”

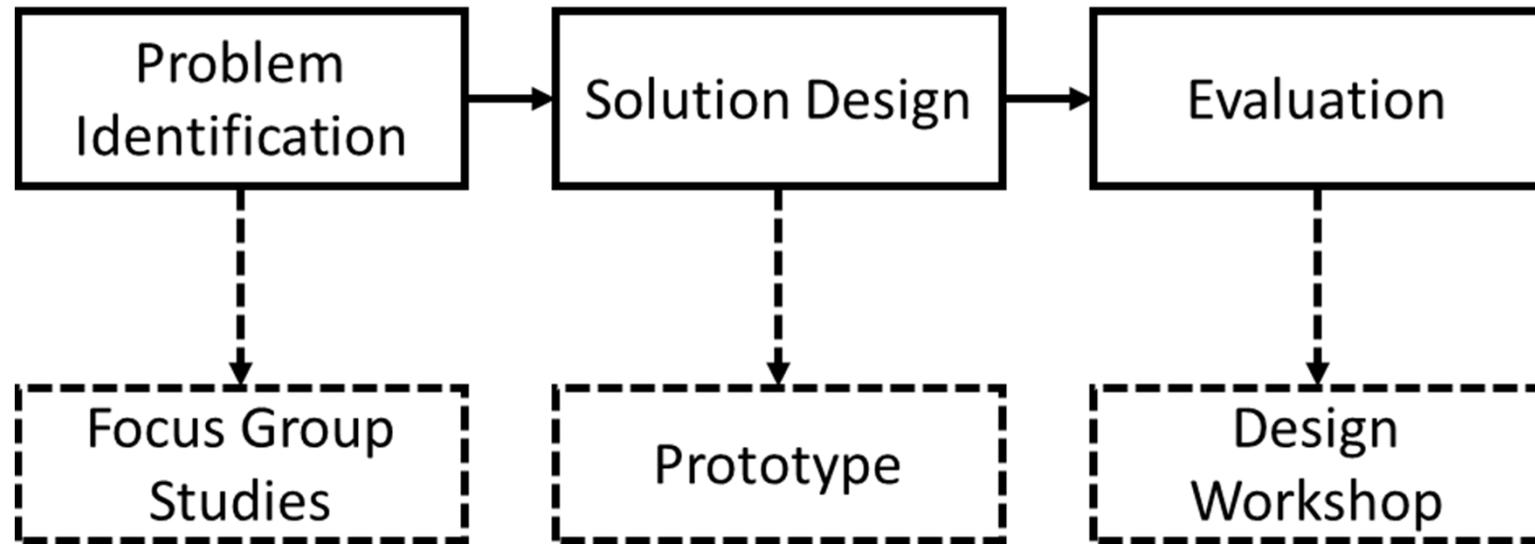
Background and Related Work

- Paper-based voting systems provide advantages such that ease of understanding for the voter and default verification of accuracy due to the vote being directly cast by the voter
- These systems are still being used by different countries even though they have not supported individuals who have visual impairments for independent voting [8]
- Most of the systems provide Braille buttons [9], but in Sri Lanka, 71% of visually impaired persons had some sort of schooling [10] and only 41% of the individuals who know Braille could use it [11].
- Thus, it is important to have other modes of input and navigation, providing blind voters with the flexibility to choose a method they prefer.

Topic	Findings
Design features relevant to accessibility	Tactile features <ul style="list-style-type: none"> • Buttons • Rotation dials • Sleeves with punched holes Touch features <ul style="list-style-type: none"> • Single/Double tap • Slide rule Multimodal features <ul style="list-style-type: none"> • Combining tactile, touch and/or voice input
Design features relevant to privacy	Security aspect <ul style="list-style-type: none"> • Cryptography-based solutions Interface aspect <ul style="list-style-type: none"> • Accessible interfaces • Screen off feature
Design methodologies	Design principles & guidelines <ul style="list-style-type: none"> • User Centred Design (UCD) • Universal Design (UD) Evaluation models <ul style="list-style-type: none"> • Unified Theory of Acceptance and Use of Technology (UTAUT) • ISO usability standards • System Usability Scale (SUS)

Research Methodology

- Design science research methodology by Offermann et al. [21]
- 3 studies were conducted



Focus Group Studies

Focus Group Study 1: Election authority and election professionals

- National Inclusion and Program Advisor of IFES (International Foundation for Electoral Systems) of Sri Lanka
- Additional Commissioner of Elections (Local Authorities) of Sri Lanka

Focus Group Study 2: Voters with visual impairment

- A sample group of nine (9) potential voters with visual impairments from the Sri Lankan Council for the Blind were selected by convenience sampling because reaching blind persons from all locations was not feasible
- Expert evaluated structured questionnaire

Conducting a Design Workshop

- After conducting interviews and gaining insights, the blind voter's journey in the voting process was identified as a sequence of steps in the proposed system.
- The solution was designed incorporating the identified design features and the prototype was created based on the designed solution.
- The design considerations of the prototype were discussed with the voters with visual impairments.

Conducting a Design Workshop Ctd.

- A sample of 8 persons was selected.
- A pre-survey questionnaire.
- A set of six activities were conducted where each participant was allowed to attempt each activity a maximum of three times.
- Observations were noted down.
- Post survey conducted to get feedback.

Results and Findings

Focus Group Studies

Focus Group Studies

- Among the participants, the majority were literate in Braille but when their preference of using Braille was questioned, 88.8% disliked (continuous touch of Braille which causes fatigue in hand muscles, complexity in learning braille, and lack of teachers).
- Experience in using mobile phones or Automatic Teller Machines (ATM), is considered a potential to use an electronic voting solution with ease implying that similar interfaces are incorporated [8].

Digital device/equipment	
ATM	11.1%
Computer	22.2%
Mobile phone with basic features	44.4%
Mobile phone with touch interface	66.6%

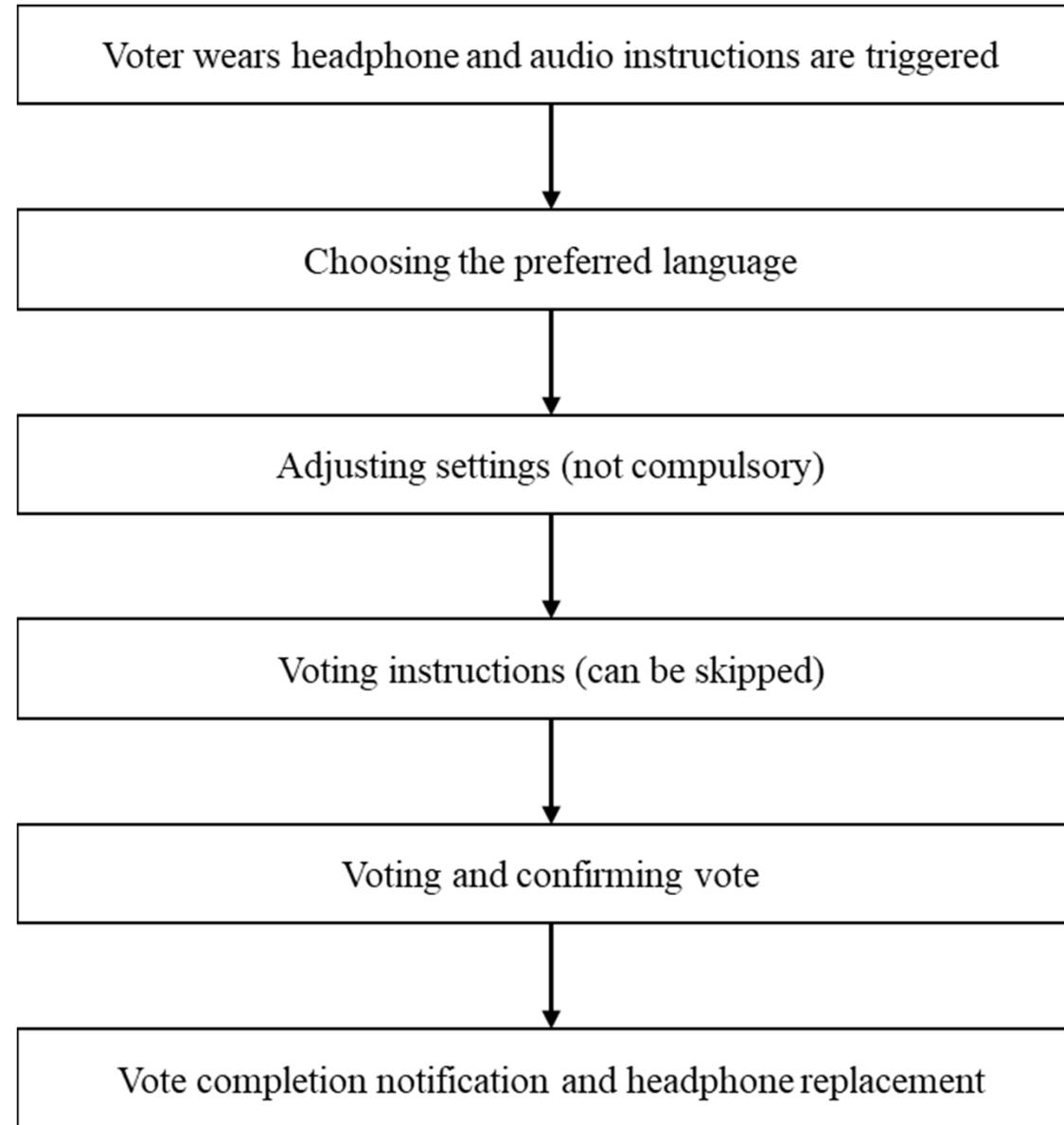
Focus Group Studies Ctd.

- Participants who had prior experience in using smartphones were familiar with both interaction types found in smartphones which provide accessibility: Using single/double tap, and slide rule [16].
- Majority of 83.3% liked the tapping (single/double tap) interaction over slide rule interaction.

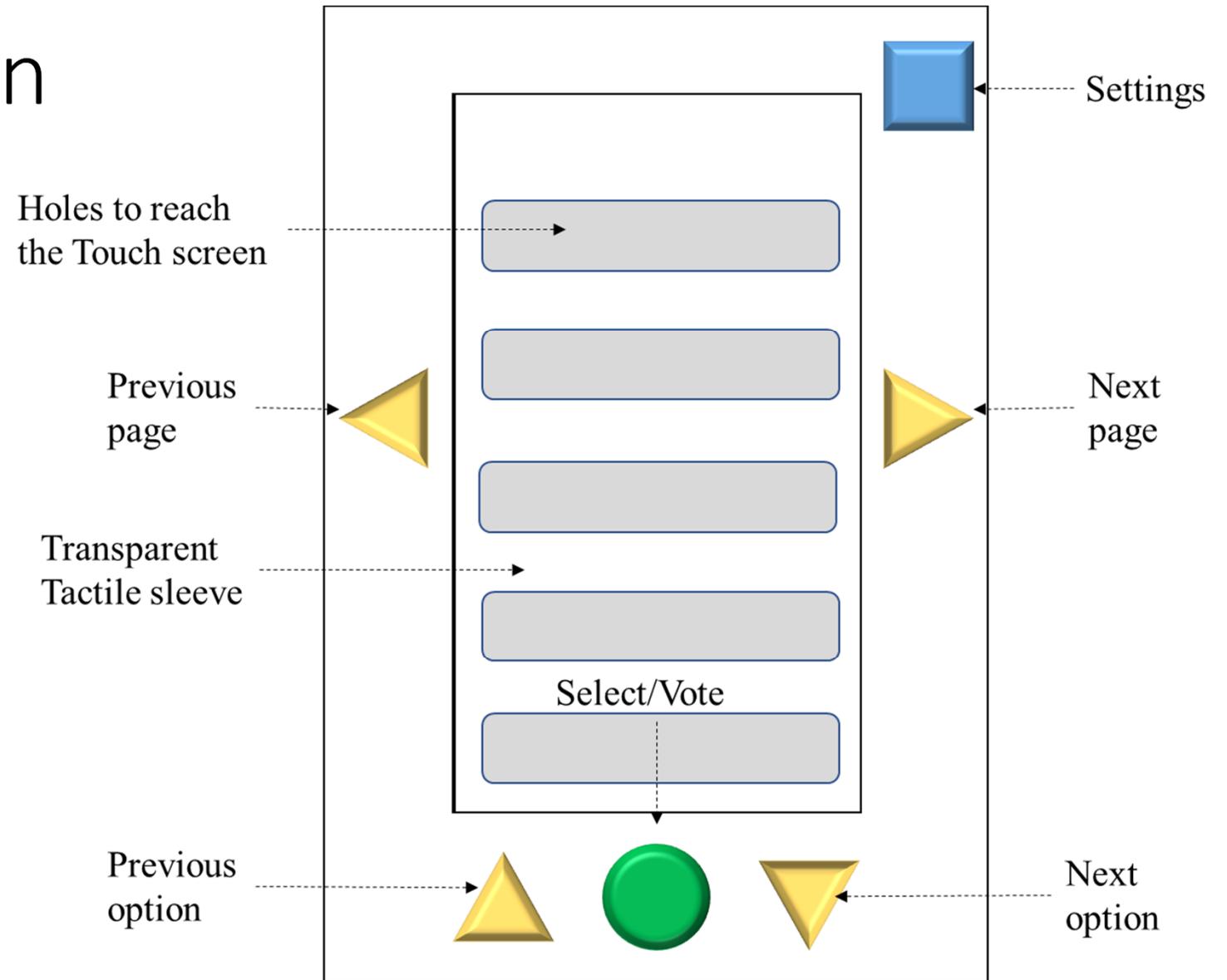
Solution Design

Design Interfaces and Features

Voter Journey



Interface Design



Touch Interface

- Tap interactions on the holes in the tactile sleeve can be performed for both navigation and selection
- The political parties or the candidates are listed on the voting page.
- When a hole is tapped once, the relevant political party/candidate is announced.
- Double tap to vote
- Double tap again to confirm the vote

Button Interface

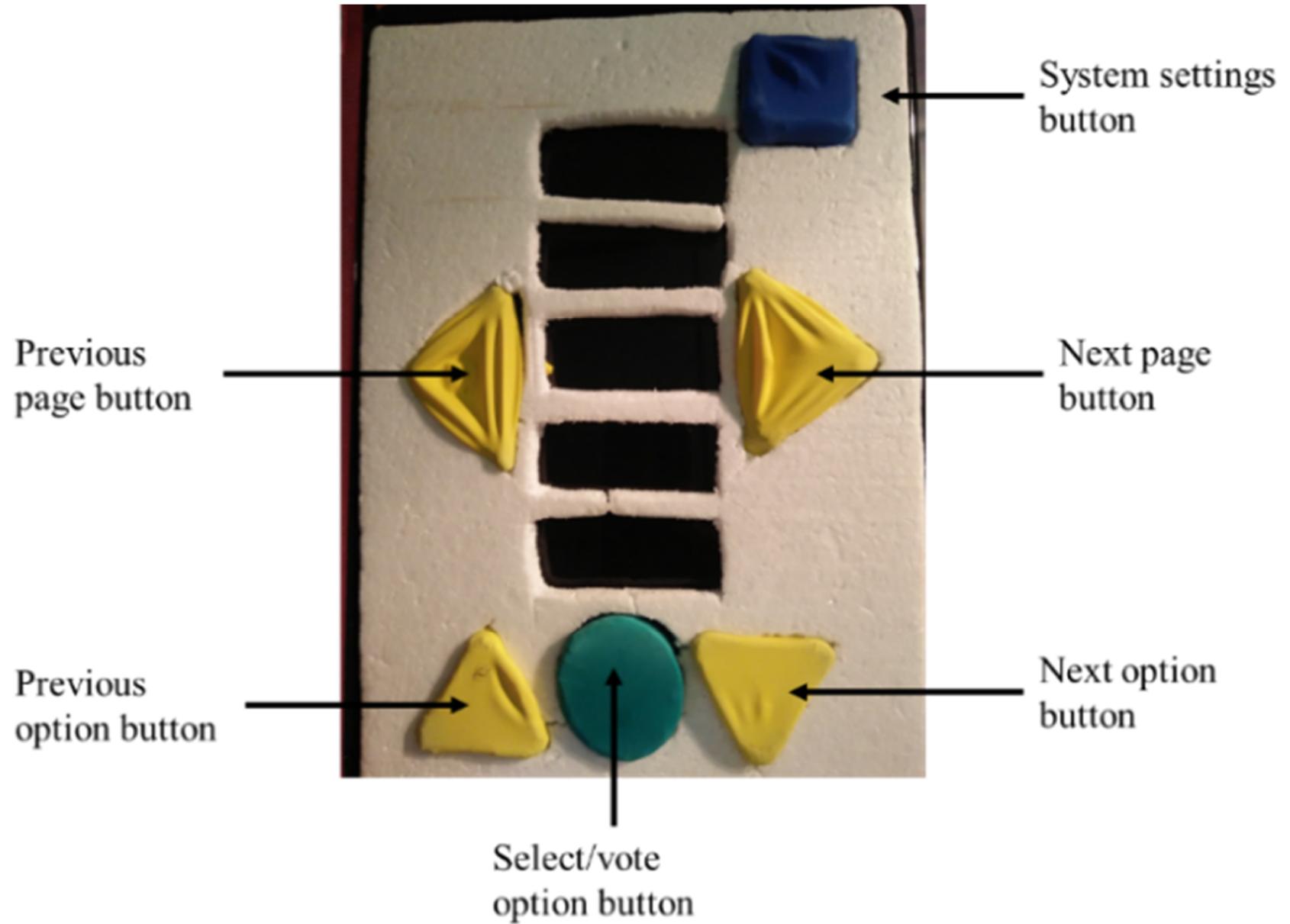
- Next option, previous option, next page, previous page, and settings buttons are used for navigation
- Select button (circular green) is used for selections
- The political parties or the candidates are announced through audio recordings. After each political party/candidate, there is a pause allowing the voters to cast their vote.
- Press the yellow triangular button on the bottom right side to move to next or skip
- After a voter presses the green circular button, the voter is asked to confirm the vote by again pressing the same button

Design feature	Justification aligning Universal Design (UD) Principles
Having button controls with unique features	<p><i>UD Principle 4: Perceptible Information</i> Satisfying both sub-principles in UD, buttons are with different shapes and colours are used as a tactile input because then, it is easily understood by persons with visual disabilities by feeling the shape of the button. Having differently shaped buttons also helps to guide the voter with instructions. Shapes and colors of the buttons based on the EZ control keypad [23].</p>
To do a selection either of <ul style="list-style-type: none"> • Press ‘select’ • Touch the hole 	<p><i>UD Principle 2: Flexibility in Use</i> Voters are given two methods of doing selections/voting. They can choose their preferred method.</p>
Voting by listening to the list of political parties/candidates and press the ‘select’ within the given time interval	<p><i>Principle 6: Low Physical Effort</i> Here the complexity of voting is maintained by the simple press of a button while listening to audio clips. Also, it does not require high physical effort.</p>
Voting by single tap/ double tap on the touch interface	<p><i>Principle 3: Simple and Intuitive Use</i> Voters being familiar with single tap/double tap interaction due to their experience in using smartphones.</p>
Tactile sleeve with punched holes on top of the touch interface	<p><i>Principle 6: Tolerance for Error</i> Tactile sleeve acting as guidance for voters that would avoid touching unintended areas and less prone to errors that were reported in an existing voting system, which have touch interfaces [17].</p>

Design Workshop

Evaluating Prototype

Prototype

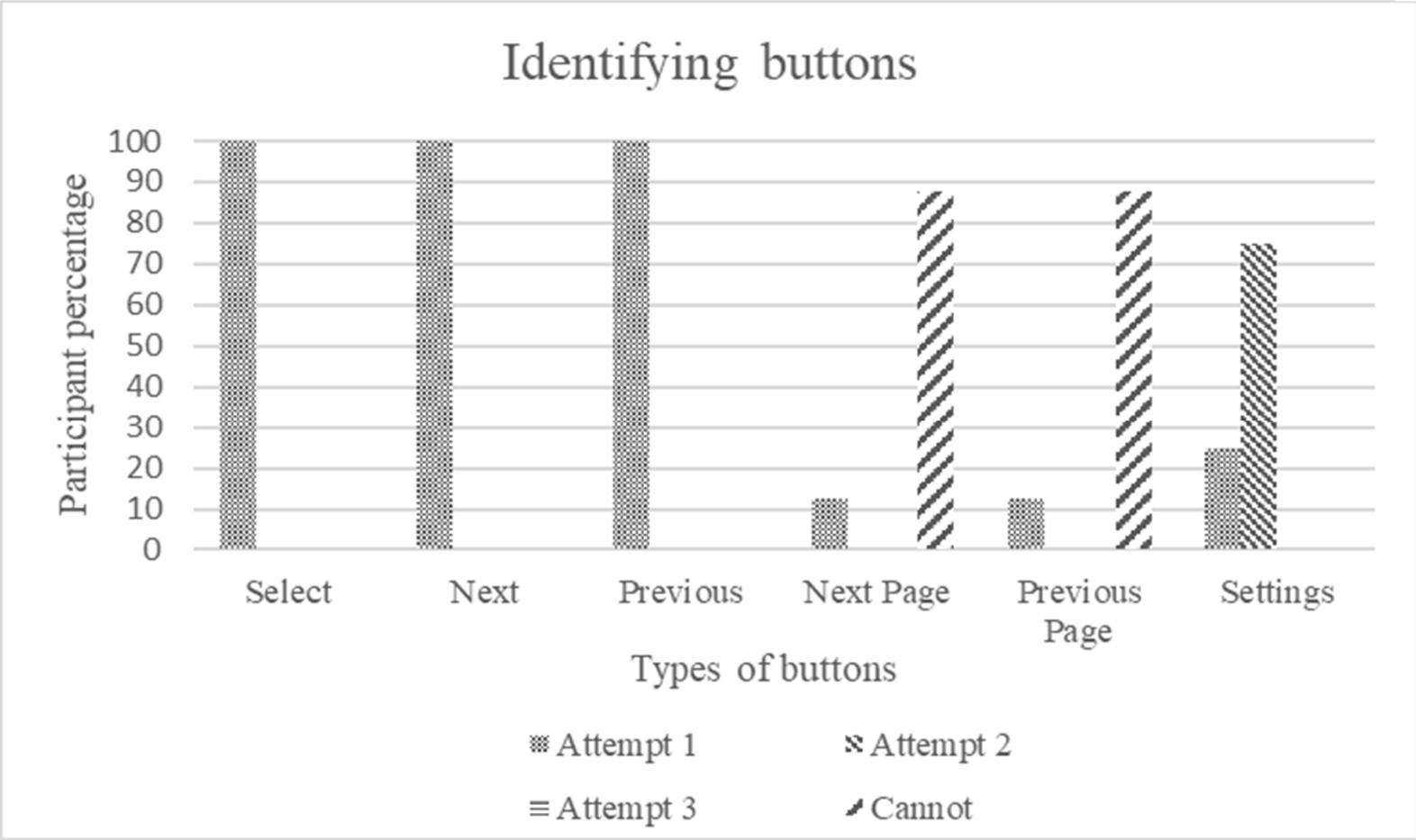
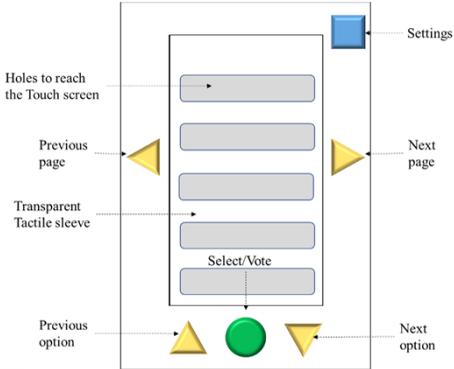


Tasks

1. Find the buttons one by one
2. Identify the function of the buttons
3. Press the 'select' button when a particular political party is played by the audio clips (3 sec, 4 sec, 5 sec)
4. Identify and touch the five holes on the tactile sleeve from the bottom to the top (1st hole, 2nd hole, 3rd hole, 4th hole, 5th hole)
5. Identify and touch the holes in a random order (2nd hole, 4th hole, 3rd hole, 5th hole, 1st hole)
6. Vote for the instructed political party (to identify their ability to differentiate and perform single tap and double tap)

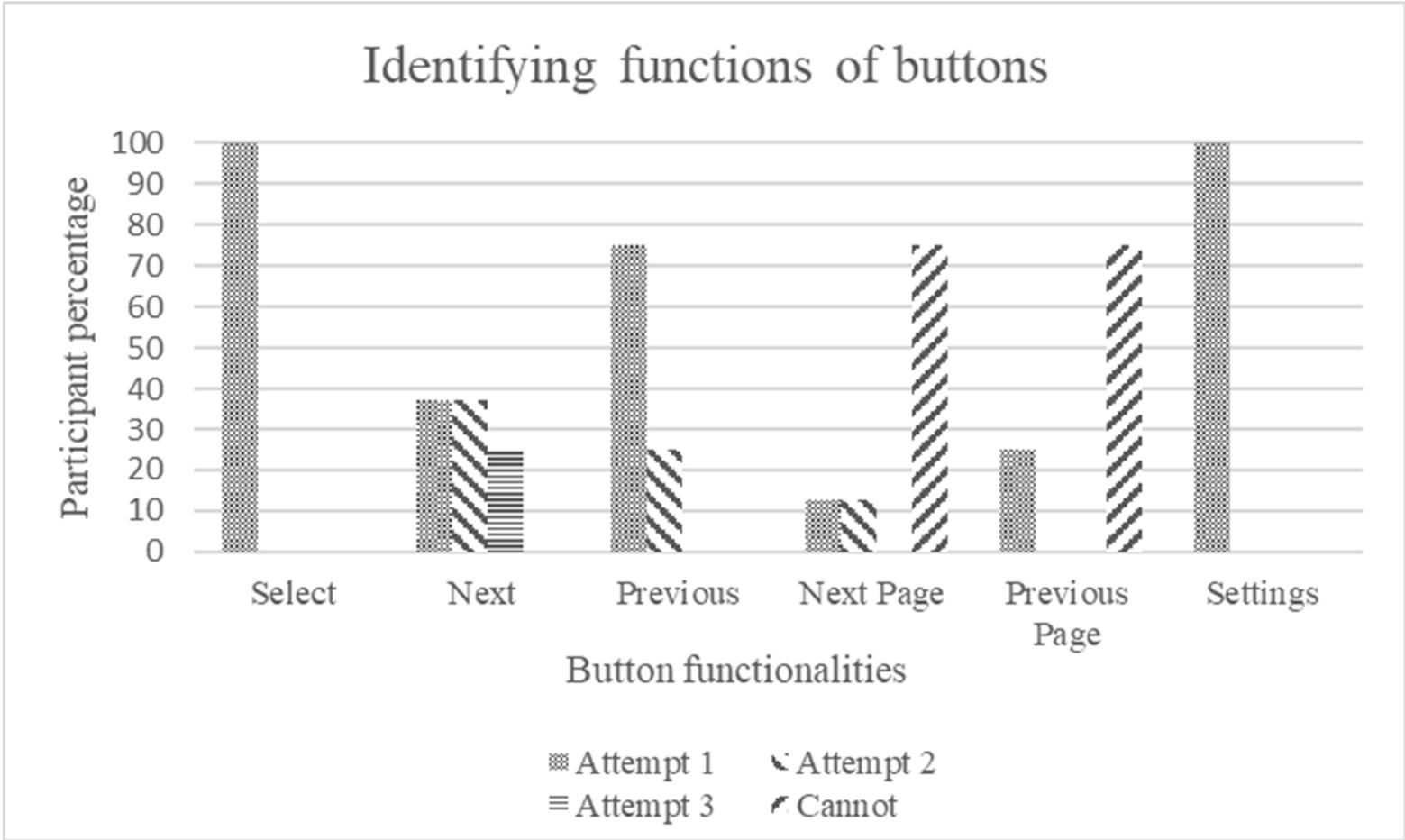
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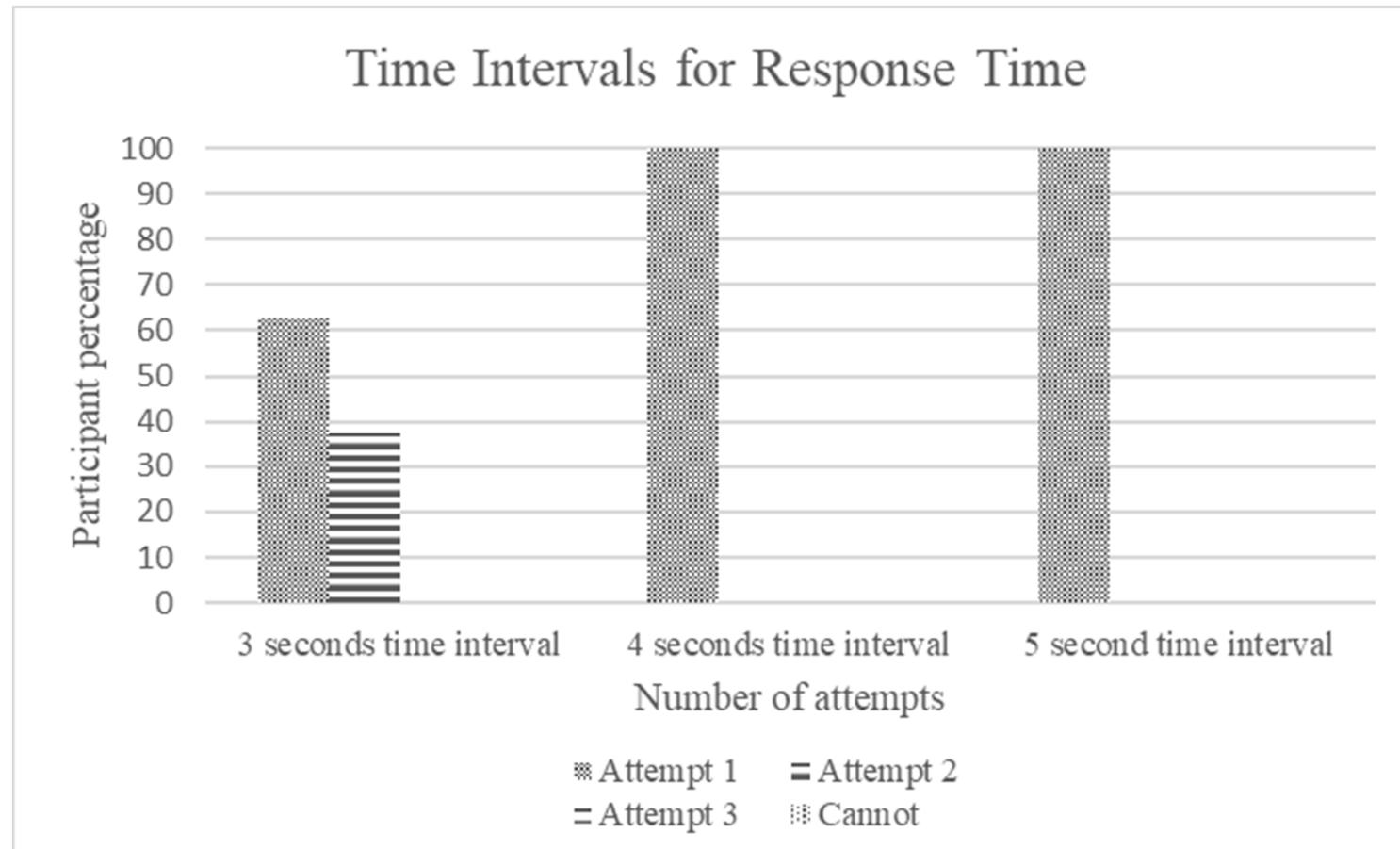
Tasks

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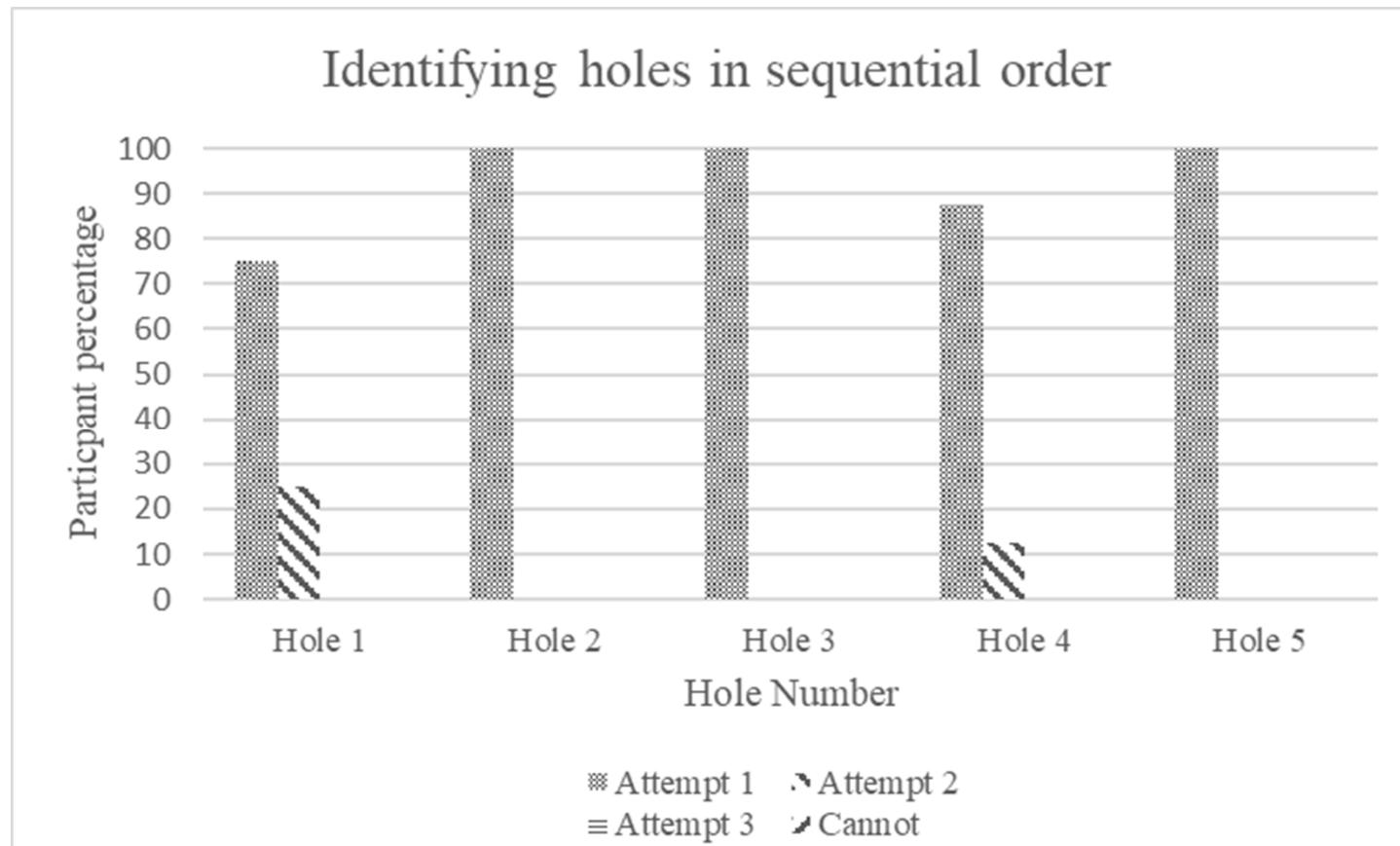
Tasks

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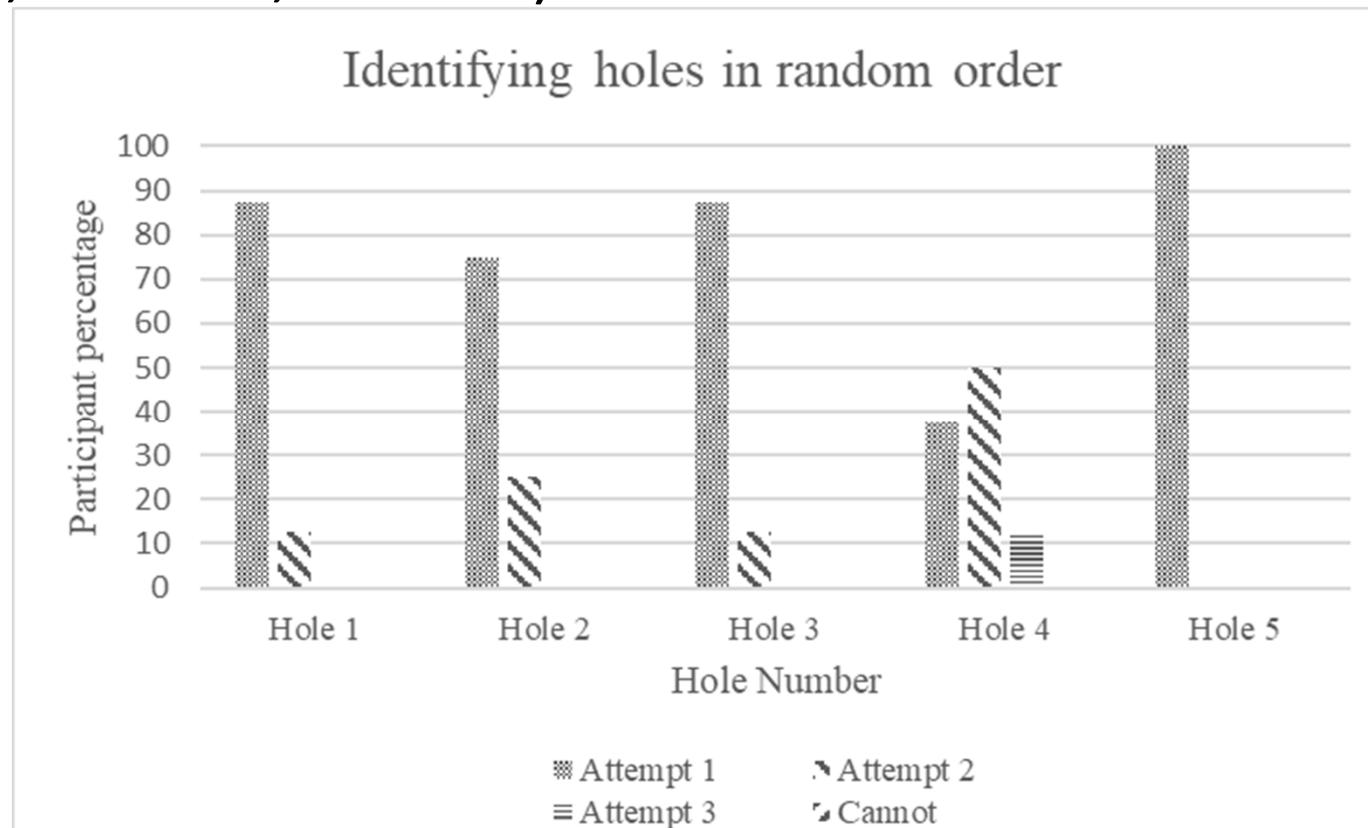
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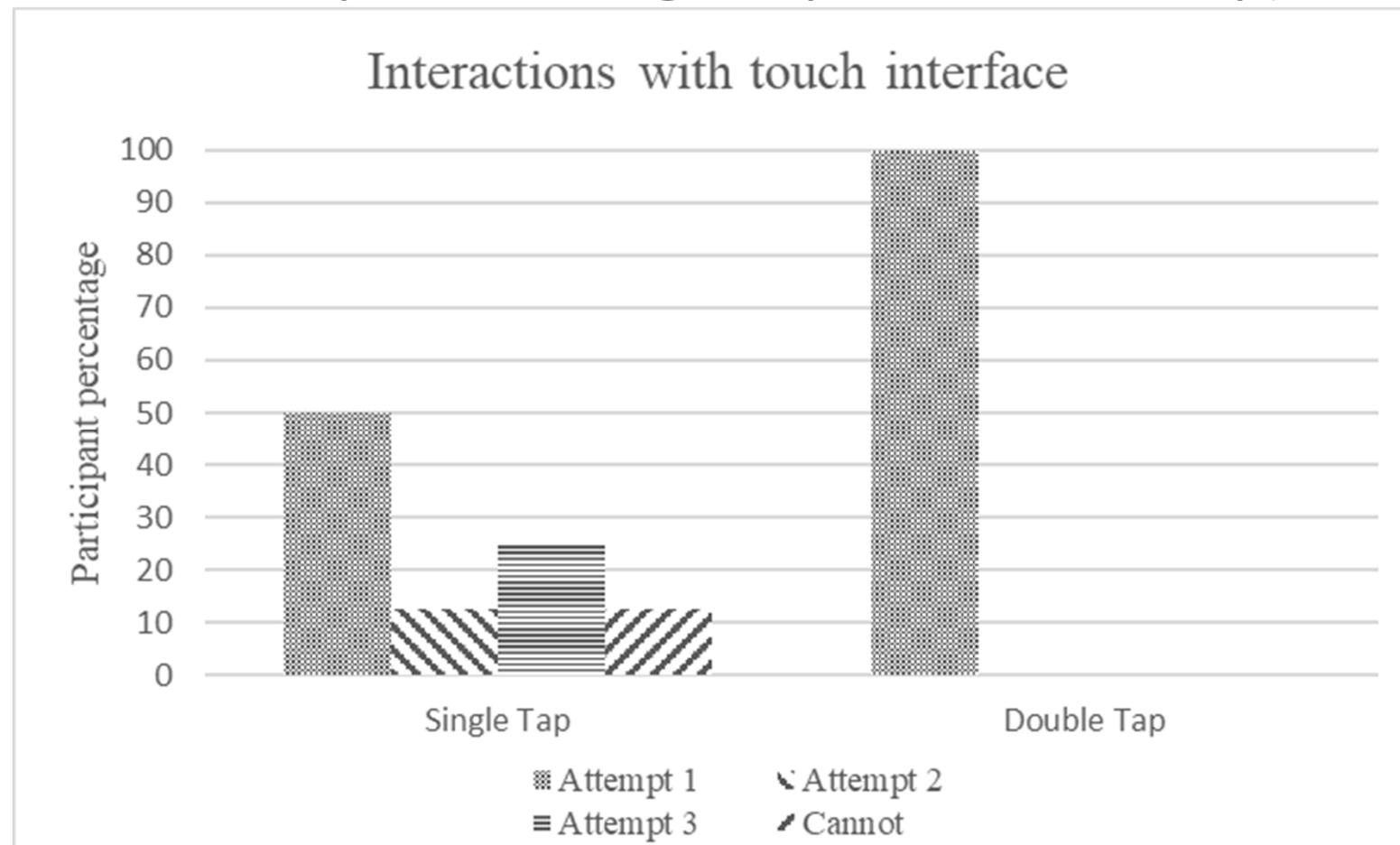
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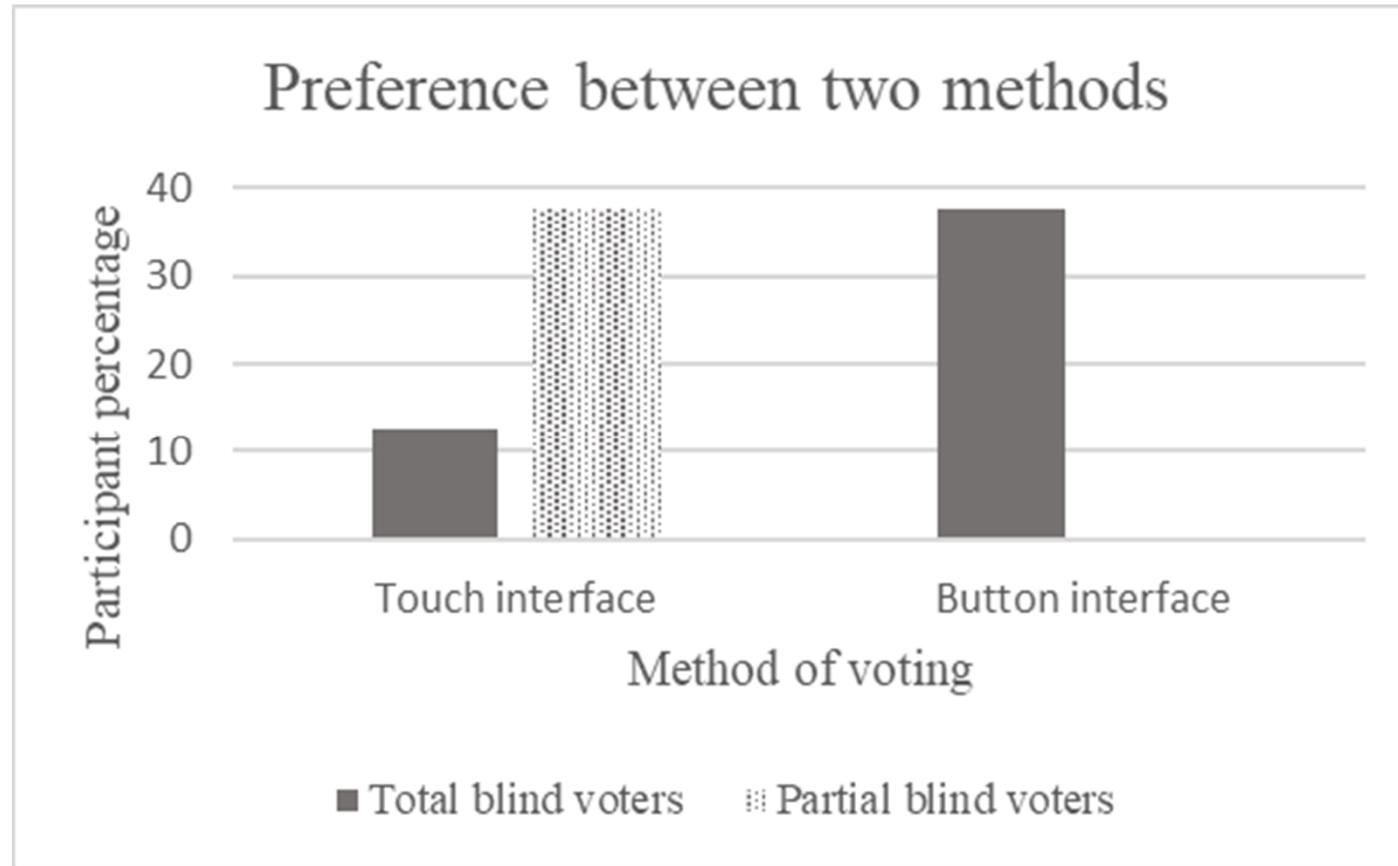
Tasks

- Vote for the instructed political party (to identify their ability to differentiate and perform single tap and double tap)



Tasks

Preference



Discussion

- Almost everyone had some sort of experience in using mobile phones.
- Their experience in using different types of mobile phones varied.
- In order to interact with the voting system, voters should be provided with several modes such that they will choose the most familiar mode, which is bringing in the **Multimodality concept** for voting
- Colors have to be refined because some blind persons have difficulties with respect to color contrast
- Although it was attempted to make the buttons easily identifiable by keeping the buttons in different locations, results showed it was inconvenient for the blind voters.

Discussion Ctd.

- Next page and previous page buttons made less sense to the participants.
- Instead of going through pages, the suggested approach is to consider a single page, which can be scrolled down from 'next' option after every five political parties/candidates.
- Results informed that users are capable and prefer to use the tactile sleeve with the touch interface but
- some participants used trial and error in tracking the holes. Thus, improvements have to be made by including a feature as a guide to track the holes, so that they do not require to remember the holes or guess.

Discussion Ctd.

- Even though a single tap is performed when using smartphones to listen to a description, prototype results showed that majority of the blind persons are familiar with double tap more than a single tap.
- But there were also some participants who were familiar with a single tap gesture. Thus, in order to listen to a description or make any kind of selection (selecting settings options, vote, confirm, etc.) tap can be allowed, where no restriction is placed.

Conclusion

- The focus group studies with authorities ensured that there is a necessity of having an accessible voting solution designed which supports the persons with visual impairment in their voting process.
- Also, it was reported that no research has been conducted in Sri Lanka with regard to this requirement
- The focus group study with the sample of voters with visual impairment showed that they are familiar with the touch interfaces as they have experience in using smartphones. Equally, some showed their interest in using keypads.

Conclusion Ctd.

- Findings resulted in designing a multimodal voting solution incorporated with Universal Design principles. The prototype was tested through a design workshop.
- Interfaces were tested only for the voting step and no other steps such as language selection, adjusting settings, etc.
- Full comprehensive system was not developed in this stage but has to be created after making necessary improvements reported
- Comprehensive evaluation method should be used such as System Usability Scale or following ISO Usability Standards