

MAUU5900
MASTER THESIS
in
Universal Design of ICT

May 2019

Visual Reading vs. Screen Reading

(On Demand Summary Generation and Text Tagging - ODSG&TT)

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Abstract

The 20/20 vision readers – the readers with no vision impairments, are able to read text and perceive information simultaneously while this is not very easy for people who are visually impaired. 20/20 vision readers or readers with normal vision (“What Does 20/20 Vision Mean?,” 2016) can quickly get an overview of the information within a text; however, it is not as easy for the visually impaired. This project introduces us with United Nations declaration on right of access to information. It carries out a detailed study on possible factors affecting the successful screen reading and the possible factors that can contribute towards the improvement of screen reading. The efficient text extraction, summarization and representation techniques are discussed so that the resulting text carries the intended essence for the readers. This research leads towards the development of a new summarization technique, which is referred to as On Demand Summary Generation and Text Tagging – ODSG&TT. This technique makes use of a summarization algorithm (“Summarizer - Algorithm by nlp,” n.d.) and text tagging algorithm (“AutoTag - Algorithm by nlp,” n.d.) developed by Algorithmia, which enables visually impaired to summarize the text using a button control. When a user presses this Summarize button in ODSG&TT it displays the summarized text and keywords within the same webpage dynamically and focus of screen reader is also transferred to the keywords using a button control and summary section with minimum navigation and simplified and faster approach towards screen reading.

Acknowledgements

This thesis owes many thanks for many people in my life. First and foremost, Thanks to Almighty Allah who made capable of completing this thesis within the time. I can never thank Him enough for the blessings and opportunities He has bestowed upon me.

Further, I would like to dedicate this effort to my parents and my wife who have always supported me in my life and because of whom I am at this position today. Their sacrifices and support are always continuous and thankless.

Last but not the least, I would like to thank my supervisor for this thesis Ms. Evelyn Eika. Her guidance and supervision helped me finalizing my thesis. Her support was always available online or offline and doors of communication were always open during the course of this research thesis.

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Chapter 1 Introduction

Reading with having a 20/20 vision is quite a normal and common way of reading. However, when it comes to the accessing the digital information through screen readers, it is not as trivial.

Interpretation and visualization of text is easier for 20/20 vision people and they are able to carry out these tasks simultaneously. However, for visually impaired, there are number of challenges associated with it. Therefore, it becomes essential that they have access to an efficient screen reading software that can give them as closer experience of reading as they are reading visually.

This research leads towards designing and development of a new approach towards text summarization, which is referred to as On Demand Summary Generation and Text Tagging – ODSG&TT. This technique makes use of a summarization algorithm (“Summarizer - Algorithm by nlp,” n.d.) and text tagging algorithm (“AutoTag - Algorithm by nlp,” n.d.) developed by Algorithmia, which enables visually impaired to summarize the text using a button control, by giving them an opportunity to summarize the lengthy text. Pressing the summarize button given in the developed interface, generates the summarized text and keywords programmatically and embeds them as new sections at the top, within the same webpage. Moreover, after key words and summary generation, the program shifts the focus of screen dynamically to these newly added sections and this allows screen reader to start reading the screen automatically from the new sections.

There exist many screen reader Software in the market, but they still have some issues and challenges associated with them. These issues can be related to screen reader itself as well as with the design of document also. Therefore, before continuing, it is important to understand that why the right of access to information is important? What are the challenges associated with screen reading? and the role and importance of Assistive technologies for the impaired.

1.1 Right of Access to Information

It is of utmost importance that every person regardless of their physical impairment must be treated on equality basis and must have equal opportunities in every walk of life. Article 21 - Freedom of expression and opinion, and access to information (“OHCHR | Convention on the Rights of Persons with Disabilities,” n.d.) states that:

“Parties shall take all appropriate measures to ensure that persons with disabilities can exercise the right to freedom of expression and opinion, including the freedom to seek, receive and impart information and ideas on an equal basis with others and through all forms of communication of their choice, as defined in article 2 of the present Convention, including by:

1. Providing information intended for the general public to persons with disabilities in accessible formats and technologies appropriate to different kinds of disabilities in a timely manner and without additional cost;
2. Accepting and facilitating the use of sign languages, Braille, augmentative and alternative communication, and all other accessible means, modes and formats of communication of their choice by persons with disabilities in official interactions;
3. Urging private entities that provide services to the general public, including through the Internet, to provide information and services in accessible and usable formats for persons with disabilities;
4. Encouraging the mass media, including providers of information through the Internet, to make their services accessible to persons with disabilities;
5. Recognizing and promoting the use of sign languages.”

The Committee on the Rights of Persons with Disabilities (CRPD) is the body of independent experts which monitors implementation of the Convention by the States Parties (“OHCHR | Committee on the Rights of Persons with Disabilities,” n.d.).

1.2 Common Challenges Related to Screen Reading

Reading something with the Screen Readers brings in many associated challenges for the users. With the widespread digital information, it becomes very hectic and time-consuming task to extract relevant and quality information out in the minimum time for 20/20 vision people and it is even more cumbersome task for visually impaired people. Browsing through the digital documents can be a frustrating experience for many readers if accessibility guidelines are ignored or improperly implemented e.g. if the images in a document do not have respective alternate text then screen readers do not detect the images and there are chances that a very useful information is ignored. Similarly, if in a video audio aid is not available, the content becomes inaccessible for the user. Therefore, it becomes an important task to design a document in such a way that accessibility

guidelines are followed, so that the documents or web pages can work properly and efficiently with Screen Readers.

In practice, it has been observed, that accessibility guidelines are usually ignored, and vendors or content creators really do not care much about the physically impaired userbase of their product which is a serious violation of human rights. In few countries, there are authorities which may hold the responsible answerable for not following the rules and denying someone the right of access to information. In addition to above stated factors, another important aspect is the performance of available screen readers. The screen readers read the text in iterative manner. They read the text line by line and sometimes it is possible that screen reader reads through the whole document and user does not find anything important. This is extremely tiring and time consuming for the user. There must be some intelligence dynamics within the screen reader software that can lead towards an efficient navigation through the electronic document. This exercise will make users learn more quickly about the subject and content of the document and they can decide on whether continue with it or search for some other. These points are the motivation for this project.

1.3 Use and Importance of Assistive Technologies

It is important to understand the concept of Assistive technologies, because assistive technologies help the physical impaired to carry out day to day tasks and they make life easier for the people who are using them.

According World Health Organization (WHO) (“WHO | Assistive devices and technologies,” n.d.)

“Assistive technologies are those whose primary purpose is to maintain or improve an individual’s functioning and independence to facilitate participation and to enhance overall well-being.”

Assistive technologies may also be helpful in preventing an impairment at times. Assistive technology can include both hardware and software products that can help the impaired. Visual aids, Hearing aids, wheelchairs, prosthetics, crutches, specialized computer software or embedded systems are some most commonly used assistive technologies. These aids can enhance the wellbeing of a user by assisting them in mobility, communication, vision or hearing. Screen Readers are a specialized computer software of that is used to assist the visually impaired audience. It is a point of concern

that despite being a need of the hour, assistive technologies are still rare in low-income countries. According to (“WHO | Assistive devices and technologies,” n.d.), only 5-15% of the people who require assistive technologies, have access to these aids.

In this project, we are trying to do a detailed literature study of the subject and perform research that can lead us to make the current situation of screen reading for visually impaired people more convenient and flexible. The project aims to focus on finding out the efficient text representation and extraction techniques that can lead towards an effective screen reading.

1.4 Research Questions

The following are the research questions for this project and during our research we will try to answer these questions. The questions are as follows:

1. What are the Navigation challenges within the digital content?
2. How the faster and effective screen reading can be achieved with Screen Reader software with minimized navigation?
3. How lengthy text reading through screen reading in websites can be simplified?

1.5 Thesis Report Roadmap

This thesis final report carries 14 major section which include:

1. [Introduction](#)
2. [Background](#)
3. [Literature Review](#)
4. [Research Methods](#)
5. [ODSG&TT](#)
6. [Prototype Testing and Evaluation Protocol](#)
7. [Result and Analysis](#)
8. [Discussion](#)
9. [Conclusion](#)
10. [Future Work](#)

11. [Bibliography](#)

12. [Appendices](#)

Introduction section mainly includes the introduction to the problem and highlighted the importance of the subject. Introduction provides us the motivation to work further in exploring the subject and finding what improvements can be made in order to make screen reading more efficient and successful. In the end we list the Research Questions based on the problem introduced in the introduction, these Research Questions are our main focal points of research during this project.

Sections 2 and 3 covers the background and Literature Review of our research. The basis on which we are going to carry out this thesis research. Section 2 starts with the accessibility guidelines and continues with available screen reading software. It also incorporates the techniques for summarizing the lengthy texts through plugins, websites and other software. It also gives a brief overview of screen readers in smart phones. Section 3 carries a detailed literature review in the light of stated research questions and explains what is the relevant work that has been done already or is in progress. This detailed literature study will help us investigating more about the issues and challenges related to screen reading and can help us coming out with some better suggestions and possible recommendations.

Section 4 deals with the research methods in detail and their analysis and result respectively. I have discussed in detail about what methodologies have adopted and why.

Section 5 explains my Prototype i.e. ODSG&TT in detail. It starts with project introduction and carries on with all the detailed description of the project. It explains in detail the development framework and expected results and output.

In section 6, I have explained the protocol for our experiment in detail. The terms and rules as per which our experiment will be carried out. It explains the recruitment of participants and all the ethical considerations.

In section 7, I have presented the output results of evaluation – Statistical Data collection and Feedback Data Collection. Further in this section results and analysis are carried out and finally. There is a discussion on the project and results.

Section 8 deals with the discussion of overall research.

Section 9 deals with the conclusion for this whole project and I have tried to sum up the research concluding remarks about the project.

Section 10 carries the comments related to possible Future Work based on ODSG&TT.

In the last sections, all the references and bibliography and Appendices are mentioned.

Chapter 2 Background

In the context of our research, it is immensely important to acquire the background knowledge of research, current state of the art before moving on towards actual development of the project. It is important to understand these points because this will lay a solid foundation in the outcome of this research. In the following section we will discuss current state of the art techniques that are either being developed or have been developed and are in use, in an effort of making screen reading ever easier than before.

2.1 Accessibility Guidelines

Accessibility guidelines are rules that are governed by the authorities so that every product that is developed is accessible to everyone regardless of their physical outlook. In many countries, these guidelines are not still protected by law, but these are attaining popularity and vendors do realize the importance of Accessibility.

The World Wide Web Consortium (“World Wide Web Consortium (W3C),” n.d.) has realized the importance of endorsing Web Accessibility for the visually impaired (Borodin, Bigham, Dausch, & Ramakrishnan, 2010) and they launched initiative called Web Accessibility Initiative (WAI) (Initiative (WAI), n.d.-b). The purpose of this initiative is to devise Web Accessibility Guidelines (Initiative (WAI), n.d.-a) so that all the websites that include rich media content or dynamic web content conform to these guidelines and are completely accessible to the users.

Another important initiative is towards accessibility is defining the guidelines for authoring tools. The Authoring Tool Accessibility Guidelines (ATAG) 2.0 (“Authoring Tool Accessibility Guidelines (ATAG) 2.0,” n.d.) provides guidelines for designing an accessible web content authoring tools that benefit the authors with impairments and they design the content that make it easier for all the authors to produce a more accessible web content.

2.2 Screen Reader Software

Conventionally, screen-reader¹ users use Windows computer systems. Microsoft Windows offers accessibility options to its users i.e. magnifying glass, text narration, etc., the mainstream of screen

¹ A detailed comparison of all screen readers is available at the following link

readers does not rely on built in accessibility features. Instead, they use specialized accessibility options that are used with the screen reader (Borodin et al., 2010).

A screen reader enables the visually impaired user to use the computer. It aims to help its user with an effective screen reading, where user can feel as he is reading visually. There are several screen reading software that are available for commercial and personal use. The prices are different, and each software comes with different functionalities and approaches towards better and effective screen reading. Though there are many alternatives available in terms of screen reader software, still there are efforts being made to improve the software or bring up a new system can resolve the issues of visually impaired. In this section, we will discuss some of the widely used screen readers.

2.2.1 JAWS (Job Access with Speech)

JAWS is one of the oldest and most commonly used screen reader. It has been in action since 1995 (“JAWS (Job Access with Speech) for Windows (Professional) - Product Profile - American Foundation for the Blind,” n.d.). It is mainly used for computers with Windows environment. It carries a multilingual support therefore; it has users worldwide. It incorporates voices for more than 30 different languages (“JAWS Screen Reader - Best in Class,” n.d.). The main tasks (“JAWS (Job Access with Speech) for Windows (Professional) - Product Profile - American Foundation for the Blind,” n.d.) that JAWS perform are as follows:

1. Internet surfing
2. Text Reading for Electronic documents
3. Text Reading for Computer Screen Navigation
4. Telecommunications
5. Word Processing

It is an always evolving product and keeps on coming new features to facilitate its users. The output formats for JAWS are speech and Braille for most of computer applications (“JAWS Screen Reader - Best in Class,” n.d.).

2.2.2 NVDA (Nonvisual Desktop Access)

NVDA is another widely used screen reader software. It was first launched in 2006 and the key factor for NVDA is that it is Open Source software, hence freely available (“NVDA (Nonvisual Desktop Access) - Product Profile - American Foundation for the Blind,” n.d.-a). It is able to perform the following tasks:

1. Browsing the Internet
2. Reading Text for electronic documents
3. Telecommunications
4. Word Processing

NVDA is also multilingual, and because of being an open source product, has a large number of users. The output formats for NVDA are also speech and braille and supports Windows operation system (“NVDA (Nonvisual Desktop Access) - Product Profile - American Foundation for the Blind,” n.d.-a).

2.2.3 Voice Over

VoiceOver is a screen reader that was introduced by Apple. It offers an all-inclusive audible description and complete keyboard navigation of Mac OS X and come preinstalled in every computer shipped with Mac OS X 10.4 and later (“VoiceOver - Product Profile - American Foundation for the Blind,” n.d.). It helps the user for many tasks as web browsing, e-mail, word processing, iTunes, chat, PDF reader, media player, and chess.

Since, it is a licensed product, it costs money. But this is not less than a blessing for MAC users as it comes pre-installed with the package. It is also platform dependent, therefore, cannot run on other operating systems. Also, the supported output format so far is only speech it was introduced in 2005 (“VoiceOver - Product Profile - American Foundation for the Blind,” n.d.).

2.3 Browser Plugins for Summarizing the Text

Several browser plugins have been introduced, that summarize the content of an electronic document. They play an important role as their working with screen readers can bring out the best and most relevant content out a document in no time. (Ahmed et al., 2012) discuss the best available

Mozilla Firefox plugins or addons GreatSummary, Pluribo-Instant-Summaries and SummaryFox that are used to summarize the different webpage content. We will discuss all of them and the related issues when used with screen readers.

2.3.1 GreatSummary

It is general purpose summarizer introduced by Firefox. It is used to summarize any web page. Just right click on any webpage and choose "Summarize this page", and GreatSummary returns the key sentences from the page ("GreatSummary," n.d.). It can quickly provide essence of any site, if user does not want to read through whole content. It is very useful in research projects and idea is to shorten the sentences without losing the gist. The summary created by GreatSummary would be of much use when used by screen reader to read out to the visually impaired.

2.3.2 Pluribo-Instant-Summaries

Pluribo-Instant-Summaries is also summarizer developed for the product reviews at Amazon.com (Ahmed et al., 2012) ("Pluribo," n.d.). It is not a general addon as GreatSummary. Pluribo-Instant-Summaries uses artificial intelligence to scan all of the reviews on any Amazon webpage and summarizes them into a single paragraph and save time reading through endless reviews ("Pluribo," n.d.).

2.3.3 SummaryFox

SummaryFox is Mac-based addon (May 24 & Permalink, n.d.) (Ahmed et al., 2012) and users highlight the text to be summarized and use slider to set the size for the summary. Summary Service will generate the summary of highlighted text. SummaryFox uses the MC OS's Summary service in order to summarize the long text. As it is a Mac specific plugin it only works on Mac OS X 10.5 and above on Intel Mac (May 24 & Permalink, n.d.).

2.3.4 Limitations and Discussion

Summaries generated through these summarizers do not hold any correspondence between the summary and the original content (Ahmed et al., 2012). Therefore, it becomes impossible for the blind users to retain their reading position within the text. It reflects that if a user switches to original content from summary and vice versa, they would not be able to start from where they left. They will have to start from first point every time. This present users to some serious navigation

challenges. Which is as mentioned before is not very pleasing. The normal cycle for a screen reader user when generating summaries, in most cases, would be in the following steps.

1. Select the text that is to be summarized.
2. Copy the selected text.
3. Open link, shortcut, website, plugin or other summarizing software.
4. Paste the copied text.
5. Press/Push summarize button or control.
6. Read the generated summary.
7. Close the pop up, web page or plugin.
8. Come back to original page where text was copied from.
9. Decide whether to continue or not.

These steps may seem very simple and easy but when it comes to screen reader users, these are just an overhead. As mentioned earlier, the reader loses all the focus and context and they must restart the reading, which is tiresome and time consuming and reader may end up losing interest and not going through the text again.

2.4 Voice Overs on Mobile Devices

We are in a digital era, where mobile phones have become a basic commodity of life. Users, physically impaired or not, do carry a mobile phone with them in order to carry out day to day tasks. Therefore, there is a need of time that these handheld devices are also made fully accessible to its users. Most commonly used smart phones in the present time are Android and Apple phones. Since, these two types of phones capture most of the market, we will discuss screen reading/voice over technology within these two.

2.4.1 Google Talkback

Talkback is the screen reader from Google that comes preinstalled on all Android devices (“Get started on Android with Talkback - Android Accessibility Help,” n.d.). It responds with speech feedback, eliminating the need to use the phone by looking at it. The basics include knowing about the platform gestures that what gestures will perform what actions on the phone. For example, In

order to Move to next item on screen user needs Swipe right (“Use TalkBack gestures - Android Accessibility Help,” n.d.) .

2.4.2 Siri and VoiceOver

Siri and VoiceOver are used Apple phones. They also come pre-installed in modern Apple phones. VoiceOver is a screen Reader that is used to read out the screen contents for the users and perform actions as per gestures. Siri is used as a feature to perform tasks for example, setting up an alarm with Siri “Hey Siri, wake me up at 7 AM tomorrow” (“iOS - Siri,” n.d.). Siri will set an alarm for the user as per the told time. This is also very interesting feature for people with cognitive or other physical impairments other than visual.

Chapter 3 Literature Review

The extensive availability of digital content online has impacted the way people consume this content and it has also impacted the consumption of one's auditory information (Guerreiro & Gonçalves, 2016a). The digital content can be available in several forms, e.g. Online Web Page, PDFs, Word documents and Video Streaming or any other mixed form text and graphics offline. (Peoples & Tilley, 2011) also explains that auditory media is getting popular and it is affecting how this information is consumed. People prefer listening to the books while driving or doing some other tasks, therefore, auditory feedback of screen readers performs a vital role in providing access to digital information to visually impaired audience.

It is a common observation that even 20/20 vision readers get frustrated while skimming through the hugely available information, so we can imagine how frustrating it can get for visually impaired readers, if they do not get intended information successfully. In the following section, we will carry out a literature review regarding the issues of Screen Readers performance and related navigation problems on different platforms i.e. Web, Desktop and Mobile.

3.1 Issues with Screen Reading

Following are some important issues that arise when Screen Readers are used.

3.1.1 Accessibility vs Usability

There is one common misunderstanding that a document which is apparently an accessible document, but actually it is not. This is a usability problem than that of accessibility, as user can access the document but cannot use it properly and the document ends up being useless. (Borodin et al., 2010) discuss this problem as a document "Technically" accessible but is of no use. Examples for such cases can solving CAPTCHAs without an audio (Bigham & Cavender, 2009).

3.1.1.1 *Impact of Usability Problems*

When usability problems reach a certain threshold of severity, they may entirely prevent access to content that is technically "accessible" (Petrie & Kheir, 2007). So, we can deduce that if an accessible content is not usable, then it is eventually not accessible at all. For example, if an image in a file has alternate text then technically, it is an accessible element. However, if this alternate text is not

informative enough and does not carry all the necessary details about the image, it is useless, hence not accessible.

3.1.2 Web Browsers vs Screen Readers

According to (Borodin et al., 2010), Browsing the Web with screen readers sometimes might not be a smooth experience because of persistent accessibility and usability problems. It is simply impossible to access some content through screen readers. The very common example of this scenario is an image without an alternative text. Screen reader will ignore this information as it would not be able to find the relative text to describe the content. Though the screen reading software are advancing and coming up with new features, but new web technologies appear on regular basis that bring inaccessibility with them.

Implementing an accessible Website without any rich media is a laborious task in itself (Chapdelaine & Gagnon, 2009), as for each browser W3C recommendations are implemented differently. It becomes more cumbersome task when dealing with rich media even with availability of the resources.

3.1.2.1 *Practical Example*

In (Borodin et al., 2010), they discuss that the multimedia content in Flash was completely inaccessible to screen-reader users and this issue lasted for years. As of now, it is not a major problem but with HTML 5 introducing canvas, such problems of content inaccessibility may arise again that will affect the working of web technologies with screen readers. There are arguments within the working group of HTML 5 that all the accessibility features must be included from start so that technology does not lack behind for incorporating accessibility for longer period of time. There have been accessibility issues with Java Script and other web technologies too.

3.1.3 Performance Issues with Screen Reading

When reading through screen readers, it is important to understand how screen readers perform. Screen Readers are usually slow because they read out the content sequentially. In their research (Sun, Shieh, & Huang, 2013) and (Chapdelaine & Gagnon, 2009) both state that it is a known fact that interactions of visually impaired take much longer time than sighted users, it can take up to three minutes to get to the main content of page with a screen reader. Therefore, it becomes essential

that Screen Reader should be smart enough to the users a better and real understanding of the content.

Sound created with Screen Readers are not very human therefore, it is harder to get attention of the listener. According to ("Advantages and Disadvantages of Using a Screen Reader Instead of Braille," 2012) mentions the fact that companies are trying to develop speech synthesizers that can mimic how humans speak but it is a matter of time until a very realistic synthesizer comes out.

3.2 Visual Skimming vs Audio Skimming

3.2.1 What is Skimming?

Skimming is a reading technique that allows users to capture the overall idea of the content and navigate through the content quickly ("Skimming and Scanning," n.d.) ("Speed Reading," n.d.). This technique allows user to get complete meaning and essence of the content without reading the complete text.

3.2.2 Benefits of Skimming

It is a very useful technique to look up specific information within the content. If information is non-digital or a digital content page where search is not available, skimming saves a lot of time for the reader. However, this is not very easy for people who use screen readers instead.

3.2.3 Problem for Visually Impaired

Screen readers (Ahmed et al., 2012) ("NV Access," n.d.) ("JAWS Screen Reader - Best in Class," n.d.) are assistive technology software that use text-to-speech technique to narrate the digital content and allow users to navigate through the content marked up by HTML tags for headings, paragraphs, links, buttons, etc.

3.2.4 Skimming with Screen Readers

Regrettably, this trivial Visual skimming is not applicable to blind users because of the way screen-reading software navigate through content. A screen reader scans the whole page from start till the end that makes the process sequential. Screen-readers have a feature where users can move through information by character, word, line, paragraph, section, page, etc., but these functions are not comparable to the ability to skim through information (Bigham, Cavender, Brudvik, Wobbrock, &

Ladner, 2007). 20/20 vision people can easily skim through the content while perceiving and reading simultaneously.

3.2.5 Time Consumption and Cognitive Overload

Because of the low bandwidth of a serial audio interface and the fact that one has to hear the information before deciding if it is relevant, people who are blind spend considerably more time identifying the information they need (Borodin et al., 2010)

Cognitive overload (Sweller, 1988) is a very basic problem that arises when user has to process a large amount of information i.e. digital information; In our case people with vision impairments cognitive load is very important as they have to listen the online content sequentially. Therefore, there should be some summarizing techniques that can help reducing this cognitive load for the users who use screen readers.

3.2.6 Automated Summarization Techniques

Automated summarization approaches are used to summarize the textual content while preserving its essence (Ahmed et al., 2012). There are mainly two types of text summarization techniques used. summarization by extraction and summarization by abstraction (Ahmed et al., 2012).

According to (Goldstein, Kantrowitz, Mittal, & Carbonell, 1999) summarization by extraction deals with selecting the most prominent and meaningful phrases from the content. Summarization by abstraction is constricting sentences (Berger & Mittal, 2000) (Ahmed et al., 2012), which involves rephrasing the content, for example, by automatically filling out a template (Jacobs, 1990).

3.3 Issues with Current Automated Summarization Techniques

Automated Text Summarization Techniques help the screen reader users in many ways. These are very effective in reducing cognitive overload and help users generating the meaningful summaries of long texts. There are many Artificially Intelligent algorithms are available developed through Natural Language Processing (NLP).

However, the process of using such software and plugins is not very simple. It involves many associated of navigation challenges for screen reader user. It normally includes multiple steps before

the summary is generated and read by the screen reader software. The common steps are as follows:

1. Select the text you want to summarize.
2. Copy the selected text.
3. Open the Text summarizer through webpage, plugin link or desktop software.
4. Paste the copied text in software.
5. Generate the Summary.
6. Read it through screen reader.
7. Come back to original text (Webpage or other electronic text).
8. User must start reading again from initial point as context is lost.

These steps seem very simple and normal for 20/20 vision users, but this becomes very hectic and tiresome for the visually impaired users. Moreover, many software in practice for summary generation show or output the summary in dialog boxes or alerts, which is again not recommended when we discuss accessibility. In our thesis we are trying to minimize these steps to avoid common navigation challenges and achieve better and affective screen reading with a simplified approach. This is an effort to generate and present summarized text in as minimum steps as possible.

3.4 Related Work for Faster and Better Screen Reading

In this section, we will present different approaches towards faster screen reading. There have been hypotheses and several experiments to verify the faster screen reading using different algorithms. In the following section, we will review the presented and some already implemented ideas towards better improving screen reading.

3.4.1 Cocktail Party Effect

The sequential reading of content makes it difficult to capture the overview of the content and rather makes it a slower process (Guerreiro & Gonçalves, 2016a) (Guerreiro, 2013). Hence, it takes much longer in order to find the relevant information.

The Cocktail Party Effect (Guerreiro, 2013) (Guerreiro & Gonçalves, 2016a) states “the human ability to focus attention on a single talker among several conversations and background noise”. It explains

that it is the human ability that can differentiate among the concurrent speeches. This idea is to start speech from multiple sources and user can segregate the part of his interest. For example, if several sounds are being played and someone calls name of a particular person, the attention automatically diverts to that speech source.

In the light of above stated reasons, the experiment was conducted simultaneously reading out, different paragraphs or sections of the text that will help the user to find the desired content out of large set of contents. This effect is somehow similar to text summarizing but in this approach the summarizing will be done by the user himself as he is the one segregating the content while simultaneously hearing from multiple channels. The audio channels, in this scenario must be of good enough quality that they can convey clear texts to the users.

Results showed in this study that simultaneous speech from multiple audio channels was a touch faster than the normal. It made content scanning much faster with retaining the essence.

On the contrary, for a single voice to keep up with the concurrent speech timing, faster speech rate increment is needed that causes a performance loss (Guerreiro & Gonçalves, 2016a). They intend to find and incorporate multiple feedback resource demands in their future work.

3.4.2 Skim Reading in JAWS

Skim Reading is available in JAWS 6.0 and later. This feature has a simple implementation where user can swiftly review long documents by reading the first line or sentence of each paragraph (“Skim Reading,” n.d.). JAWS also provide users with looking up for specific phrase and words. JAWS also provide the users with generating summaries of the text so that they can get an overview of the whole content and decide if it is relevant or not.

3.4.3 Accessible Skimming

Accessible skimming is a concept introduced by (Ahmed et al., 2012) , It is also a form of non-visual skimming. They present a summarization algorithm with a text extraction technique that have following characteristics.

3.4.3.1 *Algorithm Steps*

1. Generates variable sized summaries of the text.
2. Each sentence is summarized to cover complete text.
3. Phrases are extracted such that the meaningful connections between the words holds.

This technique has brought success towards faster screen reading as (Ahmed et al., 2012) mention that “Subjects were able to find the answer almost twice as fast using skimming, compared to using regular screen-reader navigation shortcuts. This result demonstrates that skimming can save screen-reader users a substantial amount of time depending on the size of the text”.

3.4.4 Tag Thunder

Tag Thunder (Manishina, Lecarpentier, Maurel, Ferrari, & Busson, 2016) is a cloud content representation system. It works on the principle of The Cocktail Party Effect (Guerreiro & Gonçalves, 2016a). It works on two main principles i.e. content summarization and concurrent speech synthesis.

3.4.4.1 *Implementation*

The implementation of Tag Thunder includes three main steps,

1. Web Page Segmentation in Given Zones
2. Selection of key terms using text extraction techniques.
3. Vocalization of extracted key terms that are played on an audio track concurrently in order to echo the position and visual properties of respective zone.

The implementation of first two steps is illustrated in Figure 3.1. The Web Page is segmented into several zones and then key words are extracted through text extraction techniques.

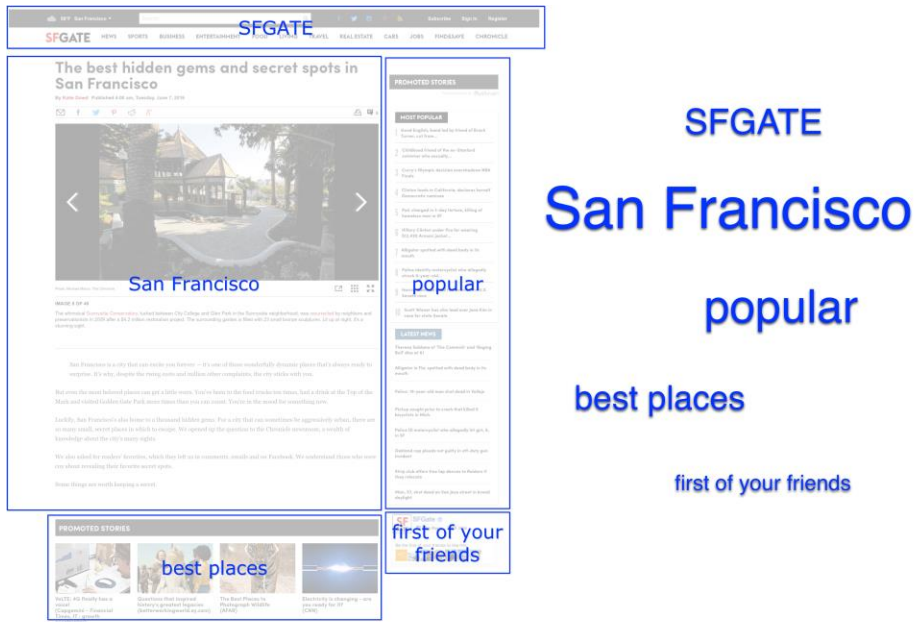


Figure 3.1 Segmentation of Web Pages and Key Terms extraction - Tag Thunder (Manishina et al., 2016)

The third step, Vocalization of extracted zones and keywords, is illustrated in Figure 3.2.

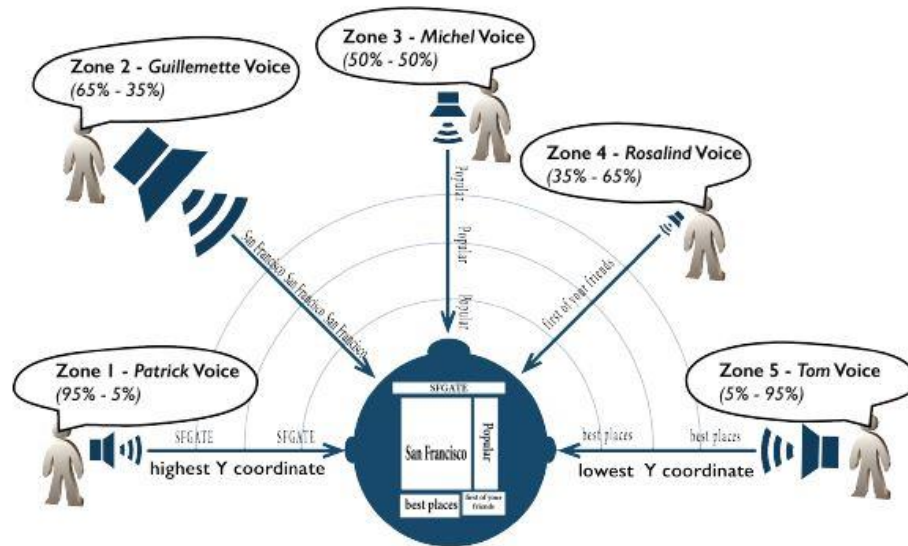


Figure 3.2 Working of Tag Thunder with 5-Zones (Manishina et al., 2016)

Figure 3.2 **Feil! Fant ikke referansekinden.** describes how Tag Thunder works and how vocalization is performed after first two steps. The workflow has 5 web page zones and their relative keywords extracted according to the algorithm and then these keywords from different zones are played on an audio track with different voice and variable volumes. It enables users to filter out the content of interest and determine the desired zone in order to navigate there.

3.5 Discussion

In the light of above stated literature, as we reviewed that there have been striving efforts towards content accessibility and usability, but still there are lot of factors that need to be addressed. These techniques discussed above somewhere need an intense training for the individuals and the users may suffer a cognitive overload (“Cognitive Load During Problem Solving: Effects on Learning - Sweller - 1988 - Cognitive Science - Wiley Online Library,” n.d.). Such condition is stressful and tiring for the users. There are continuous efforts by the researchers to minimize such effects and impacts so that screen reading becomes more natural, less stressful and faster as suggested by (Guerreiro & Gonçalves, 2016b) . This thesis is one such effort.

Chapter 4 Research Methods

4.1 Types of Research Methods

It is important to consider, while researching, that what methods are appropriate for research. The research may include some statistical data and its analysis it can either be doing survey or using a software package (lbw5, n.d.) or interviewing individuals or group of people and then analyzing the gathered data. All these are possible research methods that are categorized in to 2 main domains; i.e. Qualitative and Quantitative. The details of these 2 domains are discussed in the following sections.

4.1.1 Qualitative Research Methods

Qualitative research is immensely creative and interpretive states (“Qualitative vs Quantitative Research | Simply Psychology,” n.d.). Qualitative Research involves the understanding of human behavior (“Qualitative vs Quantitative Data | Simply Psychology,” n.d.). In this form of research, the data is collected through interviews and observation of the subject. It does not involve any fixed calculations or measurability. The analysis is more thematic than numbered and results are produced in the language of informant (“Qualitative vs Quantitative Data | Simply Psychology,” n.d.).

Qualitative research data is in descriptive form or we can say it is in non-numeric form and it is nearly impossible to perform statistical analysis on qualitative data. The data can be collected through diary accounts, open-ended questionnaires, unstructured interviews and unstructured observations (“Qualitative vs Quantitative Data | Simply Psychology,” n.d.). This reflects that qualitative research requires an active participation from the researchers so that they can in-depth knowledge of research domain and carry out the tasks more effectively.

There can be several other variants through which qualitative research data can be collected. The most common and effective processes are Interviews, Questionnaire, Social Media, Focus Groups and Text Encoding for Digital Humanities (“Research Methods and Methodologies — University of Leicester,” n.d.).

Analyzing the qualitative data is the next phase after the data is collected successfully. The analysis can be carried out through Software. Denscombe states in (“The Good Research Guide,” n.d.) that

Qualitative analysis is open for ambiguities, uncertainties and contradictions in the data, which are a reflection of social reality.

However, there are several limitations that come across to these types of researches. Since, the qualitative data is very subjective and its origin in single contexts, it is difficult to apply conventional standards of reliability and validity (“Qualitative vs Quantitative Research | Simply Psychology,” n.d.). If the research involves responses from surveys, the response rates are generally low (“The Good Research Guide,” n.d.) The overall process of collecting, analyzing and interpreting the data is extensive and lengthy and must need an experts while analyzing the sensitive data (“Qualitative vs Quantitative Research | Simply Psychology,” n.d.).

4.1.2 Quantitative Research Methods

Quantitative research deals with measurability. The data is collected in numbers. Numerical or statistical comparisons are performed on the data and the results are reported in statistical formats (“Qualitative vs Quantitative Data | Simply Psychology,” n.d.).

Quantitative research gathers data through experiments and in numerical form which can be categorized, measured and ranked (“Qualitative vs Quantitative Data | Simply Psychology,” n.d.). Results can be presented through drawing graphs and tables. Quantitative data, as Qualitative data, can be of several types. It can Ordinal, Nominal, Interval, Ratio, Discrete or Continuous (“The Good Research Guide,” n.d.)

Statistics assists us converting quantitative data into a useful information that can lead us making timely and effective decisions (“Qualitative vs Quantitative Research | Simply Psychology,” n.d.). We can use statistics to summarize our data, describing patterns, relationships, and connections.

The statistical analysis can be carried out using different software. The most commonly used software for statistical analysis are R software (“R: What is R?,” n.d.) and Statistical Package for the Social Sciences (SPSS) (“IBM SPSS Software,” 2018; “Research Methods and Methodologies — University of Leicester,” n.d.). There is many other software available as well but these two are used mainly.

The advantage or a plus point of statistical analysis is that they give researchers an additional credibility and confidence when analyzing and interpreting the data. (“The Good Research Guide,” n.d.). Also, contrary to qualitative data, quantitative data can be analyzed rather quickly and can be organized and presented through graphs and charts which give easy understanding to the readers. (“Qualitative vs Quantitative Research | Simply Psychology,” n.d.; “The Good Research Guide,” n.d.)

4.1.3 Our Approach

The scope of this thesis spans to a vast area in research that includes the detailed literature study, theoretical algorithmic design and implementation and its testing and analysis. There are several paths that can be taken from the initial literature study. The details follow.

Since, our project includes an experiment of our prototype with a screen reader users and asks for a small feedback questionnaire, we use both Qualitative and Quantitative research methods in our research as a Mixed approach. But as our major focus within this study is to come up with potential improvements and refinements within the screen reading experience by developing a prototype and testing it with screen reader users and then analyzing the gathered results and explain them through statistical analysis using SPSS software.

The detailed background, algorithmic design, implementation, protocol, user’s recruitment and testing and process of our research experiment will be discussed in [Chapter 5](#) and [Chapter 6](#).

4.2 Literature Study

Screen reading is very important when it comes to readers who have problems with their eye sights. In order to highlight the important ICT related issues, the first and foremost subject within this project, is detailed literature study. It involves the study of as much available literature related to screen reading, its potential issues and challenges and the relative solutions that have been presented to overcome the issue and challenges. This study can guide us in refining the research and come up with possible improvements and recommendations in the existing screen reading Software. The project aims to combat the challenges that people with vision impairment face while using a screen reader. Therefore, the literature study will involve the issue and challenges not only with a standalone computer or a mobile phone, but in general for both offline and online documents, that

involves how accessibility guidelines are taken care of while designing an offline or online document. The document here means any web page or electronic document.

4.3 Understanding and Choosing Screen Readers

In order to refine the possible aspects of research it is important to conduct Screen Readers Operations. There are several screen readers available as freebees and do not require a license or amount for their use. This exercise can help us investigating the working algorithms of the Screen Readers and possible aspects that have either been ignored or not yet been focused on. For example, JAWS ("Job Access With Speech") ("JAWS Screen Reader - Best in Class," n.d.) is one of widely used screen readers and has a great success. It is available for both 32-bit and 64-bit Windows computers.

Non Visual Desktop Access (NVDA) ("NVDA (Nonvisual Desktop Access) - Product Profile - American Foundation for the Blind," n.d.-b) is another software that is available for free and it is generating its revenue only through donations which is great in serving the humanity. NVDA ensures the accessibility and interaction of blind and vision impaired people with Windows OS and other applications. It includes the following features as listed on ("About NVDA," 2017).

1. Support for popular applications including web browsers such as Mozilla Firefox and Google Chrome, email clients, internet chat software, music players, and office programs such as Microsoft Word and Excel.
2. Built-in speech synthesizer supporting over 50 languages, plus support for many other 3rd party voices.
3. Reporting of textual formatting where available such as font name and size, style and spelling errors.
4. Automatic announcement of text under the mouse and optional audible indication of the mouse position.
5. Support for many refreshable braille displays, including input of Braille via braille displays that have a braille keyboard.
6. Portable and can run entirely from a USB flash drive or other portable media without the need for installation.

7. Talking Installer, very easy to use.
8. Translated into more than 50 languages support for modern Windows Operating Systems including both 32 and 64-bit variants.
9. Ability to run on Windows logon and other secure screens.
10. Announcing controls and text while interacting with gestures on touch screens.

NVDA is my primary test screen reader. We will use this screen reader to run and test my experiment. However, there are other screen readers available in the market.

4.4 Interviews with Questionnaire

Another important aspect of digging through the potential issues and challenges of the research task is to ask the people who use screen readers. Therefore, it is possible that we conduct interviews with a pre-designed questionnaire, if needed in order to get a detailed perspective of participants.

Structured interviews can be hectic and pressurizing for the participants, therefore, we can opt for a Semi Structured approach towards interviewing the participants, so that they can answer the questions in relaxed and less formal manner. This whole interview process can take a bit of time as it involves recruitment of participant and then interview them individually. This will just be an exercise to get feedback and suggestions from screen reader users (participants) for further improvements.

4.5 Algorithm Design and Implementation

It is an extended part of the project that includes the design of an algorithm for faster and effective screen reading. After the detailed study and evaluation of the topic, the recommendations and improvements that are suggested, can be drawn into actual hypothesis and carried further towards designing an algorithm for the suggested improvements and then testing this algorithm with an implementation.

4.6 Testing and Evaluation with Participants

Since, the research is related to my developed prototype i.e. ODSG&TT and it is also an important part of the thesis. This part includes the actual testing of the implementation in a real time with real participants. It leads us towards performance and test results and compare with existing practices.

Chapter 5 On Demand Summary Generation and Text Tagging (ODSG&TT)

After successfully identifying the navigation challenges and hindrances screen reader users normally face by going through the extensive literature study and consider the efforts being made by the researcher to achieve better and effective screen reading with screen readers, I have come up with an idea which can simplify extensive text reading within a web page. It is important to note here that I am not testing the algorithms and do not have any concern how they are developed. I am just using them to an extent they serve the purpose. The links to detailed code and demo video is added in [Appendix B](#). The following section explains the project in detail.

5.1 Project Details

5.1.1 Project Title

On Demand Summary Generation and Text Tagging (ODSG&TT)

5.1.2 Project Description

ODSG&TT is a unique concept that allows screen reader users to generate summary and keywords on the go. This is on demand because users may opt not to summarize the text. This concept is useful when screen reader users have to go through extensive text reading within a webpage. We have developed a prototype that can help users simplify the extensive text reading in websites. We provide users with a summarizing button that users can click and that would dynamically generate summary and keywords of the detailed text. When generated, new sections for Keywords and Summary would be added to the webpage and focus would be transferred to Keywords section and user will continue identifying through keywords and summary if the extensive text ahead is worth reading or not.

This project is just a prototype for testing and analysis. My prototype when tested and evaluated can be used as an essential website component for websites carrying text data. Entire website design depends upon website designer. They can design their website as per their need and my prototype can be incorporated within any website design with minor adjustments.

Figure 5.1 provides the complete flow of a website that has ODSG&TT feature.

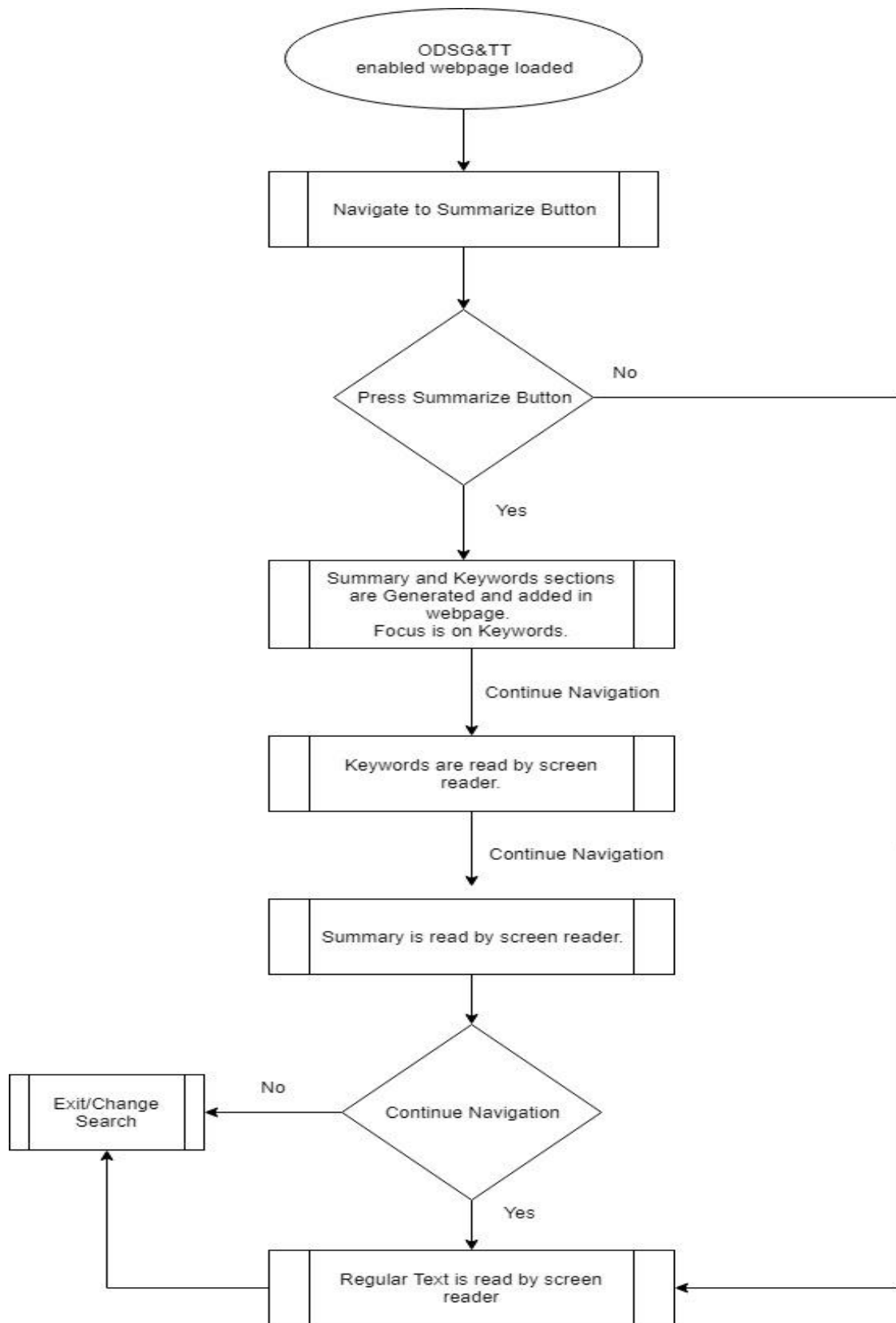


Figure 5.1 Detailed Flow Chart of ODSG&TT

Feil! Fant ikke referansebildet. Figure 5.1 explains the flow of the ODSG&TT in detail. It starts with a web page which is ODSG&&TT enabled. User can navigate to summarize button and if user decide not to press the button and carry on with detailed text they surely continue. However, if they press the summarize button, keywords and summary sections would be added at run time for the reader and focus goes with Keywords where user can navigate, and next section would be summary and then user can decide whether to follow the detailed text or not.

5.1.3 Prototype Development Framework

Though there were several modern alternatives available for the development of my prototype, we have decided to use most commonly used technologies for the website development. The prototype is developed with following technologies.

5.1.3.1 *Programming Languages*

We are using PHP as my web programming language along with jQuery library for making dynamic changes to the webpages. We will briefly explain both in the following paragraphs.

PHP is an acronym for "PHP: Hypertext Preprocessor" ("PHP 5 Introduction," n.d.). PHP is an open source scripting language which is most widely used for web development. Being a server-side programming language, the PHP scripts are executed on a server ("PHP 5 Introduction," n.d.). This makes it very fast and flexible as scripting platform for small blogs sized websites to large scientific and commercial websites. PHP is free to download and use PHP is very popular general-purpose scripting language that is mainly used for web development ("PHP: Hypertext Preprocessor," n.d.).

The voting points for using PHP are listed as follow on ("PHP 5 Introduction," n.d.)

1. PHP is compatible with all modern operating systems i.e., Windows, Linux, Unix, Mac OS X, etc.
2. PHP is compatible with almost all servers used today i.e., WAMP, Apache, IIS, etc.
3. Output with PHP is not limited to HTML only. Output can be of several types i.e., text, XHTML and XML, images, PDF files, and even Flash movies.
4. PHP supports a wide range of databases e.g., MySQL, MariaDB etc.
5. PHP is very easy to learn and runs efficiently on the server side.

jQuery is a fast, small, and feature-rich JavaScript library (js.foundation, n.d.). It is compatible with all modern-day browsers and makes traversing the HTML document easier and faster. With a combination of versatility and extensibility, jQuery has changed the way that millions of people write JavaScript (js.foundation, n.d.). It also makes event handling, animation, content manipulation and Ajax much simpler. According to W3Schools (“jQuery Tutorial,” n.d.) jQuery greatly simplifies JavaScript programming.

We are using PHP version: 5.6.35 and jQuery version 3.3.1 for ODSG&TT development.

5.1.3.2 *Design, Structure and Layout*

In ODSG&TT, we have designed and structured the layout of webpage through HTML and CSS. These are normally used technologies for designing and formatting the webpages in combination with other web development platforms.

HTML stands for Hyper Text Markup Language. HTML allows users the design the structure of their Web pages. As per (“HTML & CSS - W3C,” n.d.), HTML enables website designers to do the following.

1. Publish webpages formatted with headings, text, tables, lists, photos etc.
2. Retrieve online information through the use of Hyperlinks.
3. Design web forms for transaction on online merchandises.
4. Add media to the web page e.g., Video Clips, Flash media, TV channels etc.
5. Using HTML, authors describe the structure of pages using markup. Each element of language is defined as per content i.e., “paragraph,” “list,” “table,” and so on using relevant tags.

CSS is an acronym for Cascading Style Sheet. CSS is the language for defining the look and feel of Web pages, including colors, layout, and fonts (“HTML & CSS - W3C,” n.d.). CSS allows

It allows the designers to design website for all screen sizes e.g., Larger screens, mobile phone screens and normal sized monitor screens. CSS is completely independent of HTML and therefore, can be used with any XML-based markup language (“HTML & CSS - W3C,” n.d.). Since, HTML and CSS are independent of each other, therefore, maintenance of websites becomes relatively easier. This reflects that the same CSS can incorporated in several webpages within a website. This is referred to

as the separation of structure from presentation (“HTML & CSS - W3C,” n.d.). We are using HTML5 and CSS3 versions of these technologies.

5.1.3.3 *Accessibility*

It is primary focus of my research that any content that we create must be accessible as per Web Content Accessibility Guidelines. The detailed overview of these guidelines can be found on [WCAG](#). The importance and need of accessibility have already been discussed in [Chapter 3](#) of this thesis document. We have tried to design and develop an accessible website that is accessible by the screen reader.

5.1.3.4 *Hosting and Domain*

Since, we have developed a website, we must have a server where my website will be hosted and a domain name through which it is accessible via any browser. As of now, because project is in its testing and development phase, we are using localhost as my server named WAMP.

WampServer is a Windows web development environment (“WampServer,” n.d.). It allows you to create web applications with Apache2, PHP and a MySQL database and alongside, PhpMyAdmin allows the web developer to manage the databases rather easily (“WampServer,” n.d.).

5.1.3.5 *Summarizing Algorithm²*

We have used summarizing algorithm called Summarizer (“Summarizer - Algorithm by nlp,” n.d.) developed NLP on Algorithmia (“Algorithmia - Deploy AI at Scale,” n.d.) platform. It is an already developed algorithm and can be used with an API Key. The demo example of using this algorithm is added in [Appendix A](#) as Figure A. 1.

5.1.3.6 *Text Tagging Algorithm (Keywords Generation)²*

AutoTag (“AutoTag - Algorithm by nlp,” n.d.) is another library developed at Algorithmia (“Algorithmia - Deploy AI at Scale,” n.d.) that is used to extract keywords of text. We also need an

² There were several alternatives of summarizing and text tagging libraries, but we opted for Algorithmia libraries as it was easier to incorporate and produced better results. Another close alternate was [DeepAI](#) (“Text Analysis APIs – API Documentation | DeepAI,” n.d.)

API Key in order to use this library. The demo example of using this algorithm is added in [Appendix A](#) as Figure A. 2.

5.1.3.7 *Testing Environment (Operating System, Browsers, Screen Reader)*

We have tested the application on Windows 10 Enterprise version and Mozilla Firefox version 63.0.3 (64-bit) and Google Chrome Version 70.0.3538.102 (Official Build) (64-bit). Screen Reader used for testing this prototype is NVDA (Nonvisual Desktop Access).

5.2 Project Output and Results

The project code's screenshots and output screens are shared in [Appendix B](#). Project code with all necessary files is uploaded on GitHub. GitHub repository link is also added in [Appendix B](#). Please refer to the mentioned section for details.

Chapter 6 Prototype Testing and Evaluation Protocol

The experiment will be carried as per the following protocol. These are the rules defined for carrying out the experiment. The details follow.

6.1 Purpose

Purpose of the experiment is to test my prototype of ODSG&TT in comparison to Web-based Summary Generators and Plugin-based Summary Generators using an NVDA screen reader and compare and analyze the performance of ODSG&TT based on time taken with other available techniques.

6.2 Hypothesis

After explaining the research question 1 i.e., navigation challenges in Literature review section in detail, we move on to address my research question 2, 3 and 4 i.e., ODSG&TT will minimize the navigation challenges related to text summarization and make screen reading much more simplified than the alternate available techniques and is it a faster techniques compared to others.

6.3 Recruitment of participants

Participants for this experiment are recruited from Information Communication Technology (ICT) background. Mainly students and individuals from Computer Science background who know how to use screen readers or at least they are familiar with concepts of using screen readers. The reason for recruiting participants with ICT background is that it would save us time and we would not need lengthy briefing sessions before the actual experiment session starts.

Total number of participants for this experiment are 20 so that we can have an adequate set of data to analyze afterwards. They will be blind-folded as it is an extensive task to find and recruit visually impaired people who are using screen reader to carry out their routine tasks.

Since, the participation in this exercise is entirely voluntary and anonymous, therefore, this will be one to one session with all the participants.

6.4 Platform/Apparatus Needed

Since, experiment would be a one to one session, therefore, every participant must have a Windows based personal computer with NVDA Screen reader, Mozilla Firefox or Google Chrome installed on it. It will allow us to carry out the experiment remotely as well, if user any participant is not present locally.

In case, any participant does not have their personal computer with them, or their computer is not equipped with necessary software, we can conduct the experiment with my own computer that would have all the necessary software installed on it.

6.5 Ethical Considerations

6.5.1 Consent of Participation

This experiment is a voluntary exercise and will only be conducted when every participant forms a consent with the rules and regulations of experiment. Though there is no formal signing of any document for participation, but ethically we will seek permission before actually start conducting the exercise.

6.5.2 Right to Withdraw

Every participant will have a right to withdraw at any time during or before the experiment. As mentioned earlier, this is a volunteer routine, therefore, any participant can withdraw at any time, if they don't agree to any rules or simply, they feel uncomfortable during the experiment.

6.5.3 Anonymity

We are not using any personal information that can identify any individual directly or indirectly, from the participants. Therefore, anonymity of my participants will be made sure. Personal number, citizen number, email addresses, telephone numbers, medical records or any such details are not collected and needed for this experiment.

6.5.4 Confidentiality

Since, my experiment will be conducted in one to one sessions, therefore, it will be made sure that no information of any of the participants is leaked out.

6.5.5 Ethical Consideration Regarding Background or Health of Participation

Since, this experiment is completely scientific, and research based, we do not need any religious, demographic, or physical health details of any participant. We only need them to have basic knowledge of ICT. In any case, if such details about the participants come across, we will make sure these details are not leaked out.

6.5.6 Individual Briefing About the Project

It will be the right of every participant to have a detailed briefing about the experiment and project. It will be made certain that before starting the experiment that every participant knows the key points of the product and process of carrying out the tasks.

6.5.7 Additional Aid

If any participant needs additional aid in terms of briefing, hardware or software, we will make sure that all these aspects are taken care of. In case, if any participant is feeling uncomfortable with the environment, we will try my best to make them comfortable, so that they can carry on with their tasks with ease.

6.6 Testing and Evaluation Procedure

Experiment procedure is very simple and easy to understand. As we have mentioned repeatedly now that this process is one to one session, therefore the detailed process to be carried out for every session is described in detail in numbered form below.

1. Making sure all the requirements are fulfilled to carry out the tasks.
2. To the point, detailed briefing about the project is given to each participant.
3. Briefing is given about how to carry out the required tasks.
4. Start with generating summary from a website and using NVDA as screen reader, complete the process, come back to source and we will note the time taken for the task completion.
5. Next step is generating summary using a browser plugin and using NVDA as screen reader, complete the process, come back to source and we will note the time taken for the task completion.
6. Next step is to generate summary using ODSG&TT, complete the process and we will note down the time taken for the task completion.

7. After the 3 tasks are completed, a small semi-structured questionnaire-based interview will be conducted.
8. No further information is required from participants. All tasks are completed.

I have opted for this procedure for testing an evaluation because, in one-to-one sessions, it is less demanding and easy to manage. I suspected there could be possible miscommunication if I had run this exercise in groups. Also, it was not possible for me to have all the participants at one place at one time as everyone was busy with something. Therefore, it was better to have it done as one-to-one sessions.

6.6.1 Sample Reference Platforms

To estimate time taken for Summary Generation via Website, [Resoomer](#)³ (Resoomer, n.d.) will be used and for estimation of time taken to generate a Summary via Plugin, a Google Chrome Plugin is used which is called Text-Summarizer³. It is available for free in Chrome store.

6.7 Testing Windup

After the experiment is completed successfully, all the estimates will be collected and submitted for analysis. Complete Analysis will be done using One-Way Repeated ANOVA (*one-way-rm-anova-DE300.pdf*, n.d.) once all the sessions are completed successfully and we have collected the data for acceptable number of participants.

6.8 Feedback/Questionnaire

I have designed a small Questionnaire that is designed to carry out a small semi-structured interview with the participants that was used to take feedback, suggestions and recommendations for future research from participants. Interviews were carried out after the evaluation of ODSG&TT.

Questionnaire is added in [Appendix C](#).

³ These platforms are just used as reference platforms for testing purpose. Any other platform can be used for conducting the experiment. We are not evaluating any of these or similar platforms. These are just a reference point to estimate the time taken to generate summary through a website and a plugin.

6.9 Evaluation Results and Analysis

We have 3-time calculations for each participant by the end of all the sessions. These calculations include:

1. Time taken to generate summary via a website.
2. Time taken to generate summary via a plugin.
3. Time taken to generate summary via ODSG&TT.

We have evaluated and analyzed these estimates and discussed the details in [Results and Analysis](#) section. The small interview with the participants has projected whether the effort was useful, and it has contributed towards better screen reading experience for the visually impaired.

Chapter 7 Results and Analysis

As explained the earlier sections, we recruited 20 blind folded participants to perform the testing and evaluation of my Prototype and also perform the same task using 2 existing alternatives. After noting down the time for all 3 case studies, we aim to perform One Way Repeated ANOVA (as we have 3 level means) (*one-way-rm-anova-DE300.pdf*, n.d.) using SPSS software and see how 3 approaches differ and how/if my approach is better/not better based on time taken to generate the summary of the lengthy text.

7.1 Evaluation and Testing - Data Collection

The complete evaluation process consisted of 20 one-to-one sessions, one for each participant as per my defined protocol. The evaluation results based on time using all 3 alternatives including ODSG&TT is shown in the Figure 7.1 below.

*SPSS DATA for Experiment.sav [DataSet0] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Add-ons Window

23 : ODSGTT

	Plugin	Website	ODSGTT
1	81.00	85.00	30.00
2	90.00	88.00	26.00
3	86.00	87.00	25.00
4	83.00	87.00	29.00
5	84.00	84.00	31.00
6	93.00	90.00	27.00
7	89.00	88.00	25.00
8	80.00	85.00	28.00
9	87.00	84.00	23.00
10	91.00	90.00	26.00
11	83.00	80.00	28.00
12	88.00	89.00	30.00
13	99.00	80.00	29.00
14	85.00	86.00	26.00
15	86.00	89.00	24.00
16	82.00	91.00	27.00
17	83.00	88.00	26.00
18	98.00	83.00	29.00
19	93.00	84.00	26.00
20	87.00	90.00	24.00

Figure 7.1 Time taken (in Seconds) for 20 Participants for all 3 alternatives

Figure 7.1 shows the time taken for all the 20 participants for generating a Summary of the same text using all 3 alternatives. The time is calculated in seconds and it is done using a stopwatch. After completing the data collection for the evaluation of ODSG&TT, we ran One-Way Repeated ANOVA on the collected data, the output of these measurements will be discussed in Analysis part.

7.2 Feedback – Data Collection

After noting down the time for each participant, as mentioned above, we had a small semi-structured interviews based on my questionnaire given in [Appendix C](#). These were 5 simple Yes/No questions that were answered by all the participants. The participants were quite excited being the part of the testing and evaluation process. The table shows the summary of the answers posted by the participants.

Answers to these questions are shown in Table C. 1 in [Appendix C](#), are discussed in detail in analysis section. There were some suggestions as well from the participants, that we will discuss in Analysis section. Here, to get an overall response of the evaluation and testing we have focused on direct binary answers.

7.3 Analysis

Since the span of this research is both Quantitative and Qualitative, we separate the Result and Analysis section into two subsections. One for Statistical Results and Analysis and other for Feedback Interview Results and Analysis.

7.4 Statistical Results and Analysis

The results of One-Way Repeated ANOVA indicated that compared to Plugin and Website process, ODSG&TT summarization technique took relatively lesser time. These repeated measures are carried out significance level .05 with confidence interval 95%. The following **Feil! Fant ikke referansekilden.** indicates the mean time taken in seconds to generate the summary of the text.

Summarization Technique	Mean (seconds)	Std. Deviation	N
Plugin	87.4000	5.31532	20
Website	86.4000	3.21837	20
ODSG&TT	26.9500	2.23548	20

Table 7.1 Average Time taken by participants using given alternatives

On average, summary generation through plugin and website took 87.4 seconds (1.45 minutes approx.) and 86.4 seconds (1.44 minutes approx.) respectively. However, ODSG&TT took only 26.95 seconds i.e. 0.45 minutes which less than half a minute. In the above table, N implies the total number of participants in the activity. In Table 7.1, we can clearly observe that there is a difference in means of my prototype and other techniques. These results can also be viewed through the following bar charts with confidence interval of 95%.

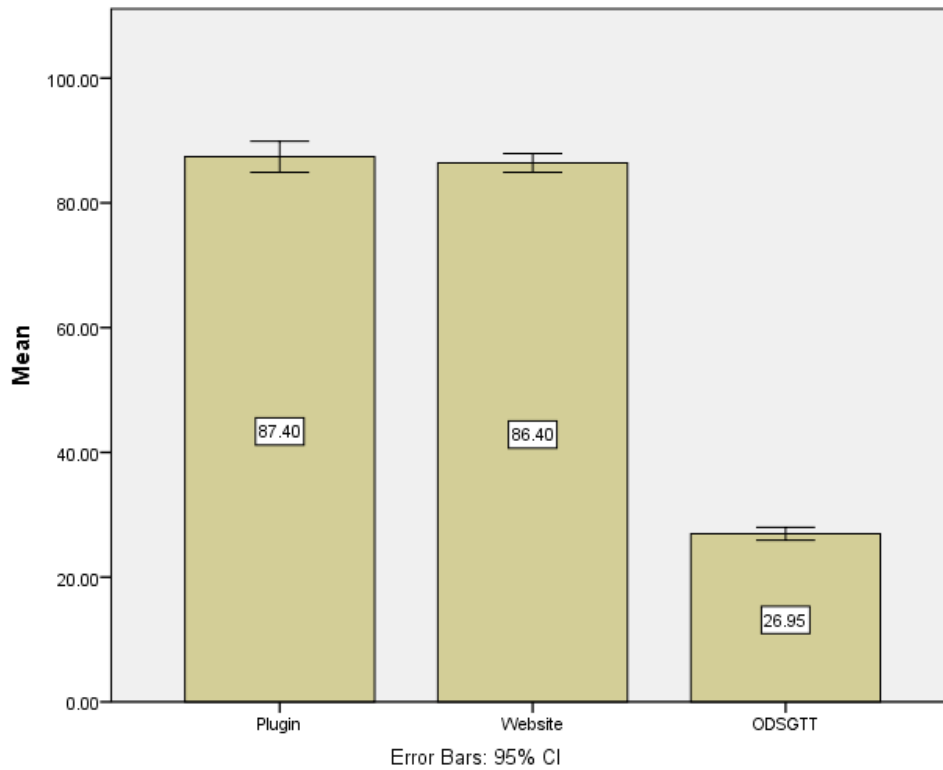


Figure 7.2 Bar Chart for Calculated Means with 95% Confidence Interval

In Figure 7.2 bar chart for calculated means with the error bars. As mentioned earlier, ODSG&TT took the minimum average time in order to generate summary and keywords while other took relatively longer durations.

SPSS resolves the data as we enter in the sheet. As reflected in the above Table 7.1, system has numbered the techniques as we have entered in the sheet. For information, we refer to Figure 7.3 below.

Within-Subjects Factors	
Measure: MEASURE_1	
SummarizationTechnique	Dependent Variable
1	Plugin
2	Website
3	ODSGTT

Figure 7.3 Within subject fields

Moving on to check Sphericity, SPSS automatically conducts the test for sphericity – the Mauchly’s test (*Sphericity.pdf*, n.d.). Sphericity states to the equivalence of the variances of the changes between levels of the repeated measures (*Sphericity.pdf*, n.d.). Its significance value will determine whether or not we will analyze based on Sphericity assumed. In our case, we look at the results obtained from SPSS.

Mauchly's Test of Sphericity ^a							
Measure: MEASURE_1							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^b		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
SummarizationTechnique	.813	3.718	2	.156	.843	.916	.500

Figure 7.4 Mauchly's Test of Sphericity

Figure 7.4 indicates the test for the assumption of sphericity. This is similar to assumption of homogeneity of variance for independent tests (*Sphericity.pdf*, n.d.), but in this case it tests the assumption that the relationship between the different pairs of conditions is similar. Moreover, it tests the null hypothesis that the error covariance matrix of the orthonormalized transformed

dependent variables is proportional to an identity matrix. In this case as sphericity value is greater than .05 i.e., p -value $> .05$, we can state that we do not reject the null hypothesis i.e. $\chi^2(2) = 3.718$, $p = .156$.

The One-Way Repeated ANOVA also known as Within Subject ANOVA, was run with Summarization Technique as Independent Variable (IV) and Summarization Time as a dependent variable. The values are reported as per the following equation.

$$F(\text{IV df, error df}) = F\text{-ratio, } p = \text{Sig, } \eta^2 = \text{Partial Eta Squared}$$

In the above equation, **Sig** stands for Significance Level, **df** stands for degree of freedom, **F-ratio** is calculated by dividing the mean squares for the variable by its error mean squares and, **Partial Eta Squared** tells you about the magnitude of your effect. We can simply refer to it as a measure of effect size.

Results of ANOVA showed a significant difference of Summarization Time between the Summarization Techniques (Plugin, Website, ODSG&TT); $F(2, 38) = 1439.5 = p < .001, \eta^2 = .987$.

The results are reflected in the Figure 7.5 below.

Tests of Within-Subjects Effects							
Measure: MEASURE_1							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
SummarizationTechnique	Sphericity Assumed	47930.033	2	23965.017	1439.492	.000	.987
	Greenhouse-Geisser	47930.033	1.685	28437.880	1439.492	.000	.987
	Huynh-Feldt	47930.033	1.831	26172.344	1439.492	.000	.987
	Lower-bound	47930.033	1.000	47930.033	1439.492	.000	.987
Error (SummarizationTechnique)	Sphericity Assumed	632.633	38	16.648			
	Greenhouse-Geisser	632.633	32.023	19.755			
	Huynh-Feldt	632.633	34.795	18.182			
	Lower-bound	632.633	19.000	33.296			

Figure 7.5 Tests within Subjects Effects

Bonferroni (Stephanie, 2015) post-hoc analysis revealed that **Plugin Summarization Techniques ($M=87.4, SD=5.315$)** compared to **Website Summarization Technique ($M=86.4, SD=3.22$)** and vice versa, took almost the same time for summary generation hence, the two techniques are not significantly different. However, **ODSG&TT Summarization Technique ($M=26.9, SD=2.23$)**, compared to other

two techniques, took much lesser time to generate the summary, we can state that ODSG&TT is a significantly a faster technique compared to the other two.

These results are reflected in the Figure 7.6 below.

Pairwise Comparisons						
Measure: MEASURE_1						
(I) SummarizationTechnique	(J) SummarizationTechnique	Mean Difference (I- J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
1	2	1.000	1.508	1.000	-2.958	4.958
	3	60.450*	1.301	.000	57.035	63.865
2	1	-1.000	1.508	1.000	-4.958	2.958
	3	59.450*	1.014	.000	56.787	62.113
3	1	-60.450*	1.301	.000	-63.865	-57.035
	2	-59.450*	1.014	.000	-62.113	-56.787

Figure 7.6 Pairwise Comparison for Significant Difference

As mentioned in Figure 7.3, the labels 1,2 and 3 symbolize Plugin, Website and ODSG&TT techniques respectively.

In order to explain these results in more detail, we can plot the estimated Marginal Mean against the 3 techniques and analyze the results. As shown in the Figure 7.7 below.

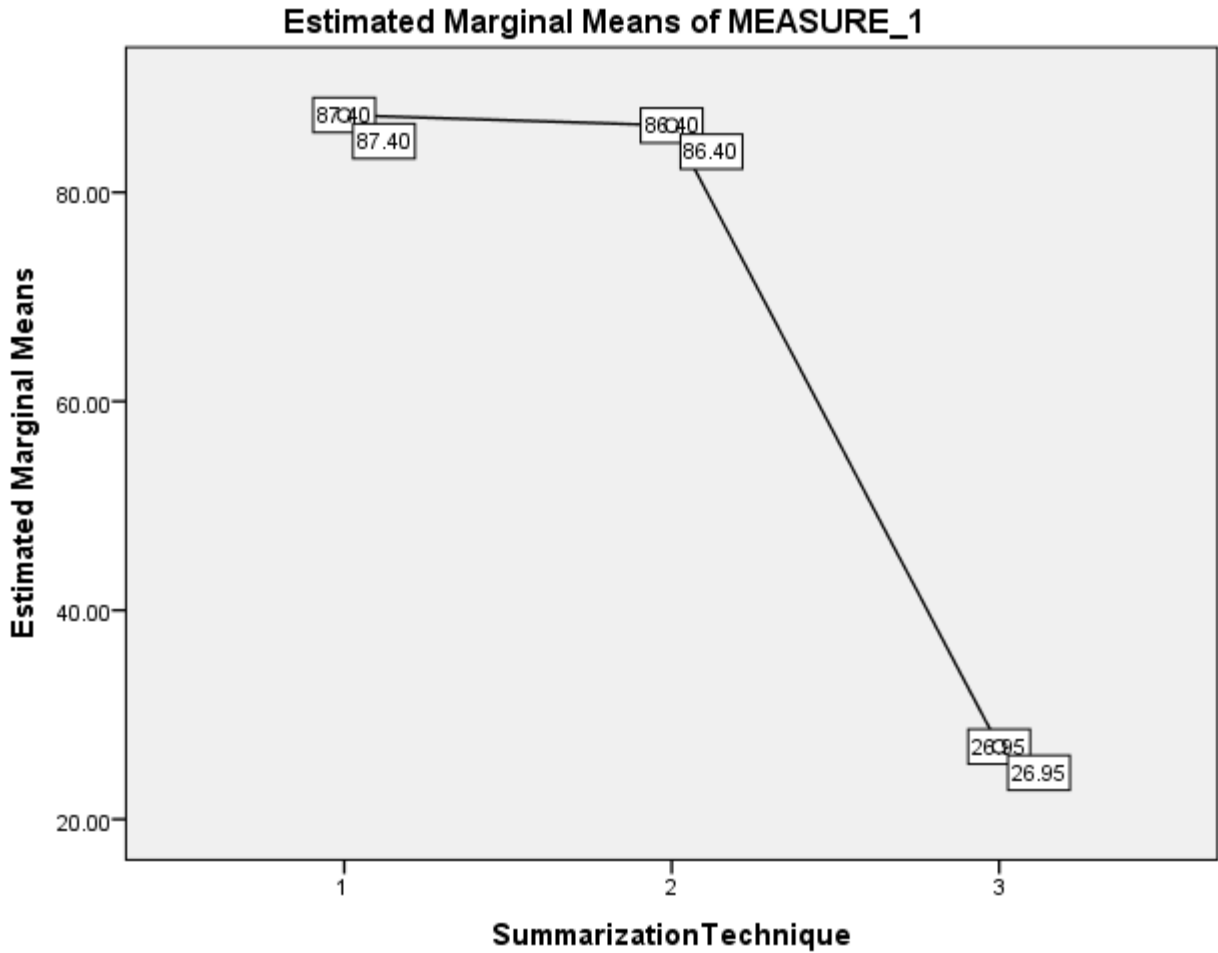


Figure 7.7 Summarization Techniques vs estimated Marginal Means of Time Taken

This plot reflects the Average Time Taken (in seconds) for each technique and it is evident that Summarization Technique 3 took the least time with a significant difference than the other two techniques. This also support my hypothesis that ODSG&TT is a faster summarization technique than the available alternatives.

These results support the hypothesis that ODSG&TT is a significantly faster summarization technique compared to available alternatives.

7.5 Feedback Interview Result and Analysis

In this section we will discuss the answers collected through interviews that we conducted after the evaluation and testing process. The answers to all questions are already presented in **Feil! Fant ikke referansekinden..**

We will analyze question by question and see what the answers are given by the participants.

Does ODSG&TT address the purpose?

80% of our participants were of the view that ODSG&TT is addressing the purpose properly and it is performing the functionality that is designed for. While 20% of the participants thought it is not entirely addressing the purpose.

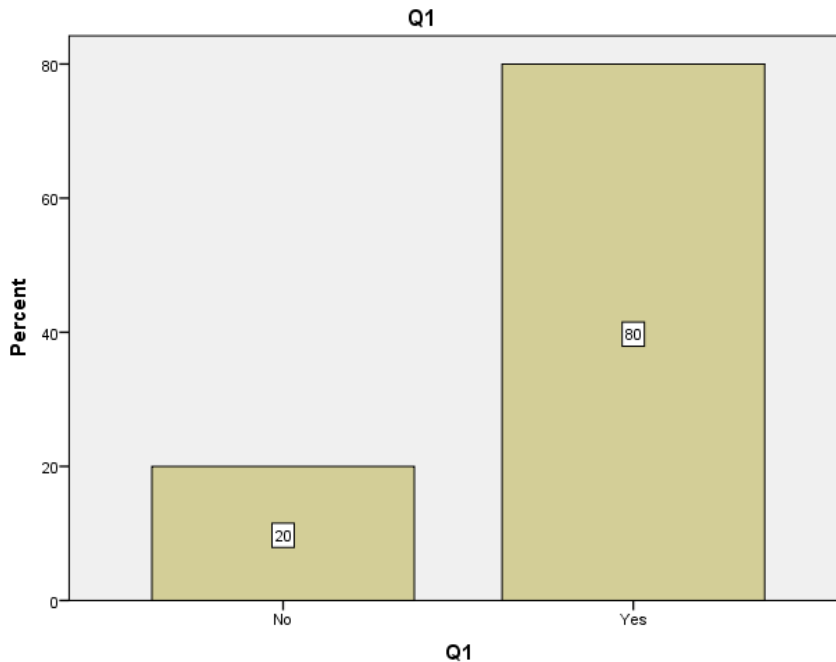


Figure 7.8 Answers to Q1 (Does ODSG&TT address the purpose)

Based on answers given to my first question I can deduce that the dominant majority of my participants are of the view that ODSG&TT addresses the purpose of summary generation quite well. The response to this question in a bar chart can be seen Figure 7.8 above.

Was it faster than trivial summary generation techniques?

In response to the 2nd question, 95% of the participants found that the prototype faster than trivial summary generation techniques. While 5% of the participants did not find it faster. These results are shown in Figure 7.9.

This 95% majority's feedback give us a clear result that ODSG&TT is faster than other alternatives.

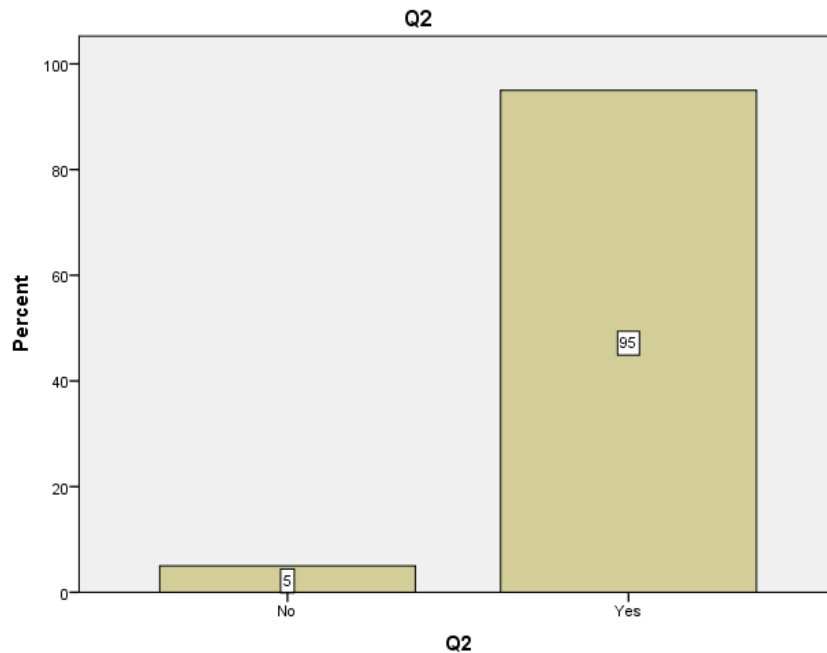


Figure 7.9 Answers to Q2 (faster than trivial)

Moving to other questions in the feedback interview we check the response of 3rd question.

Was ODSG&TT simple and straight forward enough?

Most of the participants found the prototype simple and straight forward to use as they were no complex calculations or processes involved. Therefore, 70% of the participants voted for this system

as a simple system while 30% thought it is simple but probably not the simplest. Figure 7.10 refers to results of Question 3.

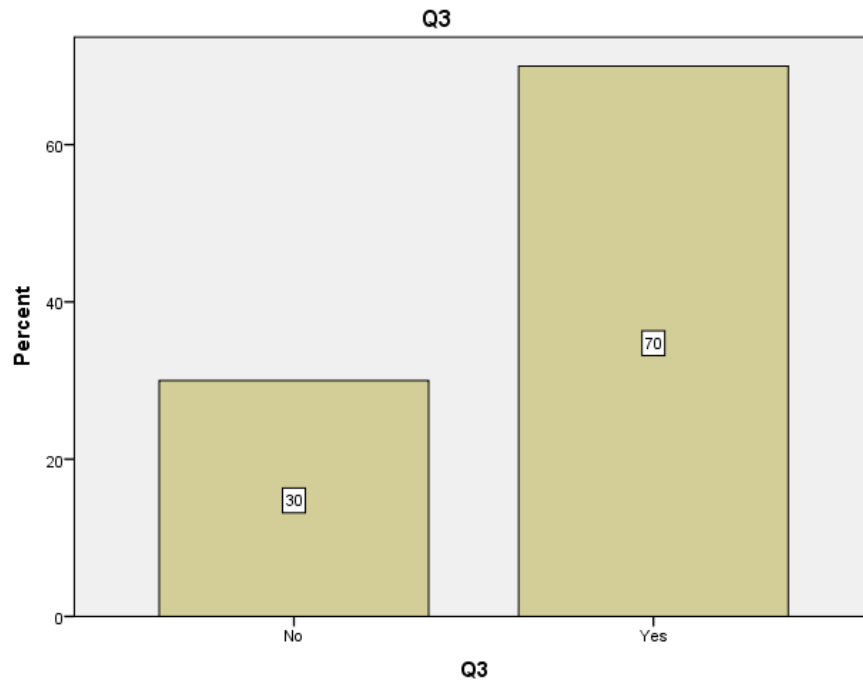


Figure 7.10 Answers to Q3 (simple and straight forward)

Does it address the navigation issues while generating summaries through alternate ways?

Navigation challenges are the most cumbersome challenges for visually impaired. One of the main focuses for this research is to minimize the navigation challenges and try to build something which is less tiring for the users with visual impairments. Question 4 deals with this scenario and answers to this are really encouraging where participants seemed to have liked the product where they navigations are minimal and less cumbersome. 75% were of the view that Yes, ODSG&TT addresses the navigation challenges which is a good number while 30% had the other opinion. The bar chart of responses to this question is provided as Figure 7.11 below.

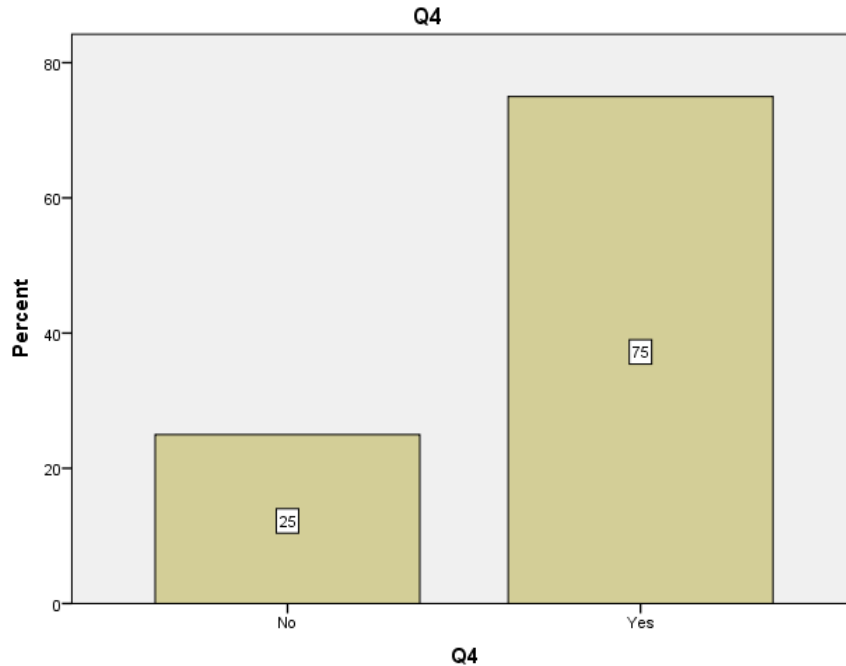


Figure 7.11 Answers to Q4 (address the navigation issues)

Does it simplify the screen reading when generating summaries?

In this whole research and evaluation, we were comparing ODSG&TT with other possible alternates for generating summaries. Therefore, it is of immense importance to get a feedback from participants in order to understand that whether or not this prototype simplifies the screen reading. 85% of the participants are of the view that it does simplify the screen reading mainly because the focus of the screen remain within the webpage and navigations are reduced and as a visually impaired user, they do not have to move here and there in order to develop an understanding of the content. However, 15% participant thought, there are still things that are needed to be done in order to improve the system.

Figure 7.12 reflects the responses recorded for Question 5.

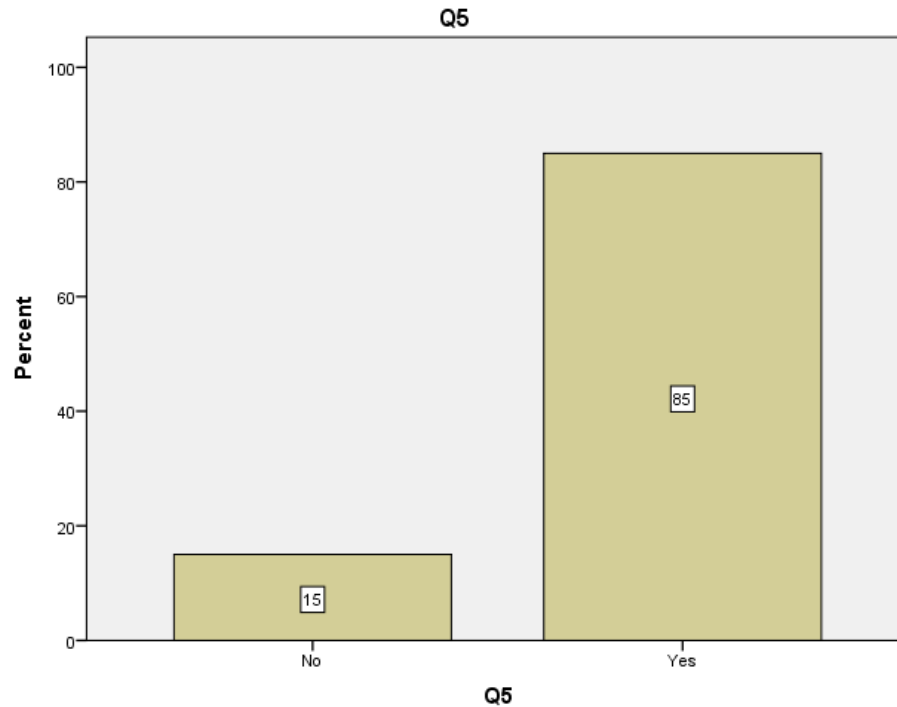


Figure 7.12 Answers to Q5 (simplify the screen reading)

Apart from these there were few suggestions from the participants. Since all the participants were IT students or had at least a minimum level of IT qualification, they were very technical regarding this product. Some were curious regarding the design of this Prototype in a real-world website. One of the participants actually suggested few design improvements and gave us few tips on involving a web designer on it so that this can be incorporated in as many websites.

As of now, after reading summary, the regular text reading starts automatically. Few of the participants suggested that there should be a pause and some instruction, that lets user know that summary is finished and if they want to continue or change the search. This is indeed a great suggestion.

Overall, it went out as a good practice to hear the end user point of view and we have taken these points towards the improvement of the product.

Chapter 8 Discussion

In this thesis, I have started with introducing the problem that is related to Screen Reading vs Visual Reading. To start with, we have discussed the right of access to information i.e., everybody has a right to access any publicly available information, regardless of their physical impairments. It is discussed in detail when a user is undertaking visual reading they read, perceive and understand the written text simultaneously. However, when it comes to screen reading, process of perceiving and understanding is not straight forward. It brings many associated challenges with it and screen readers users can find it difficult and cumbersome to perform a complete text reading. In the light of these points, we prepared 3 research questions. First question covers the Navigation challenges within the digital content. Second question deals with the techniques and approaches to achieve faster and effective screen reading using Screen Reader software with minimized navigations. Similarly, third question covers that how the lengthy text reading through screen reading in websites can be simplified.

A detailed background research and literature review is carried out in order to identify the potential challenges that come across when screen reader users use the screen readers for information retrieval. Screen Reading is not as easy as the 20/20 vision reading. This covers the content for our first research question. In this section, I have tried to cover the existing state of the art technologies and products. Further, associated challenges, if any, are also highlighted and based on these findings came with an idea of developing a prototype that make screen faster and simplified.

In the literature review section, it was observed that existing summarization techniques require too many steps to perform by the users and in order to minimize these navigation challenges and in an effort to make screen reading simplified, we have developed a Prototype named On Demand Summary Generation and Text Tagging - ODSG&TT, that addresses the issues related to lengthy text readings through screen readers and navigation challenges involved, if user wants to summarize the lengthy text. This prototype uses the existing summarization and text tagging algorithms and incorporates them within the website. This Prototype helps the visually impaired to summarize the lengthy text using a button control. Pressing the button displays the summarized text and keywords

within the same webpage dynamically and focus of screen reader is also transferred to the keywords section dynamically.

Since, this research involves the development of a prototype and its evaluation with users, it was of utmost importance to choose the accurate Research Method. After careful analysis, it was decided to go with mixed approach as this whole process deals with quantitative as well qualitative results. After the development we have run an evaluation and testing with 20 blind folded users in one-to-one session by following the protocol that is defined and explained in detailed in Chapter 6 of this report.

In Analysis section, it is discussed the statistical and feedback interviews results. That covers the Quantitative Research Method as well as Qualitative Research Method. The overall results seem very promising. It is statistically proven that ODSG&TT takes significantly lesser time to generate a summary while existing methods take longer.

After explaining and reviewing the results, I can conclude that this project helps minimizing the navigation challenges when generating summaries of lengthy texts and it simplifies the screen reading because in the prototype, there are auto control transfers and users only have to do the minimum. These results cover the span of our research question 2 and 3 respectively.

Chapter 9 Conclusion

As we have been insisting that Visual Reading is not same as Screen Reading. Visual reading is normal or trivial way of reading something. However, the Screen Reading has associated challenges with it, especially if readers are visually impaired. In this thesis we have identified the lagging points, which draws path between the two forms of reading, through the literature review and studying the state-of-the-art technologies. This background study covers the Research Question no. 1.

This software testing and evaluation answers the Research Question 2 and 3. As, lengthy text can be summarized within same webpage and user will automatically be referred to keywords and summary we can say that ODSG&TT simplifies the screen reading. After reading the summary through screen reading, users can decide, whether or not they want to continue. Hence, it saves time for the users and users do not have navigate between the web pages and browsers. Adding to it, participants' feedback makes it clear that ODSG&TT does not involve complex navigation and control transfers, therefore it is faster and easier to use.

Chapter 10 Future Work

ODSG&TT is just a beginning. It can have a number of perks along the time. As of now, it is very simple summary generation software that generates the keywords and a summary of the lengthy text with a button and embeds it on the same webpage, however, As a developer of this software, I see many additions to it.

Currently we are using a third part summary generation API. The system can have its own summary generation API. This will involve the writing a summary generation algorithm using advanced Natural Language Processing techniques and its integration with ODSG&TT.

Another future work can be, as the participants suggested, we can enhance this prototype to let user know when summary is finished and ask them if they want to continue reading or not. This is not a very big enhancement, but this can be a starting point for new Master thesis.

After the improvements, this prototype can be integrated with Search Engines like Google, MSN or others through Internet of Things (IoT). User will give a voice command to modern day devices like Alexa, Siri and similar to generate the summary of an article or text and the Prototype can run in the backend Summary will be generated and read out loud by the device.

There can be many other future improvements and enhancements in this project. I would like to wish best of luck and anyone who would like to take things from here and start for next level.

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Appendices

Appendix A

```
var input = "A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.";
Algorithmia.client("simGGwxDJ3WNMvMFK4jriJBTQvD1")
  .algo("nlp/Summarizer/0.1.8")
  .pipe(input)
  .then(function(output) {
    console.log(output);
  });
```

Figure A. 1 How to Use Summarizer Algorithm ("Summarizer - Algorithm by nlp," n.d.)

```
var input = "A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.";
Algorithmia.client("simGGwxDJ3WNMvMFK4jriJBTQvD1")
  .algo("nlp/AutoTag/1.0.1")
  .pipe(input)
  .then(function(output) {
    console.log(output);
  });
```

Figure A. 2 How to Use AutoTag Algorithm ("AutoTag - Algorithm by nlp," n.d.)

Appendix B

The following figures reflect the code of ODSG&TT.

```
<script src="https://ajax.googleapis.com/ajax/libs/jquery/3.3.1/jquery.min.js"></script>
<script src="//algorithmia.com/v1/clients/js/algorithmia-0.2.0.js" type="text/javascript"></script>
```

Figure B. 1 jQuery and Algorithmia sources

Figure B. 1 refers to the jQuery and Algorithmia sources and their integration in our code file. When using PHP and HTML, external libraries are added through Script tags as shown in figure.

```
<script>
|
function setFocusOnKeywords ()
{
    document.getElementById("keywordsdiv").focus();
}

function setScroll()
{
    //var objDiv = document.getElementById("detailedtextdiv");
    //objDiv.scrollTop = objDiv.scrollHeight;
    window.setInterval(function() {
        var elem = document.getElementById("detailedtextdiv");
        elem.scrollTop = elem.scrollHeight;
    }, 5000);
    share
}
</script>
```

Figure B. 2 Functions for setting focus and handling scroll

Figure B. 2 refers to the functions that are responsible for setting up the focus within the webpage and managing the scrolling of webpage. When keywords and summary are generated, new sections are added in the webpage hence, these function help managing focus and scroll to provide a better user experience.


```

<script>
$(document).ready(function(){
  $(this).scrollTop(0);
});

$(document).ready(function(){
  $("#summarize").click(function(){
    var input = $( "#detailedtext" ).text();
    //$( "#summarytext" ).text( input );
    Algorithmia.client("simGGwxDJ3WNMvMFK4jriJBTQvDl")
      .algo("nlp/AutoTag/1.0.1")
      .pipe(input)
      .then(function(output) {
        if(output.error) return console.error("error: " + output.error);
        //console.log(output);
        $("#keywords").text( "Keywords: " + output.result);
        $("#keywordsdiv").show();
        //$("#keywordsdiv").focus();
        setFocusOnKeywords();

      });

    var client = Algorithmia.client("simGGwxDJ3WNMvMFK4jriJBTQvDl");
    client.algo('nlp/Summarizer/0.1.3').pipe(input).then(function(output) {
      if(output.error) return console.error("error: " + output.error);
      //console.log(output.result);
      $( "#summarytext" ).text( "Summary: " + output.result );
      $("#summarize").hide();
      $( "#summarydiv" ).show(100);

    });
    //alert(str);
  });
});
</script>

```

Figure B. 3 Core Program of ODSG&TT

Figure B. 3 explains the main code of our product i.e., ODSG&TT. The function written in above snapshot reveals that how dynamically the web page text is extracted from the web page and passed on Algorithmia libraries as input and the output, when received, is dynamically added to webpage. Adding new sections on the go and focus being shifted to newly added section so that screen reader can start from Keywords and Summary. The code is written in JavaScript and jQuery.

Following Figure B. 4 shows a website that has ODSG&TT functionality enabled that means if users want, they can generate the keywords and summary of the text within the webpage they are at. It will make things easier for them in order to decide if they want to continue or not. This picture shows a webpage that is normal, and ODSG&TT is not yet run on it.

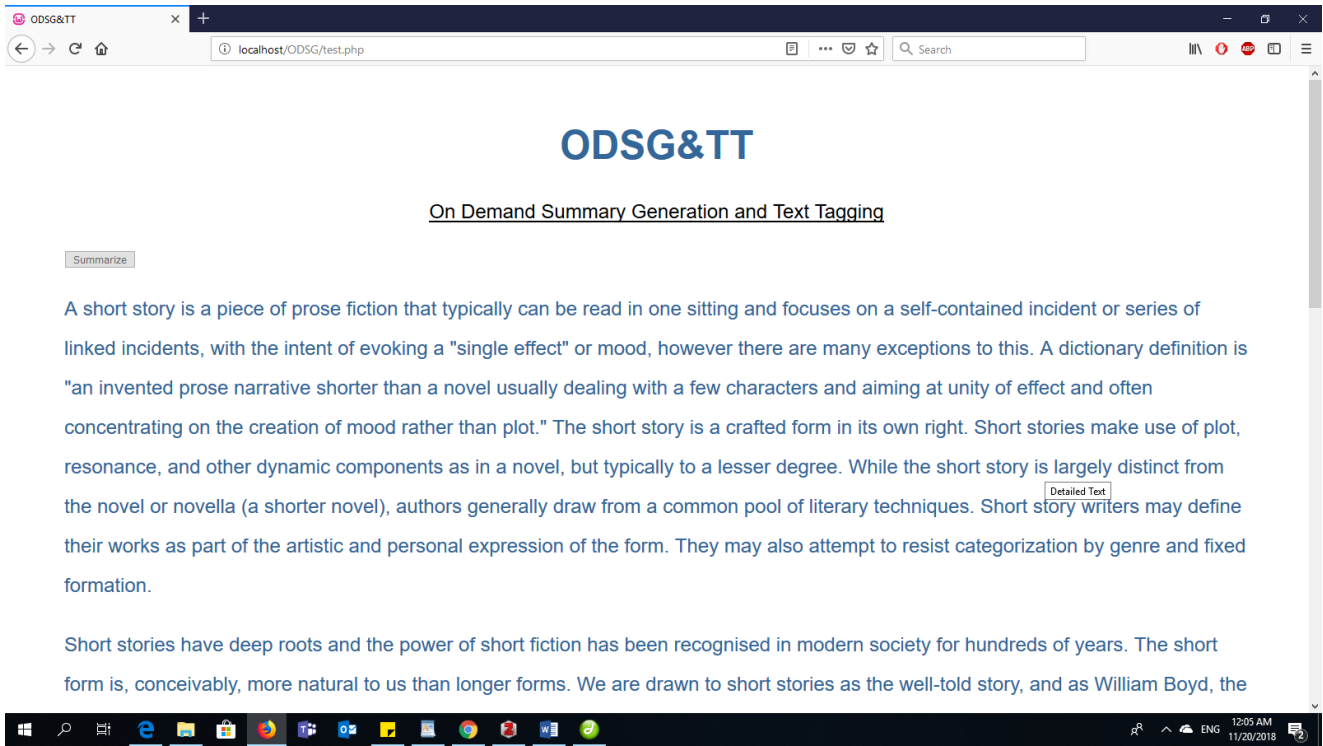


Figure B. 4 ODSG&TT enabled webpage

In the following screenshot, we will observe how the webpage will look like when ODSG&TT is executed and what makes it one of the unique concepts.

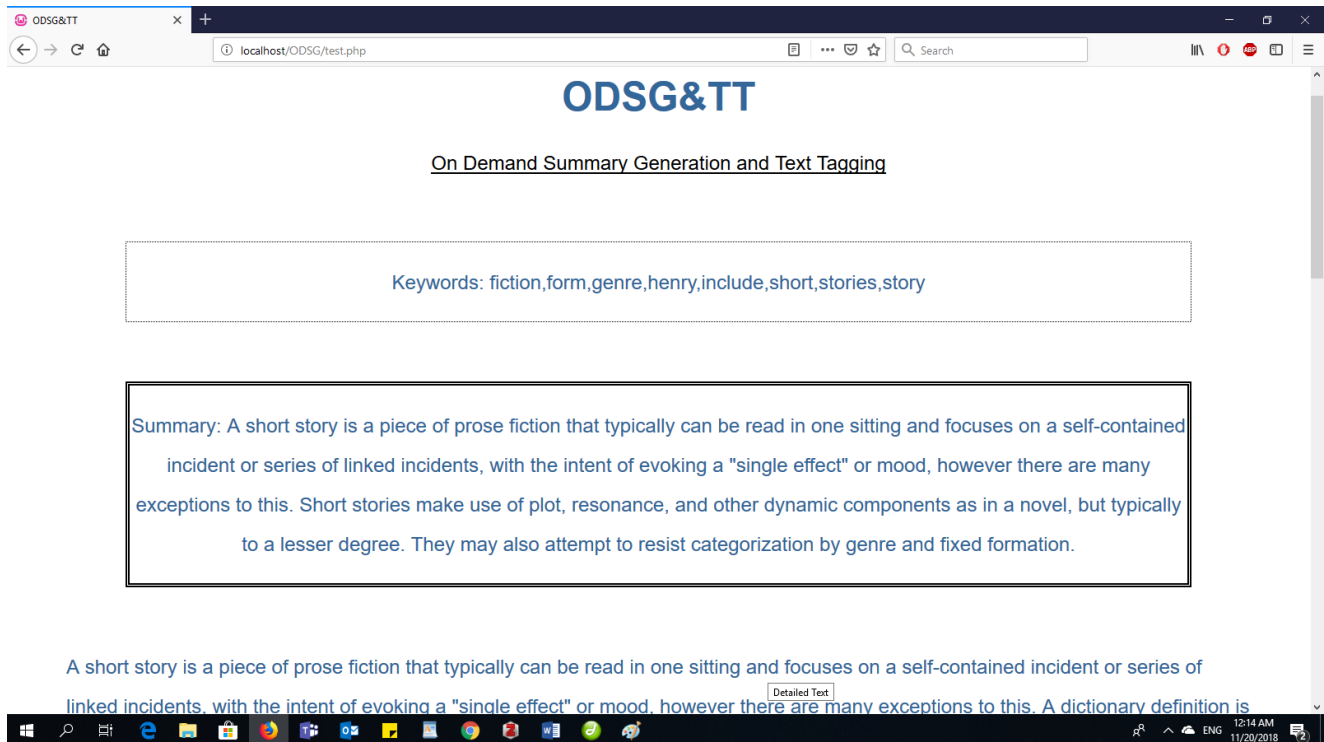


Figure B. 5 Web Page after the execution of ODSG&TT

Referring to Figure B. 5, we can see that there are 2 new section generated within the same webpage that was shown in Figure B. 4. Newly added sections are Keywords and Summary. Detailed or actual text is still there for users, but that will be read after screen reader reads out these 2 section. This will give user an ample time to think whether the article or text is relevant and interesting or not. If yes, screen reader will continue with detailed text as well, otherwise user can simple go to some other webpage. This will make situation less cumbersome for the screen reader users.

Complete Code and Video Demo

Complete code of the project with all necessary files is available on my GitHub account for review. Please follow the link; [ODSG&TT Complete Code Repo](#).

A small demo video to see how the concept would work is available on YouTube. Please follow the link to view; [ODSG&TT Demo Video](#).

Appendix C

The following is the questionnaire we will use to take feed back and opinion of screen reader users.

Q1 Does ODSG&TT address the purpose?

Q2 Was it faster than trivial summary generation techniques?

Q3 Was ODSG&TT simple and straight forward enough?

Q4 Does it address the navigation issues while generating summaries through alternate ways?

Q5 Does it simplify the screen reading when generating summaries?

Answers to the questions

Participant no.	Q1 (address the purpose)	Q2 (faster than trivial)	Q3 (simple and straight forward)	Q4 (address the navigation issues)	Q5 (simplify the screen reading)
1	Yes	Yes	Yes	No	Yes
2	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	No	Yes	Yes
4	No	Yes	No	Yes	No
5	Yes	Yes	Yes	Yes	Yes
6	Yes	Yes	No	Yes	Yes
7	Yes	Yes	Yes	Yes	Yes
8	Yes	Yes	Yes	Yes	Yes
9	No	Yes	No	No	Yes
10	No	Yes	Yes	No	No
11	Yes	Yes	Yes	Yes	Yes
12	Yes	Yes	Yes	Yes	Yes
13	No	Yes	No	No	No
14	Yes	Yes	Yes	Yes	Yes
15	Yes	Yes	Yes	Yes	Yes
16	Yes	Yes	No	Yes	Yes
17	Yes	Yes	Yes	Yes	Yes
18	Yes	Yes	Yes	No	Yes
19	Yes	Yes	Yes	Yes	Yes
20	Yes	No	Yes	Yes	Yes

Table C. 1 Answers by All the Participants to my Semi-Structured Feedback Interviews