Visual-Tactile Image Representation For The Visually Impaired Using Braille Device

by

Abdulaziz Bagiev

Dissertation submitted in partial fulfilment of
The requirements for the
Bachelor of Technology (Hons)
(Business Information System)

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CERTIFICATION OF APPROVAL

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Approved by,

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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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ABDULAZIZ BAGIEV

ABSTRACT

Nowadays Internet usage is dramatically increasing all over the world and the information dissemination and acquisition is easier for sighted users. Unfortunately, visually impaired are still facing difficulties in interaction with websites. Particularly, screen reader is unable to facilitate disabled users to identify images such as basic geometric shapes. Inability to identify the shapes displayed on the screen creates restriction to interact and comprehend the content of websites for visually impaired. Thus, this project examines earlier researches and eases the web interaction of the blind people by identifying the shape of visual image converted into tactile representation using Braille device. For further investigation of the hypotheses, qualitative and quantitative method is used. The study findings are addressed to build a system that tackles the issue that screen reader is unable to address. System evaluation is executed upon producing the prototype of the system which comprises of user testing. The system is expected to improve understanding the content of webpage and enhance the interaction of visually impaired with web. Future recommendations and further findings will be discussed when system prototype milestone is fulfilled.

ACKNOWLEDGEMENT

I would like to take this chance and express my utmost gratitude to my supervisor Dr. Suziah Bt. Sulaiman for her guidance and endless support throughout completion of the project.

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It is with pleasure and pride to acknowledge my family members' support throughout my studies in Universiti Teknologi PETRONAS.

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ABBREVIATIONS AND NOMENCLATURES

et al.	And others
etc.	Et cetera
API	application programming interface
WHO	world health organization
SDLC	system development life cycle

CHAPTER 1

INTRODUCTION

1.1 Background Study

Visual-Tactile image representation applies science of touch in order to create an interaction between impaired and computers. Tactile tools give an opportunity to the users not only to implant information to the computer but the ability to receive necessary content by means of fingertip sense as well.

Bodily touch among mainframe with visually impaired via key in/key out apparatus like a pin array is involved in haptic interaction that helps to figure out the shape of the image by fingertip sensation in our research. Force feedback device like pin array is used to recognize the fundamental figure of image displayed on the monitor. The system functions just by receiving a visual information (image) and converts it into tactile representation on pin array. Then the user will be able to sense the shape of an image by fingertip.

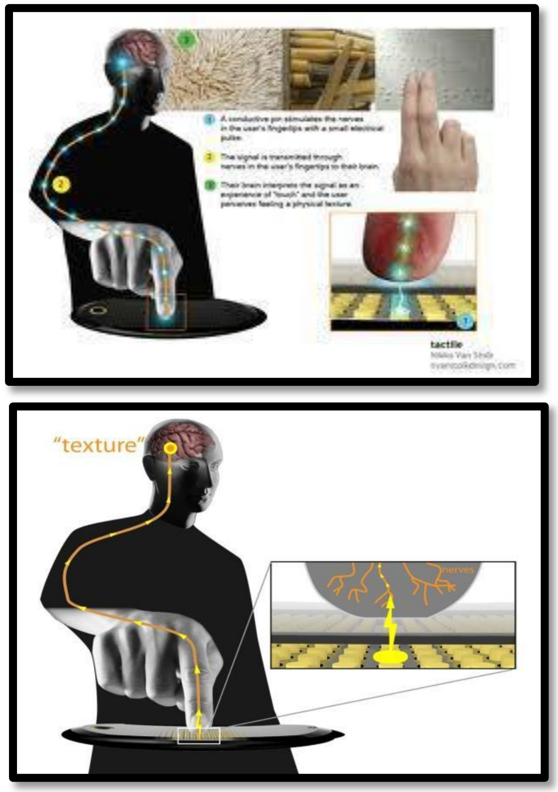

FIGURE 1: Pin Array Representation

1.2 Problem Statement

Figure 2- WHO Logo

Based on the report of the World Health Organization (WHO) visually impaired people are raising in numbers approximately making two hundred and eighty five million in the globe. Among them almost forty million are considered to be fully blind whereas the remaining numbers go to the low vision population of the planet earth. People who are above average age are suffering from blindness and majorities are the residence of developing countries of the world. Worldwide, the key grounds of blindness are proven to be cataracts, transferable diseases and uncorrected refractive errors.

The rapid technological advancement and the trend of increased interaction of Web technology have lead to website accessibility by visually impaired users yet the challenges are inevitable. One of the examples of assistive technologies is screen reader that enables disabled user to interact with web; however, it has limitations of representing images in tactile form. Moreover, **the visually impaired have difficulties in learning the images on the web/ document as the screen reader does not support description on images hence the system that is being proposed is oriented to identifying the shape of the images projected on screen.** Furthermore, by having this system the limitations that restricts Web accessibility will be narrowed down among impaired.

1.2 Objective & Scope of Study

Nowadays with the current trend of advancement of information technology the virtual reality in conjunction with multimedia is providing the unseen and desirable opportunities for the disabled people. The systems that are being created more or less are helping those impaired people to ease their lifestyle and add more joy to it. Hence, not going far from that objective our research has aimed at developing a system that will enable visually impaired community to interact with the information technology product such as computer. The image displayed on the computer is recognized by fingertip of those parties.

It is very important to know the details of the system and align it with the objectives of the end product that is going to be developed prior to discussion of the factors that may affect it directly and indirectly.

The System should have the following features:

- User friendly
- Fulfill all the requirements of end users

- The level usefulness conducted by survey
- The different features that the existing ones.

The Haptic Interaction has led to the improvement of many aspects of human being via the systems that it has offered to solve the daily problems of mankind. Thus this research is aimed to look at the possibility of easing the lifestyle of disabled people and **proof of concept** with the following objectives:

- To investigate the barriers in existing GUI for blind people
- To investigate how blind people are interacting with web images and how it can be improved.
- To develop a system for visually impaired people to identify basic shapes of images on the web.
- To improve and enhance the interaction of visually impaired with web from the test.

CHAPTER 2

LITERATURE REVIEW

2.1 Existing Technologies used for reading web pages for visually impaired

Visually Impaired users are dependent on the various types of assistive technologies that ease web interaction of one. In fact the type of assistive technology is identified by the degree of how the user is impaired. The content of web page might be represented either in auditory or tactile modality, however, the combination of both is inevitable phenomena.

2.1.1 Screen Reader

JAWS is considered to be world's most popular screen readers. It allows navigating the visually impaired access web page and read aloud the screen content.

2.1.2 A Refreshable Braille Display

Electro-mechanical device that allows Braille characters to be displayed as pin arrays in a flat surface. Visually impaired users will be able to read the content of the screen by sensing the pins.

2.1.3 A Screen Magnifier

One of the types of assistive technology that permits visually disabled users to read the large content of the web page that interfaces with computer's graphical output.

2.1.4 Voice Browser

The functioning method of voice browsers is analogous to web browser, however, it detects pre-recorded audio file and presents information aurally. It is often encoded in standards-based markup languages.

2.2 Defining Haptics & Tactile

Different definition has been given to the terms *haptic* and *tactile.* Tactile are used as the main category whereas the haptic is seen as the one of the examples of tactile. On contrary some scholars claim that haptic is considered to be the main category and tactile is the subset of it. Despite the claims by the scholar the fact is that while referring to tactile the static aspect of touch is used whereas the haptic includes the dynamic aspects of touch.

Science of touch is defined as the area where the exploitation of the substance exists in order to get or send felt sensation. According to some references the contact is usually occurred in a range of HID (haptic interface device) with the involvement of human being hand as well as actual substances.

FIGURE 3: Example of Haptic Devices

2.2.1 GUI for input devices for visually impaired:

Distinct betterment in everyday mainframe relations with respect to in pace, accuracy, plus lessening of tiredness are indicated in human aspect studies. Particularly, cases with intention of the enhancement of designated tasks such as tip and tick as well as sketching sets. Furthermore, science of touch will be enabled to represent exigency as well as pace giving a priority to both. In a latter case it might be used for interactive annotations. For instance, in order to retrieve efficiently documents and databases haptic tabs can be implemented and it can be capable to execute multi-author document editing. Therefore, the scope of the haptics can be observed not solitary from visually impaired peoples' side but in various fields of research too. The haptics are applicable in the following areas as well:

Games: Applying force feedback will enhance the interaction and the sense of immersion of player/user. Sophisticated games that require placing, balancing, hitting and bouncing can be easily programmed. Moreover, haptics will be handy in educational games too whereas the concepts of math and physics possible aided by science of touch.

Multi-media publishing: Text, sound, images, as well as video is components of applications of a one. Haptics have been ignored as a result being deficient in suitable equipments as of now. Applying of science of touch could be able to aid "mechanical documents". For instance it would provide an experience of visual, auditive and haptics. Hence, the concern to develop and implement tools such as Immersion Studioe is necessary to feel the haptic sensation. There was mentioned application of such functionality which is online catalogue with sense feedback. In fact, this sort of application would lead to the competitive advantage as the matter of the fact that it is not available yet in market.

Arts and creation: The usage of computers among musicians and visual artists are considered to be high. On the other hand, the creators prefer to use their hands to draw up sketches. There is a claim that haptic involvements in computers give a vast opportunity for one.

Editing sounds and images: Sound and video documents are given rapid access by the science of touch (haptics) for the purpose of mixing, editing and splicing (MacLeanet al., 1999).

Vehicle operation and control rooms: In hectic as well as swinging environments, haptic interaction can be implemented to ease illustration pack. Equipments such as iDrivee are commercially mounted into cars such as Rolls-Royce Phantom and BMW 7 series which proves how advanced the science of touch is getting. It gives an aid to navigate menus and control sliders with a primitive rotary controller. Here the single controller is considered as input to sense the haptic feedback more intuitively and ordinary use. Likewise, applications are implemented vastly in controller system of an air traffic control and nuclear.

Engineering: It is usually difficult to display or visualize meticulous details in computer design however the existence of haptics and its implementation will ease the designers work in a way to feel those details via hand sensation the desired artifacts. Moreover, simulations can be examined, assessed and debugged physically.

Manufacturing: Haptics provide a chance to eliminate prototyping for assembly in terms of substituting the necessary parts with feel sensation. Moreover, it aids to verify the capability of human being to maintain and sustain complex system ahead of development of one. The coding of those equipments such as many-axis and controlled machines via numeric are executable.

2.2.2 Haptic graphing:

There is a claim as to the support of usage static and dynamic method of representation of two dimensional plots where one (dynamic) is used whilst exploring scientific observable fact. Two dimensional plots in a form of 3D VE is able to be remunerated in the virtual computer unit on plane. The virtual physics experiments allow the reproduction of plots positioning, velocity and acceleration as well. In addition to reproduce the 2D graphs likewise method is applied as linear line segments that connect the data points. In 2D Graphs to find and sense the thin lines are cumbersome hence a method called virtual fixturing is applied to sense it. It aimed to produce a force feedback to guide the receiver in sophisticated tasks as tele-operation of artifacts. The lines will be sensed by a fingertip of user afterwards of generating the forces analogical to magnet pulling iron case. Despite the fact that these senses are only upright to the line, although, it permits the users to without difficulty glide the length of the row, as a result, tag along the data curve.

A different method is used for sensing three dimensional plots in science of touch. The dataset for a 2D matrix values are used 3D dataset which are Z coordinates on an XY grid. The object surface is piecewise linear in case of connection vertices with polygons. The haptics can be implemented to enumerate such objects' volumes as spheres and cubes. Another method can provide polyhedral substance, however contain quite a few limits like the amount of polygons with the aim of usage. However, the common drawback of haptics is to find an appropriate force vector direction. The problem occurs when the IP go through the exterior, the difficulty arises since the course would not be the ordinary vector of the exterior at that point. Though, as the IP penetrates the exterior, the vigor course is premeditated by seminal of what facets the IP would recline on if it cannot cross all the way through the exterior. The point that has been discussed is considered and defined as shadow point. The shadow point of plane is considered to be the point which is close to IP.

The science of touch for a discrete data points is applied in a similar way as the method that is used for the sphere to feel the force feedback. To sense the sphere a little calculation needs to be done which distance between IP and the center of sphere in case if the distance is lesser than radius system generates output of it to feel the feedback. For that reason so as to sense numerous points, there is step to place a sphere around the IP (IP - the sphere center), then only is possible to calculate the distance. Haptic interface will receive nonzero zero forces upon one is being added and calculated. In a such way receiver will sense the points. It is complicated to understand the details of graphic data devoid of numbered axes and tick marks. The axes can be seen in haptic environment as bumps and grid is as well necessary to identify the location of plot. In order to create a force grid is created when IP passes through them which permit the receiver to sense the grid with no prying with the data itself. Additionally, IP coordinates can be converted to speech via text-to-speech tool.

2.2.3 User Interfaces based on gesture for Blind People & Touch Screen Accessibility:

Visually impaired, nowadays, have an ability to access to the systems like touch screen. The reference state that the early touch screens had a difficulty to be accessed. Since the early days of touch screens the limitations of one were and have been studied in order to widely spread the system all over crowded places. As a result of it new equipments were mounted in the system which supports the read functions for impaired and ease the interaction of them with system. As mentioned earlier concerns about the accessibility of touch screens have been considered for decades.

As the form factors of touch screens have changed, so have the approaches to making them accessible. In order to make touch screens accessible to blind users it can be categorized into three approaches that is **software**, **hardware**, and **hybrid approaches.**

Interacting with Touchplates: touchplates can be tracked and used on most imaging-based touch screen systems. It has been tested on both the Microsoft PixelSense4 interactive tabletop, as well as a custom diffused illumination (DI) tabletop display that is constructed. Depending on the materials used to construct it, the “body” of the touchplate may be transparent to the touch screen’s sensing system, or it may be identified as a touch “blob” and ignored by the application. Thus, applications that take advantage of touchplates can typically be implemented using existing touch APIs.

2.3 Designing a Haptic System

An actuator or also known as a motor is controlled by an embedded software and used to create a haptic sensations therefore it is integrated into a devise's user interface with the help of application programming interface (APIs) (Robles & Joes, 2012). One of the most important elements of enabling the utilization of an actuator is carried out through system level integration approach which on the other hand ensures the best user experience by collaborating of components and software. The key components of any haptic system include:

- **Actuator** − hand-held devices assembled in box to sense force.
- **Electronics** − A haptic system device with power amplifier to drive the actuator.
- **Run System** − plays a role of receiver of instruction from a software application and sends desired sensation.
- **Application Software** – to widely interact with GUI of the system.

2.3.1 Graph Generating Device based on Web:

The device is to be like web page and easily modifiable through server modification. The area researchers have utilized such device in order to instill basic principles of education to the impaired students. It comprises of double functions which are namely supposed for scratching and drawing of objects. One is executed in manner of excel plots via using such devices as force feedback mouse.

Moreover, this device allows blind users to be in interaction with sighted humans as the system generated plots are easily printable as well as it provide an ability to scratch the drawings manually. A great substitute for the rubbers this system might be as it will enhance the understanding capability of visually impaired. It will aid the impaired once to enhance and comprehend the content of daily notes via drawing it practically on their own. The drawings are assisted by force feedback device to navigate the users (blind) to scratch their desired picture, graph, and anything they wish to.

2.3.2 Haptic/Audio based exergaming:

There has been scheming that has been built up is called "VI Tennis" where a basic tennis game is set up with improvements for blind participants.

A new spatial audio that was added to bring a new type of sensory where one can guess and plot the direction of ball. Haptic feedback was included through the rumbles ability.

Using wearable accelerometers allows observing the energy expenditure level and apparently finding extents of force expenditure upper than normal film match in performance. It is reported that the energy consumption level was sufficient enough to provide the daily recommended dose of exercise for children.

Although, the VI Tennis game concentrated only on the player's dominant arm, after many researches, force feedback has a motion to coordinate player of game.

2.3.3 Haptic exploration of online web maps:

Through synchronous haptic devices, multimodal interactions and typical Web browsers, the HapticRiaMaps has the sufficient technology to provide an online 2D map exploration. By using the haptic interaction, users can simultaneously perceive the structure of the road environment (including POIs, crossroads, road names, etc.) Based on the utilization of regular web browsers and favorable Web mapping applications (e.g. OpenStreetMap).

The effect of road map is analogical to the experience of not blind people by impaired.

Consequently, the scheme makes online maps easily accessible to blind people. It is aided by the use of devices to engage with map such as pointer cues, and the scheme will justify the highway, directions and junctions via unlike modules. Moreover, the map possesses valuable information about the environment, destination of passage points and automobile stops, and pavement. Because it gives the visually impaired the gift of navigation and interaction through the internet maps, navigation easily accessible, it is crucial for them. The user can search for a specific address or provide the exact longitude/latitude of any given map area through the OpenStreetMap functionality.

2.3.4 Tactile-auditory interaction:

According to researches the concept is to develop digital documents into three dimensional audio spatial The blind users communicates via device or a graphic tablet, and listens to the system's calls through headgears. It works in way when user get feedback using fingertips and this response is sent to audio gadget respectively.

The feel place is the stringer to the resonance site in the auditory hole. For example, if the location is on left side the sound will come from the left and if it comes from right it come from right. There are more devices that assists impaired the likes of which include:

* A three dimensional audio Web browser aids to use an internet for impaired.

* A Web sonification tool that helps to track sound and position of our fingertip.

* A cluster of sonic games that helps blind users to interact with mainframe.

* To understand graphs and images the tool idea is applied.

2.3.5 The Visual haptic workbench & Enabling Audio-Haptics:

This particular workbench allows many-sided communication as to the extent of an improvement of immersion which lets haptic feedback that is made from Phantom 3.0 for immersive workbench. The device is suited above the workbench with a cross-braced lumber frame. As a result this device aids to remunerate the fingertip of user in 3D space to give force feedback. Computer tackles the fingertip once it is spotted by sensor. It is developed in a way of how an object is close to software if one is far the software will assign zero hence no sense is received. Force is sensed by the motors that are called DC in triple quantity.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In this particular part the researcher will abstract the methodology that is going to be used throughout the system development life cycle (SDLC). As the final product is going to be a system thus the development methodology is to be selected for the entire execution of it.

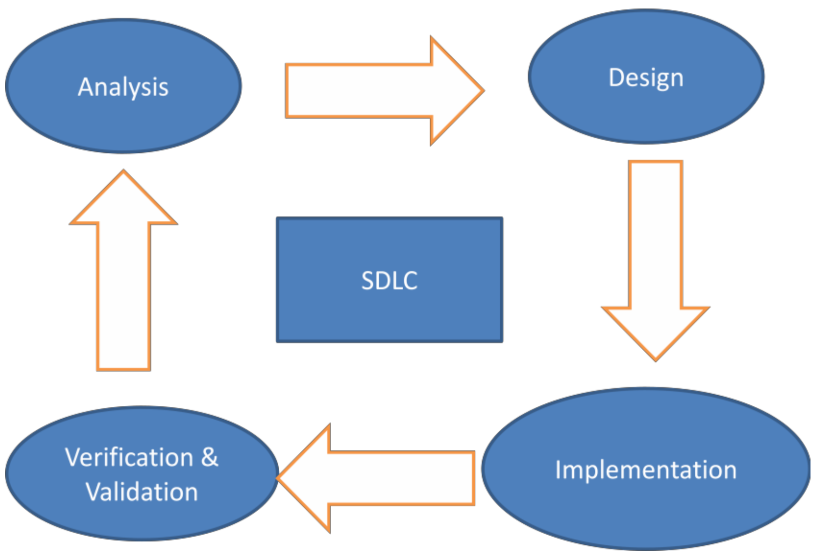

FIGURE 4: Development Methodology

3.2 Prototyping (project activities)

Prototyping method is slightly different from the traditional SDLC method where software is created in a well-planned pattern. The SDLC includes System analysis, Design, Testing and launching. Most other development software also uses this pattern. The software development will be initially planned to start, thus this will be well-organized as intended. Execution will follow the arrangement as written by the developers.

This however is mainly focusing on developers and not consumers despite all the recompenses. The prearranged formation of a program makes it harder to generate variations prior to the program is executed. Thus it is proposed to take the prototype approach so that errors can be found along the way to perfecting the software. For this project visually impaired opinions and ideas attendants of courses at Malaysian Association of Blind located in Ipoh is considered to make the software more efficient and aid in the development of the software.

The feedback received from attendants of courses at Malaysian Association of Blind located in Ipoh and developers can further analyze the software design and requirement thus creating more and more perfect product. The features will be more satisfying and more user-friendly.

There are several reasons as of why this methodology is proposed. However, the main reason is due to the effect of prototyping which basically allows the sample software to be tested on real users where they can try it out before the system is completely ready. This approach is better when compared to asking for users opinions based on their knowledge and interpretation after they read reports if they are able to do so. Rather than reports, it is better for the users to have a chance to try it first hand on a sample of the product and commenting on it so that the flaws can be corrected in the real system.

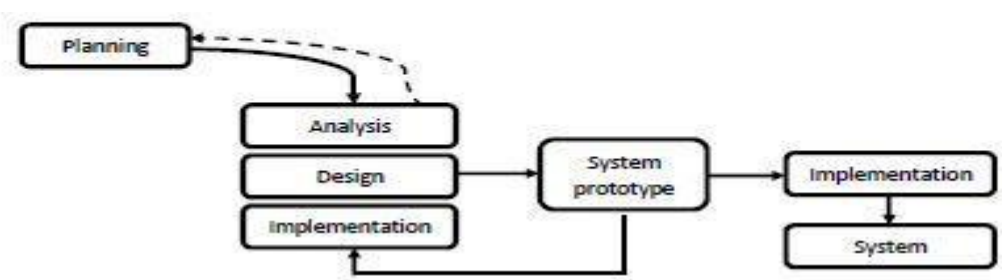

FIGURE 5: Prototype Modelling

3.2.1 Analysis:

In this stage the critical analysis of the previously conducted researches by UTP students will be taken as feedback as well as identifying the problems that are being faced by visually impaired through thorough literature review.

Data Gathering will be divided into two stages. The first stage will involve only the feedback from existing resources such as research papers, journals and students' FYPs. However, the second stage will be done by interviewing visually impaired who are attendants of courses at Malaysian Association of Blind located in Ipoh via prototype of the system.

3.2.2 Design:

The interface of the currently being developed web page is used as it is related and similar in the scope and additional features will be mounted onto the system that allows the visually impaired to identify basic shapes such as triangle, circle and square in that particular web page.

3.2.3 Implementation:

In this stage a bulk of coding is executed in order to develop system prototype. All the system requirements must be met as per the specifications gathered in designing as well as analysis part of the project. Additionally, this stage will end by the feedbacks provided by experts (external examiners, final year project coordinator, internal examiners and project supervisor) and user (attendants of courses at Malaysian Association of Blind located in Ipoh) for the reference to make amendments and eliminate some complexity in the system.

3.2.4 Verification & Validation:

Blind fold testing is to be carried out with the assistance of end users (attendants of courses at Malaysian Association of Blind located in Ipoh) to verify & validate the functional and non-functional requirements are appropriate as per the preference of the end user.

The general idea of this stage is to be consistent without any conflict between requirements in order to develop complete system that will enable future researchers to use as reference for their project analysis. The detailed content of user testing is as follow:

- Measure efficiency in terms of time to detect the shape. The result should indicate the time taken to complete the tasks using system
- Testing on comprehension of the shape by drafting it. The result should indicate the understanding and naming the shape on the basis of the test conducted via system.

3.3 Tools Required:

- Pin Array
- Web Interface: Notepad++ 6.4.2
- Job Access With Speech (JAWS)
- Borland C++ 5.02
- Microsoft Visual Studio 2008
- C#

3.4 Key Milestones

Each activity should be considered in incremental terms. Prior to finishing the preceding activity the following is not started.

Activities	Week
Submission of Progress Report: - **Additional information attachment to the project** - **Submission of draft GUI (coding)**	**4**
Pre-Sedex: - **Complete Prototype**	**10**
Submission of Draft Final Report: - **Working on the comments issued by supervisor** - **Submission of technical paper**	**12**
Viva	**13**
Submission of Project Dissertation	**14**

TABLE 1: Key Milestone

3.5 Gantt Chart

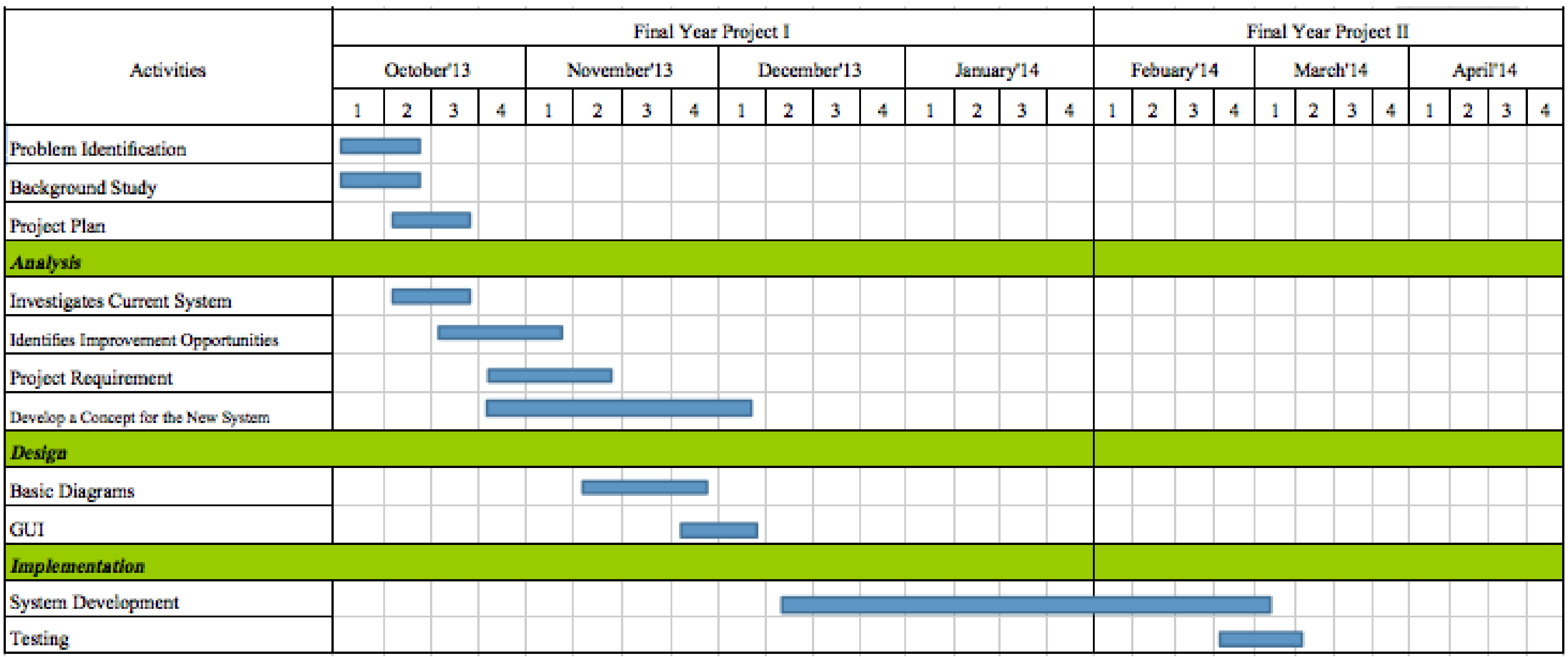

TABLE 2: Gantt Chart

CHAPTER 4

RESULTS & DISCUSSIONS

4.1 Summary of findings:

The respondents have stated that the current system that they have been using does not support image/graphics representation; it just replies that it is a graphic not giving out any detailed information regarding the image (shape, color, etc) According to one of the respondent the importance of image identification is one of the most important factors which leads to comprehending the content of the Web. Hence, the proposed system is considered to be as the formulation of the foundation for further enhancing and not only limiting the scope to basic geometric shape but more advanced graphics representation and objects. Moreover, later on the system can be used for academic purposes among visually impaired kids.

4.2 Preliminary Interview with Malaysian Association for the Blind:

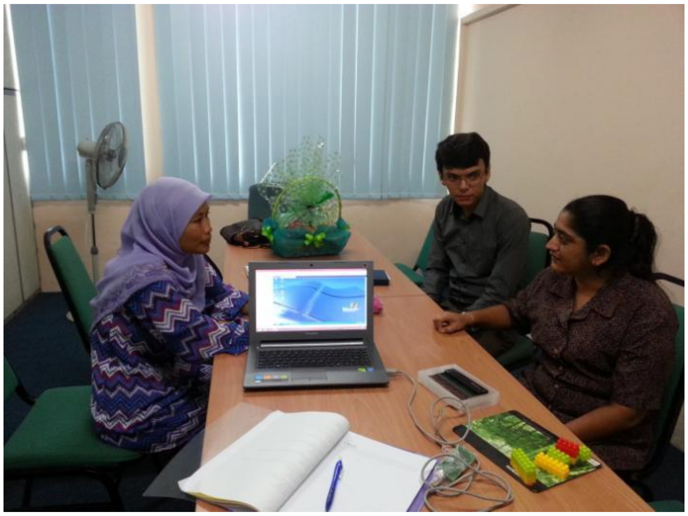

FIGURE 6: Interview Session

Interviews had been conducted with several representatives from Malaysian Association for the Blind (MAB) Kinta Valley Rehabilitation Centre, Ipoh, Perak; Ms. Meena Kumari, the MAB"s Computer Literacy Trainer; Mr. Khairuddin and Mr. Hanafi trainees at MAB. The objectives of the interview are:

- To find out the difficulties in understanding of Web content.
- To discover the relevancy of the project proposed and importance in interacting with Web.

4.3 System Flowchart:

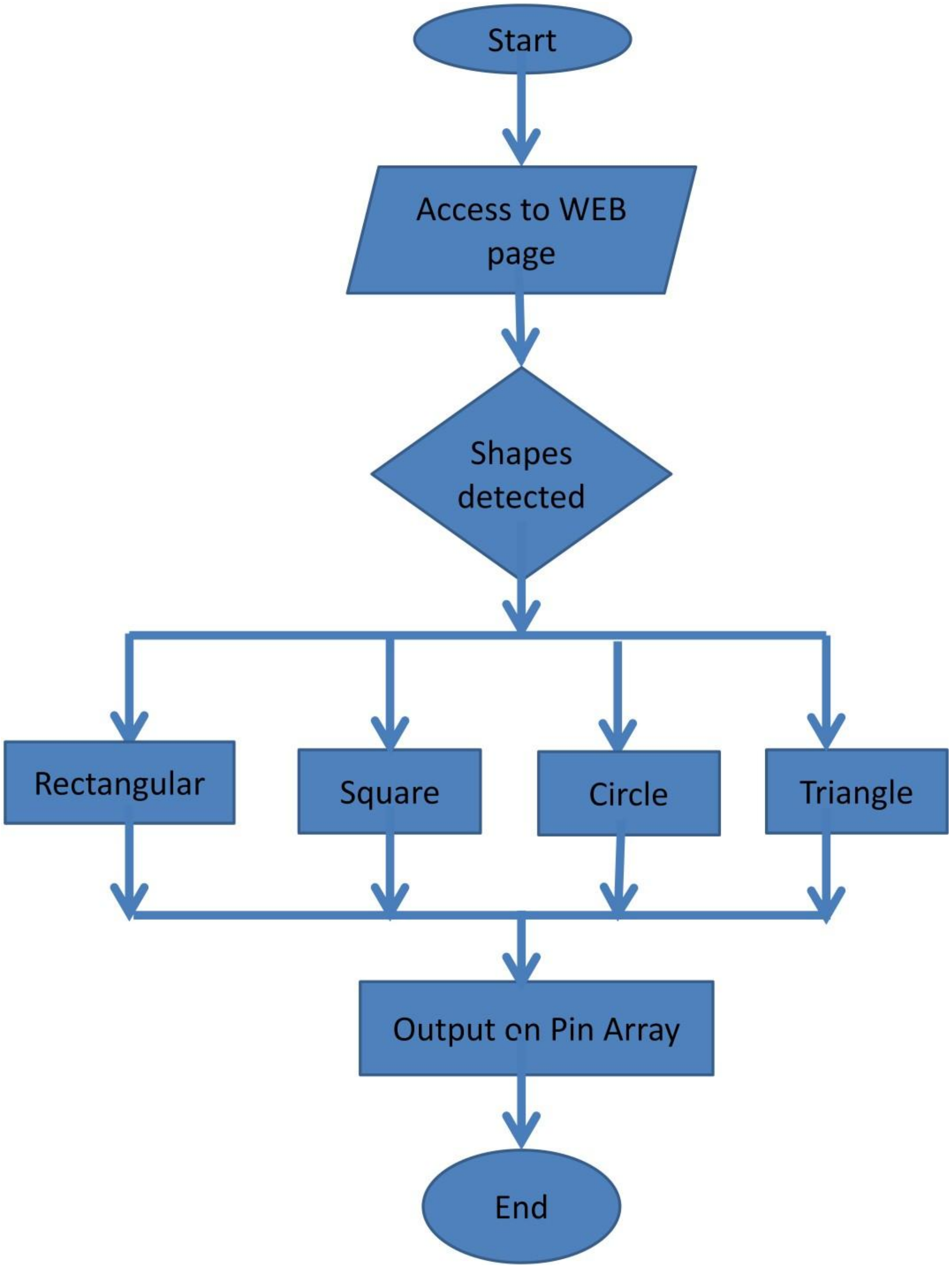

FIGURE 7: System Flowchart

4.4 Prototype Design

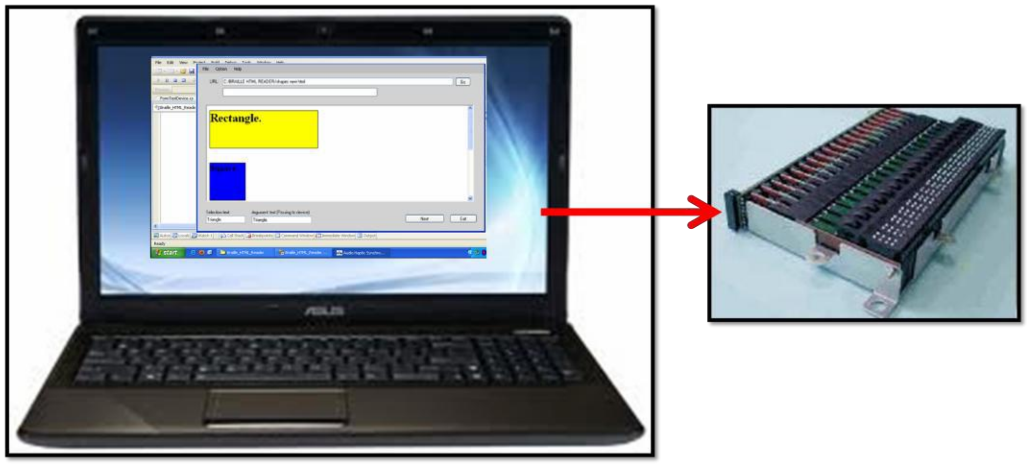

FIGURE 8: Prototype

4.5 Sample codes for GUI:

```
<html>

<H1><div style="background-color:yellow;width:300px;height:100px;border:1px solid #000">Rectangle.
</div></H1><BR>

<H2><div style="background-color:blue;width:100px;height:100px;border:1px solid #000">Square.
</div></H2><BR>

<P>Circle. <img src="circle.jpg" width="100" height="100"/></P><BR>

<U>Triangle. <img src="triangle.jpg" width="126" height="100"/></U><BR>

</html>
```

4.6 Sample codes for Braille:

```
void test()
{
    char   ttt[100];
    char  *pttt=ttt;
    int i;
    //If changed write text via Change Table in the braille Line
    strcpy(ttt,value.c_str());  //strcpy(ttt,Edit1->Text.c_str());
    //std::cout << ttt << std::endl;
    std::fill_n(Zeile, 80, 0);


    if (mode == "normal")
    {
        //Zeile[0]=0;
        //Zeile[1]=0;
        Zeile[0]=HardwareChange(0xbe);
        Zeile[1]=HardwareChange(0x77);
        //Zeile[0]=HardwareChange(0x0);
        //Zeile[1]=HardwareChange(0x0);
    }
    else if (mode == "bold")
    {
        //Zeile[0]=28;
        //Zeile[1]=20;
        Zeile[0]=HardwareChange(0x0);
        Zeile[1]=HardwareChange(0x0);
    }
```

```
else if (mode == "italic")
{
    //Zeile[0]=20;
    //Zeile[1]=0;
    Zeile[0]=HardwareChange(0x0);
    Zeile[1]=HardwareChange(0x0);
}
else if (mode == "underline")
{
    //Zeile[0]=28;
    //Zeile[1]=3;
    Zeile[0]=HardwareChange(0xf7);
    Zeile[1]=HardwareChange(0xc4);
}
else if (mode == "H1")
{
    //Zeile[0]=HardwareChange(Braille_Char['T']);
    //Zeile[1]=HardwareChange(Braille_Char['T']);
    Zeile[0]=HardwareChange(0x36);  //i
    Zeile[1]=HardwareChange(0x36);  //j
}

else if (mode == "H2")
{
    //Zeile[0]=HardwareChange(Braille_Char['H']);
    //Zeile[1]=HardwareChange(Braille_Char['R']);
    Zeile[0]=HardwareChange(0xff);
```

```
    Zeile[1]=HardwareChange(0xff);
}
else if (mode == "PR")
{
    //Zeile[0]=HardwareChange(Braille_Char['P']);
    //Zeile[1]=HardwareChange(Braille_Char['R']);
    ///Zeile[0]=0;
    ///Zeile[1]=0;
    Zeile[0]=HardwareChange(0xbe);
    Zeile[1]=HardwareChange(0x77);
}
for (i=2;i<80;i++)
{
    Zeile[i]=HardwareChange(0x0);
    /*
    if (*pttt)
        Zeile[i]=HardwareChange(Braille_Char[*pttt++]);
    else
        Zeile[i]=0;
    */
}}
```

4.7 Results of Pilot Testing with Sighted Users

A pilot testing was conducted to test the effectiveness and overall usability of visual tactile image representation system in representing basic geometric shapes and improving the understanding of the web content among the visually impaired users. The performance of the system was then compared to the screen reader to verify for its strength, weaknesses and future enhancements. The pilot testing was also done to test the experimental framework design, so that it can be improved and adjusted later in the user testing with the actual population - the visually impaired users.

Three participants from Universiti Teknologi PETRONAS (UTP) aged between 19 and 30 years were recruited to participate in the pilot testing. It is acknowledged that they have no prior experience using screen reader or any other assistive technology for the visually impaired. The participants were blindfolded for all tasks to assimilate the visually impaired users. The shapes being tested in the pilot testing were rectangular, square, circle, and triangle. They were given a simple sample website to be explored using visual tactile image representation system.

Overall, the system was found as effective and efficient to identify the basic geometric shapes which tackles the main objective in order to comprehend the content of web and proves the concept of image representation applicability.

FIGURE 9: Pilot Testing

4.8 Results of User Testing with Visually Impaired

Actual User Testing has been conducted with the representatives of Malaysian Association for Blind (MAB) Kinta Valley, Ipoh. One of the respondents, En. Muhammad Izhar Bin Anuar, 25 have stated that The Braille Device is better than Screen Reader due to involvement of touch science and the current system without any difficulty enabled him to describe images represented and this system will ease daily web accessibility and comprehension of web content to every single details it has. A little bit practice is needed to enhance the sense of touch. Moreover, it will be useful for blind people to learn geometry and math he added.

Figure 10 User Testing

CHAPTER 5

RECOMMENDATION AND CONCLUSION

The project that has been undertaken is unique in its nature as it deals with people who are more or less frustrated with their lifestyle. Hence, keeping in mind their state one is of the challenging part thus being extra careful during information gathering session via interviews is recommended. As a result we will be able to eliminate any sensitive concern while dealing with visually impaired people.

5.1 Relevancy to the Objectives

Based on the interviews and experiments conducted, it is proven the shape representation using proposed system is important to support Web accessibility and improve understanding of the Web content. Hence the main objective with intent to proof of concept, to describe an image on web page to develop a system prototype for visually impaired people and to identify basic shapes of images on the web are met via literature review and proposed system Visual Tactile Image Representation for Visually Impaired Using Braille Device.

5.2 Suggested Future Work for Expansion and Continuation

The actual User testing has been conducted and scheduled on 14th April, 2014 with the members of Malaysian Association for Blind located in Ipoh. It is suggested that acquisition of comparatively bigger device will further enhance the ability to represent different shapes in larger scale which is very crucial to comprehend web content. In addition, it is suggested that the scope of the system should not be limited to the basic shapes; however, it should as well tackle any visual random images. The class of html tags should be created in order to represent universal shapes.

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APPENDICIES:

Interview Questions/Preliminary Survey:

1. Do you browse internet?
2. How long do you use internet per day?
3. Do you use any assistive system that support image identifying?
4. What are the problems of existing assistive technology?
5. Do you think that proposed system will be interesting to attract users (impaired)?
6. How important is it to identify the basic shapes?
7. Could it be used for educational purpose to educate kids about basic geometric shapes?
8. How would you rate the proposed system
   a. Very High
   b. High
   c. Average
   d. Law

Name: **Age:**

Interview Questions/Post Survey:

1) The system is helpful to increase Web Accessibility.
   - ☐ Strongly agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree

2) I can identify shapes represented through visual-tactile image representation system.
   - ☐ Strongly agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree

3) I get more comprehensive understanding about the web content using visual-tactile image representation system.
   - ☐ Strongly agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree

4) Level of complexity of the system.
   - ☐ Low complexity
   - ☐ Neutral
   - ☐ Complex
   - ☐ Very complex

5) The system can be used for educational purposes
   - ☐ Strongly agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree

6) Suggestions:

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