Extending the Technology Enhanced Accessible Interaction Framework Method for Thai Visually Impaired People

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**Abstract.** This paper focuses on extending the Technology Enhanced Accessible Interaction Framework Method for visual impairment based on interviews with people with visual impairment to help developers develop accessible technology solutions to help people with visual impairment to interact with people, technologies and objects.

**Keywords:** Accessible Interaction·Visual Impairment·Thailand

1. Introduction

The motivation for this research is the lack of a method to help developers with the gathering or evaluation of requirements and the design or evaluation of technology solutions to accessible interactions between people, technology, and objects in face-to-face situations involving visually impaired people in Thailand. Nearly 11% of Thailand’s registered disabled population had a visual impairment in 1996 and the National Statistics Office 2007 data estimating nearly two million women and men in Thailand, or approximately 3 per cent of the population, had a disability would suggest 220,000 people had a registered visual impairment[[1]](#footnote-1). There are 20 visually im-paired students at Suratthani Rajabhat University Thailand who have problems accessing information presented visually in classes, tutorials or lectures. For example they find difficulty reading from a board or screen and understanding what is being pointed at. In order to reduce discrimination in access to information technology developers need to produce accessible solutions while the university should also provide an accessible learning environment and the lecturers should provide accessible documents and be trained to teach in an accessible way.

1. Literature Review

There has been some research into technologies to help blind students in lectures. Quek and Olivereira [2] trained blind students to use a haptic glove with a raised line version of a diagram and computer-vision-based tracking to provide awareness of deictic gestures by providing information through the glove to inform the user where on the diagram on the board the teacher was pointing as they spoke. This system required the tactile diagrams to be pre-prepared however many companies are now developing tactile touch screens that could be used in real-time. Freire et al [3] used a mediator to add screen reader accessible text annotations to the electronic images transmitted from a teacher’s drawings on an interactive whiteboard. Many technologies have been used to assist disabled people and many researchers have been concerned with how to use technology to support some interactions between people (e.g. [4], [5]). However, until Angkananon et al.’s [8] Technology Enhanced Interaction Framework (TEIF) and Method there had been no framework that helped technology developers to consider all of the possible interactions that occur at the same time and in the same place and no method to guide developers in developing technology solutions for complex face-to-face situations for people with disabilities. The TEIF Meth-od was only developed and evaluated for hearing impairment because of time limitations of the PhD research study. Therefore this paper outlines research to extend the TEIF Method to be able to support developers to develop technology solutions to help people with visual impairment. The TEIF and TEIF Method were developed by analysing, adapting and extending the work of previous researchers and especially Dix’s framework for Computer Supported Cooperative Work [6]. Table 1 shows the five TEIF sub-components for the interactions and communication main component.

**Table 1.** Interactions and Communication In the Technology Enhanced Interaction Framework

|  |  |  |
| --- | --- | --- |
| Main Component | Sub-component | Explanation and example |
| Interactions and Communi-cation | People-People(P-P) | People communicate verbally (speak, listen, ask, answer) and non-verbally (lip-read, smile, touch, sign, gesture, nod). When communicating, people may refer (speak or point) to particular objects or technology – this is known as ‘deixis’. |
| People-Objects (P-O) | People interact with objects for two main purposes: controlling (e.g. touch, hold or move), and retrieving information (e.g. look, listen, read, in order to get information or construct personal understanding, and knowledge). |
| People-Technology (P-T) | People control technology, (e.g. hold, move, use, type, scan, make image, press, swipe) transmit and store information (e.g. send, save, store, search, retrieve). |
| People-Technology-People (P-T-P) | People use technology to transmit information to assist communication with (e.g. send sms, mms, email, chat, instant message) other people. |
| People-Technology-Objects (P-T-O) | People use technology (e.g. point, move, hold, scan QR codes, scan AR tag, use camera, use compass) to transmit, store, and retrieve information (send, save, store, search, retrieve) to, in, and from objects. |

The TEIF Method was successfully validated by three developer experts, three accessibility experts, and an HCI professor and supports other methods by providing multiple-choice questions to help identify requirements, the answers to which help provide technology suggestions that support the design stage. An experiment with 36 developers showed that the 18 developers using the TEIF Method evaluated requirements for technology solutions to problems involving interaction with hearing impaired people better than the 18 developers using their preferred Other Methods. The TEIF Method also helped the developers select a best solution significantly more often and rate the best solution significantly closer to expert ratings.

1. Research Methodology

Requirement questions and answers and technology suggestions and example scenarios for visually impaired people have been extended and developed based on a literature review and interviews with visually impaired people in Thailand e.g. :

“Golf is a blind student in the law faculty. In the class, when the teacher write or draws on a blackboard Golf needs the teacher or another student to read it aloud or explain it to him. Also when the teacher refers to material by pointing at the board he does not know what the teacher is pointing at.”

The following relevant questions help elicit requirements and the corresponding answers for this scenario aspect are given:

1. Question: What media is used to provide information? Answer: a) Non-text image, b) Printed text, c) Handwritten text
2. Question: What live in-class support is available? Answer: a) None
3. Question: What interaction types take place? Answer: (a) People to People (i.e. speech) b) People to Technology to People (i.e. writing/drawing on board)
4. Question: Is there Diexis? Answer: a) Yes

Table 2 describes a few suggested technologies (some at prototype stage) with a tick indicating whether it could address the identified requirements.

1. Conclusion and Planned Activities

Through interviews with visually impaired people the TEIF Method has been ex-tended to help developers develop technology solutions to help people with visual im-pairment to interact with people, technologies and objects. Future work is planned to evaluate its use with developers and visually impaired students at Suratthani Rajabhat University Thailand.

**Table 2.** Technology Suggestions

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Technology Suggestions | Technology Description | 1a Non-text Image  | 1b Printed text | 1c Handwritten text  | 2a No in class support | 3b P-T-P | 4a Deixis |
| Screen Reading Technology (SRT) | Automatically reads displayed text aloud and allows blind user to navigate screen | x | ✓ | x | ✓ | ✓ | x |
| Optical Character Recognition (OCR) | Converts a text image into text that can be read by a screen reader | x | ✓ | x | ✓ | ✓ | x |
| Handwriting recognition (HWR) | Converts a handwritten image into text that can be read by a screen reader | x | ✓ | ✓ | ✓ | ✓ | x |
| Diagram mediated text annotation  | Adds text to a diagram  | ✓ | x | x | ✓ | ✓ | x |
| Camera focused on board with OCR/HWR to read text & SRT | Enables text on a non electronic board in class to be read by a screen reader | x | ✓ | ✓ | ✓ | ✓ | x |
| Electronic whiteboard with OCR/HWR to read text & SRT | Enables text on an electronic board in class to be read by a screen reader | x | ✓ | ✓ | ✓ | ✓ | x |
| Pre-prepared paper tactile diagram | Static 3D representation of a diagram that can be explored by touch by a blind person  | ✓ | ✓ | ✓ | ✓ | ✓ | x |
| Live electronic tactile display  | Dynamic 3D representation of a diagram that can be explored by touch by a blind person | ✓ | ✓ | ✓ | ✓ | ✓ | x |
| Camera and haptic glove tracking of teacher’s pointing used with tactile diagram/display | Information is provided about what the teacher is pointing at using vibration in an electronic glove  | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

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