

REAL TIME AUGMENTED REALITY BASED TOOL FOR DIGITAL MEDIA PRODUCTION

Project Id: 2021-075

Individual Project Proposal Report

B.Sc. (Hons) Degrees in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

February 2021

REAL TIME AUGMENTED REALITY BASED TOOL FOR DIGITAL MEDIA PRODUCTION

Project Id: 2021-075

Individual Project Proposal Report

Gankanda G.M.J.U – IT18063738

Supervisor: Dr. Shyam Mehraaj

Co Supervisor: Mr. Thusithanjana Thilakarathne

B.Sc. (Hons) Degrees in Information Technology

Department of Information Technology


Sri Lanka Institute of Information Technology

Sri Lanka

February 2021

Declaration

We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Gankanda G.M.J.U	IT 18063738	

Name of the Supervisor: Dr. Shyam Mehraaj

Name of the Co-supervisor: Mr. Thusithanjana Thilakarathne

Signature of the Supervisor:

Signature of the co-supervisor:

Abstract

Television news broadcast is medium of having a visual aid along with voice. It is a one of the main advantages of a news broadcast through a television comparing to a news broadcast via a radio. Having such an advantage in a news delivery through a television, we can easily express more information to the general public. One of the ways of delivering news in an attractive way is by using technologies such as data visualization. Data visualization is a process of indicating large number of statistics of information or data regarding an incident or an event into a visually appealing element. Many data visualization elements contain mostly graphs or charts such as pie charts, bar chart, Histograms, scatter plots etc. and sometimes map. In news productions we can see some types of these graphs or charts are been used to simply information or data which is useful for delivering news in a more precise and visually appealing method. The main advantage of using data visualization techniques in a news program is that the viewers of all social statuses can understand the news more accurately and easily. The data visualization system developed through this research gives the user an easy access to create a visual element (graphs or charts) easily, accurately and visually blending with the correct color themes in the studio or the type of the news. Having such a system in a news studio, the producers can easily create a 3D graphs or charts. With this system, having less mathematical knowledge in graphs might not be an issue for the users. Generally, this system simplifies the process of data visualization in a television news production.

Keywords: Data visualization, 3D graphs, 3D charts, News production, visual elements, statistical data representation.

Table of Contents

Declaration	i
Abstract	ii
List of Figures	v
List of Tables.....	vi
1 Introduction	1
1.1 Background.....	3
1.2 Literature survey	4
2 Research Gap.....	7
3 Research Problem.....	9
4 Objectives	12
4.1 Main Objective	12
4.2 Specific Objectives	12
5 Methodology	13
5.1 Research Area.....	13
5.2 Architecture of the Data Visualization system	13
5.2.1 system diagram	15
5.3 Hardware Architecture	16
5.4 Software Architecture.....	16
5.4.1 Requirement Gathering and Analyzing.....	17
5.4.2 Design	17
5.4.3 Development and Implementation	18
5.4.5 Commercialization	19
5.5 Gantt Chart	20
6 Project Requirements	21
6.1 Functional Requirements	21
6.2 User Requirements.....	21
6.3 System Requirements.....	21
6.4 Nonfunctional Requirements	22
6.5 Use Cases	22

6.6 Test Cases	23
6.7 Wireframes.....	24
6 Budget	25
7 Reference List	26
Appendices	28

List of Figures

Figure 1.1 Product comparison	8
Figure 2.1 Local News Channel Example.....	9
Figure 3.1 Foreign News Channel Example	10
Figure 4.1 Foreign News Channel Example	10
Figure 5.1 System Architecture.....	15
Figure 6.1 Software Architecture	16
Figure 7.1 Use Case Diagram.....	22
Figure 8.1 Wireframe 01	24
Figure 9.1 Wireframe 02	24
Figure 10.1 Wireframe 03	25
Figure 11.1 Budget.....	25
Figure 12.1 Appendix.....	28

List of Tables

Table 1.1 Research Gap	7
Table 2.1 Technologies used	18
Table 3.1 Gantt Chart	20
Table 4.1 Test Cases.....	23

1 Introduction

Unlike a radio broadcast, the television broadcast is a combination of both audio and visual aspects. Through a television broadcast, the news presenters and news creators can use visual benefits to attract viewers and deliver the news more clearly. With the busy lifestyle of the society many people watch the news at the end of the day with a busy and tired mindset and sometimes might not pay attention vocal delivery of the news. Having a news delivery with more attractive visual elements can keep the viewers' attention throughout the news program and help the viewers to understand the news more easily. Though this research our system focuses on creating and improving visual aspect of the daily news item. Not only in news broadcasts and television programs, but we can use these kinds of technologies in any visual medias and in content creations.

This system which include Data Visualization, Point tracking, Object placement and gesture detection as one tool. This tool will be commercialized in the future under one brand name LUMOZ. LOMOZ is a system designed to help daily news creators, mobile journalists, live media creators and social media content creators to easily create daily live media content with 3D objects and Augmented Reality technology with time efficiency, budget friendly way and accurately.

This paper includes an effective approach which can be useful for a news delivery channel to use technologies such as Data Visualization in their daily news program. This helps to increase the correctness as well as the attractiveness of the program. Currently Data Visualization is not an uncommon topic in news production. Already this technology is been used to represent election information and data in election periods and currently it has been used to represent data about Covid 19 patients.

Using graphs, charts and maps to represent data and information in a news delivery, it can increase the understanding level of the viewers [6]. Because in a situation like election period, the statistics are of much larger values. Rather

than just telling the numbers, it is easier to analyze these numbers and show them in visual form.

To express these kinds of statistical information, the designers or the producers should be very careful to only show accurate analysis of data in visual manner. Otherwise the general public will grasp the information inaccurately. To create such graphs or charts of larger data sets, the graphic team should have mathematical knowledge. Lack of mathematical knowledge will create incorrect graphs. Recently we came across such inaccurate graphs created by a local channel as well as in a foreign channel also. Sometimes the news producers mislead the data in these graphical representations rather than spending time to create more accurate graphs.

That was the main reason to develop such a system to create data visualization more accurately. In this system, the graph or the charts created will have a color theme which will be suitable for the color theme in the news studio environment color theme and the type of news as well. Introducing a color theme to the visual elements can bring out the best impression to the news and it can blend nicely with the newsroom environment.

1.1 Background

In a television broadcast the data visualization plays an important part during the times which needs comparison between statistical data or when a conclusion needed to be shown precisely using a visual aid. The benefit of using a visual element to represent the statistical data is that it is much easier to the general public to understand. One of the effective ways of communicating a news to the general public is the use of Data visualization. This is practically merging data set to a visual element such as graphs, charts and maps. Large and complicated data and information can be easily represented using this technology.

For example, in the time of election, if the news presenters just read the values the viewers will might not understand or get bored by just listening. But if that statistics of the election results are shown in a diagram, the viewers will understand easily and stay turned with the news channel to get more details on the election. This example is one of the recent and most common usage of such visual elements in many news channels.

It is a responsibility of the news presenters or the news creators to create and design correct visual elements and not to intentionally or unintentionally mislead the public with incorrect graphs or charts. This has been an issue in some situations where incorrect representation of data was found in both local and foreign channel. This might be due to lack of knowledge, less planning or less concern. Using visual elements needs knowledge on analyzing data and mathematical graph knowledge. Otherwise, the visual elements might not represent the most accurate data values on them

This paper introduces an easier and budget friendly method of using Data Visualization in daily news. This system will provide easy access to create a visual element using the given data and information. The visual elements created through this system will have the option to choose proper color themes to the visual elements according to the newsroom environment or according to

the type of the news. and, it will provide the opportunity to transform these visual elements into 3D objects which can be used in the daily news broadcast.

Not only in news delivery, but this system can be used in many digital media contents such as YouTube content creations, tictok creators, and other social media creations [7].

1.2 Literature survey

In the literature survey I have focused on the Data Visualization research articles and books published in the recent years. Data Visualization is not a new topic to the society.

By the authors Brenda W. Yang, Camila Vargas Restrepo, Matthew L. Stanley, Elizabeth J. Marsh has also discussed about the potential to misleading the viewers through the incorrect data graphs [1]. Data communication through data visualization is very effective tool and easier way to convey the data to the viewers. In this study they showed that through y- axis truncation the viewers may be misled in data communication. This article provides some solutions to this research component. In our research, the main section focused is how the y-axis coordinates are changed according to the data entered. Therefore, this research helps in applying their concept into our research component.

One of the methods used in the Data Visualization to read data are from the database is using data manipulation through SQL statements [2]. After data is taken from the database, then different tools for data visualization is used. Then the data exploration is another important step in data visualization. Many users get the experience in what needs to visualized is through current explored visualizations. Many users tent to use the same visualization and only change the parameters or zooming in/out to get detailed information. XmdvTool is one of tools for Data Visualization discussed in this paper. Using the mentioned tool, they have discussed two different technologies in prefetch and prediction in Data Visualization. Current explored visualization and Historical data are the

two prefetch and predictions. For the Historical data, XmdvTool proposes three strategies. They are direction (select the most likely direction based on the user's previous trajectory tracking), focus (select the direction with hot regions) and vector (selecting the direction based on the vectors of the movement trajectories of the users). Kyrix is another interactive scalable data visualization system. Kyrix provides declarative visualization specification interface in front end and effective scalable visualization processing in back-end. But these tools and software's doesn't meet the ends of creating a visual element that can also be shown as a 3D element on the daily programs.

Another software for Data Visualization is Mondrian data visualization software. This software offers advanced high dimensional mosaic plots and continuous data [3]. In this research article it explains that, interactive statistical data visualization is a powerful tool which reaches beyond the limits of static graphs. This research paper lists Mondrian's special features and implementations. It is a JAVA based application which runs on many platforms. There is a technique introduced in this paper as the smart selection which focuses on identifying of patterns and subgroups. Furthermore, this software was never designed to be a general-purpose graphical data analysis package. It offers standard plots. More advance way of handling selection is by allowing current selection to combine with new selection [4] using Boolean functions.

Many forms of data visualizations have been used all around the world and in many fields. Data Visualization has improved the quality of displaying statistics and improve the human thinking process [5]. Not only in broadcasting medias, this has become of the decision support system to many fields of work.

When creating meaningful visualization of data, size of the data and data composition are very important factors which needs to be considered. Data analytics requires graphic representation and using temporal data, multidimensional data, 2D area plots and hierarchical representation, can demonstrate how data can be made visual [9]. In one of the researches, done in 2018, it talks about a software tool called Dashboard [10]. Dashboard provides a join to the database in Laravel, the migration process in the tables is carried out,

defining all the fields and relationships of the tables, then are performed the controllers, where the functions required by the dashboard. In this research, the tool Dashboard mainly focus on visual elements such as line charts. Radar charts and pie charts.

For data visualization difficulties, it is much important to understand the issues related to human perception. It can be finalized that data visualization methods can be improved by considering fundamental relations to the psychological principles and by implementing most natural interaction with visualized virtual objects. [15]. This paper provides a good entrance to the problems that are discussed under this research component.

In the research paper [16], the spatial Augmented Reality tool has been used for 3D Data Visualization. It uses to enhance the visual aspects of any physical object for better understanding. This tool has many limitations. As this tool uses a projector the lighting of the room is much considered. This tool provides much advanced Data Visualization method than the method that we are creating.

2 Research Gap

This component introduces many changers to increase the accuracy of a visual element as well as the attractiveness of theses visual elements. This system provides easier access to create visual elements even with less mathematical knowledge. Large statistical data can be represented accurately so that the general public will understand the news more accurately. This system helps to create more attractiveness to the news which can be achieved by creating proper color themes according to the newsrooms environment and according to the type of news which needs to be represented by these visual elements.

Features	XmdvTool	kyrix	Mondrian	Product
Creation of visual elements for the news using data	yes	yes	yes	yes
Showing color pallet.	Yes	Yes	Yes	Yes
Showing the default color theme according to the specific environment.	No	No	No	Yes
Creating a 3D effect to the visual element	No	No	No	Yes
One interface to control the all necessary items needed to create visual elements.	No	Yes	Yes	Yes

Table 1.1 Research Gap

2.1 Overall Product Comparison

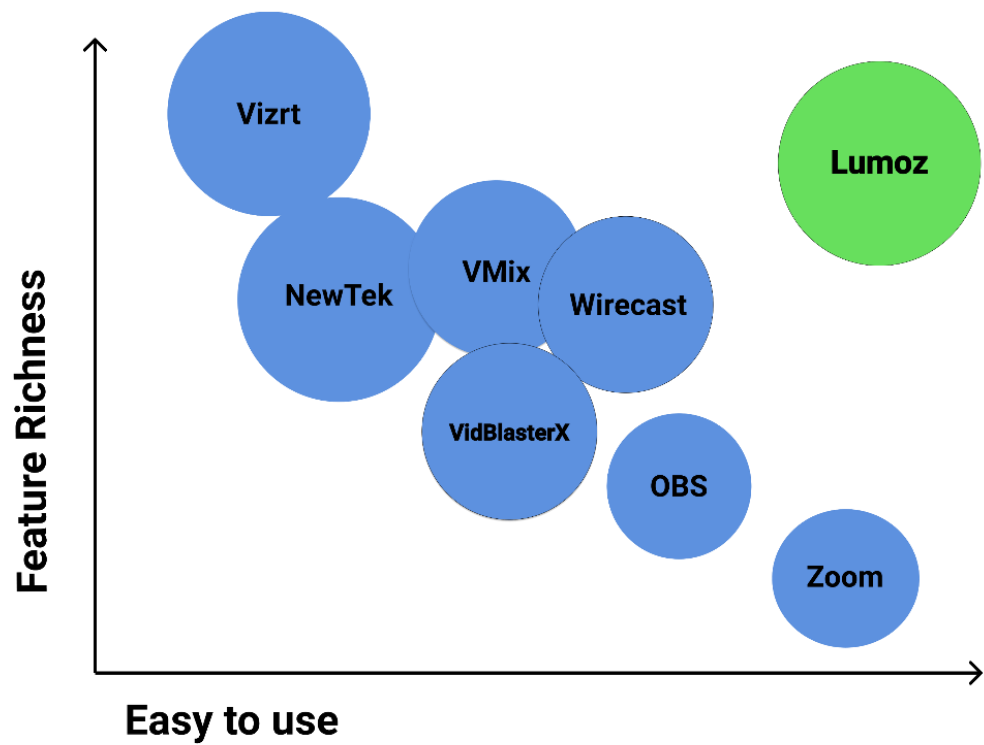


Figure 1.1 Product comparison

Figure 1.1 is the overall product comparison of the research project. With the comparison we can identify the overall tool LUMOZ can be a budget friendly and time efficient product which can be used in the live media production.

3 Research Problem

Data visualization technology is not a newer technology in the society. There are many tools and software's to produce a visual element using the given data.

Even though the current news channels use such tools to create the visual appearance of news, sometimes we can observe incorrect or misleading visual elements [13]. In our research, we observe that in some visual elements shown by local [12] as well as foreign news programs have misleading or incorrect values.

In the below figure 1.1, it shows the number of patients recovered and still recovering coverage in the pie chart are incorrect. This example is from a local channel.



Figure 2.1 Local News Channel Example

Some channels in Sri Lanka does spend much money to create correct and attractive visual elements. But some channel doesn't have enough budget and knowledgeable employees to create such elements.

Not only in local channels, but also in foreign channels as shown in Figure 2.1 and Figure 3.1, we can find such examples for incorrect and misleading graphs [14].

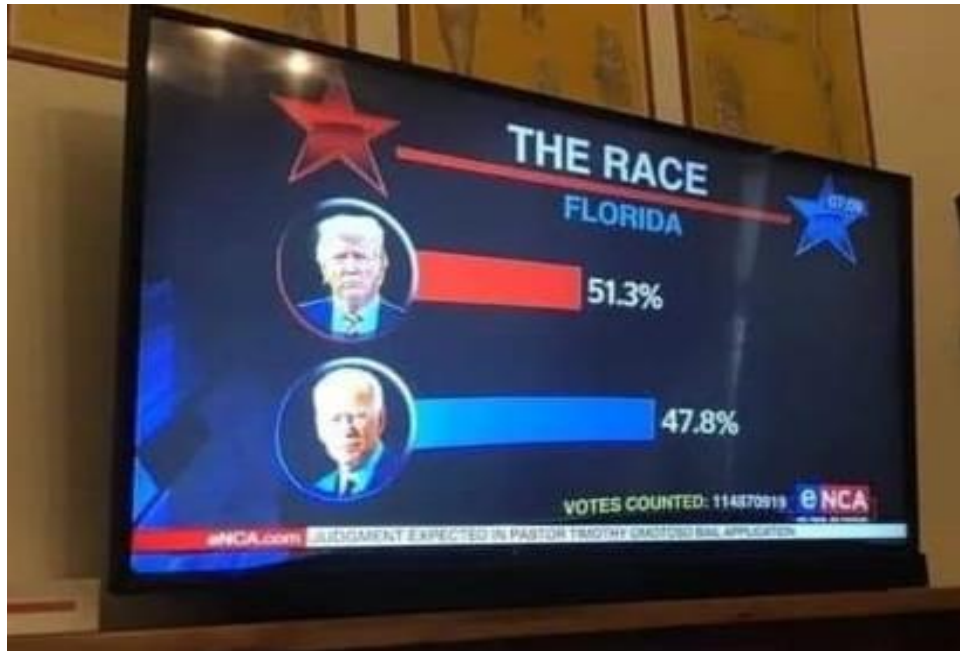


Figure 3.1 Foreign News Channel Example

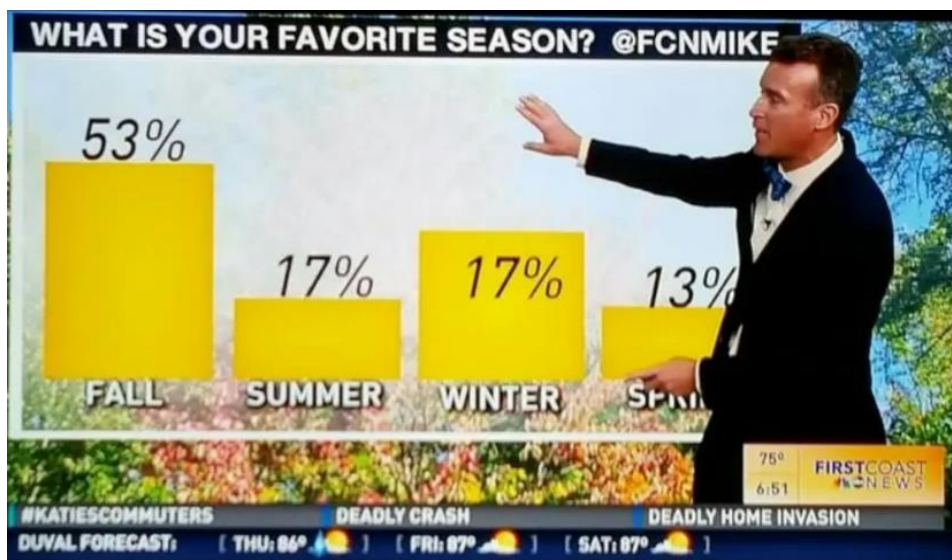


Figure 4.1 Foreign News Channel Example

With the following examples shown, we can conclude that not only the budget becomes an issue, but also not having much concern on creating accurate visual elements is also another major issue. Also, another main reasons for creating such incorrect graphs can be the lack of mathematical knowledge on visual elements. Having a profound state of basic knowledge on visual elements is needed at least to confirm the accuracy of the visual element before adding to the live news broadcast.

What if there was a system which can provide easier access to all the necessary components to create accurate and attractive visual elements? This is one of the major research problems that going to be solved using this Data Visualization system done through this research.

When a news is delivered with such visual elements, they use their whole screen to show the image with the values and the visual element. What if there is a way to use a 3D technology to adjust these visual elements which can fit the newsroom? This is the second research problem which is solved through this system. With this solution the presenters can easily present the news in the newsroom itself and the news program will be more attractive and well organized.

Does every local channel can afford and use such 3D technologies in daily news programs? Another question which I have focused to be solved through this system. Many channels don't have enough budget to outsource 3D work to other companies or get a software which are of high budgets. Because of such issue, many channels tend not to use such technology in daily news items. So the only focus goes on to the delivery of news using traditional methods of vocal delivery with video and images.

Above are the main research problems that will be solved using this research component. This tool will provide much easier access to the live media creators such as live news broadcasts, to increase their news attractiveness with less budget and time efficiency.

4 Objectives

4.1 Main Objective

The main objective is to create more accurate visual elements in a daily news broadcast. Having accurate visual element can provide the viewers of the general public to have a clear knowledge on the current situation on something or give an overall perspective on a specific news item. Through this system, it will provide opportunity to create accurate news in a daily news broadcast without having much effort and less mathematical knowledge.

4.2 Specific Objectives

- Using this system to create 3D visual element which can be used as Augmented Reality effect to the daily news program. This adds more attractiveness to the overall news program.
- Having attractive color theme to the visual elements. This can be done either by analyzing the color theme on the newsroom or having correct color theme according to the type of news. for example, if the news is about political situation, then the colors needed in the visual elements need to match with the correct colors with the political party.
- Making the system more time efficient and easy accessibility. Providing one interface which makes it easier for the user to interact with the system.

5 Methodology

5.1 Research Area

The research area of this component is discussed under the system regarding Data Visualization architecture, technology uses, related software and hardware components and requirements needed. When we are considering the television news delivery, it is a combination of both audio and visual medium. Not only the vocal attractiveness should be considered, but also as the visual appearance should also be considered. Attractiveness is broad area considering the whole news program which can continue for a minimum of 30 – 60 minutes. Therefore, the technology we chose was to add attractiveness through Augmented Reality and 3D objects.

The data needed to develop the data visualization will be collected by the reports in the channels broadcasting team. These data are then sent through the system and used to create the correct visual element which represent the conclusion of the data gathered. Both quantitative and qualitative data can be visualized using visual elements created through data visualization [6]. Data visualization creates meaning through visual effects. The forms, 3D effects, color pallet, and arrangements of data visualizations elements trigger our senses in particular ways. In this research area, it's been focused on creating visual elements which bring out viewers sense of understanding and brings out feeling towards the art of the news delivered.

5.2 Architecture of the Data Visualization system

Data visualization is the process of analyzing data sets and transforming these data sets to a visually appealing visual elements such as graphs and charts. Through one interface many different keys features are provided in order to

create a perfect visual element without any misleading visual features or incorrect data representations. The key features are listed below;

- Enabling to add a theme to the visual element created using the statistical data. Through the system a default set of colors will be given to the user according to the colors match with the studio's environment. If the user needs other colors, then another set of color pallet is provided. Choosing a color according to the news should be done carefully, because some colors might not match with the news item which the visual element is based on. For example, if the news regarding a political news, then the color selected should match with the political party. Because of that, if the default color pallet doesn't contain the matching color, the user can manually choose the necessary color which suit the news.
- Currently the visual elements are displayed as 2D image of post in a news delivery in local news. another key feature provided by this system is the ability to create a 3D visual element object which can be use in the Augmented Reality space during the news delivery. after the creation of the 3d visual element, this 3D object can then be given to the system which cover the object placement done by one of our research team.

5.2.1 system diagram

The below Figure 4.1 is the high-level representation of the component of Data Visualization.

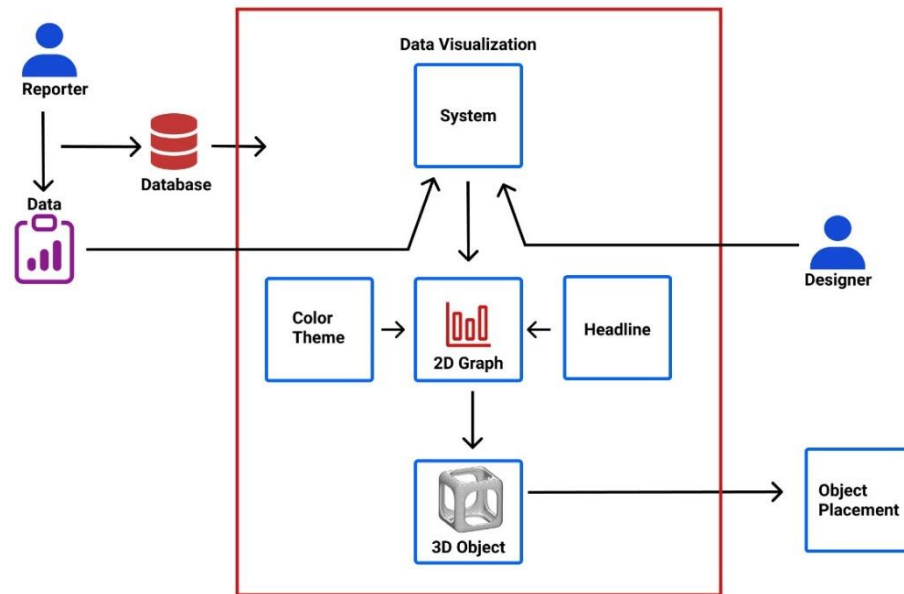


Figure 5.1 System Architecture

The analyzed data are sent into the system. The user can select the proper data visual element and add proper color theme and other features like the headlines and subtexts to the visual element model.

Color theme are automatically provided as default color theme which suits the studio environment and the user can select the color. If the color is not suitable according to the news item given by the default color, then the user can select a color manually from the color pallet.

The 3D object created from the 2D model as shown in the system diagram, will be send to the Object placement component. The whole system in the LUMOZ tool are interconnected with each other. This creates more efficient tool for the daily use for the digital media productions.

5.3 Hardware Architecture

There is no specific hardware architecture to this system. As this is software tool which is used to get data and information to the system and by processing the data, a visual element is created and modified which represent the data to the viewers. The basic hardware components such as computers/laptops will be used. The main feature in such a computer/laptop used are;

- Should be able to handle high graphic.
- Good processing speed.

5.4 Software Architecture

One of the best software models which describe our flow is the waterfall method.

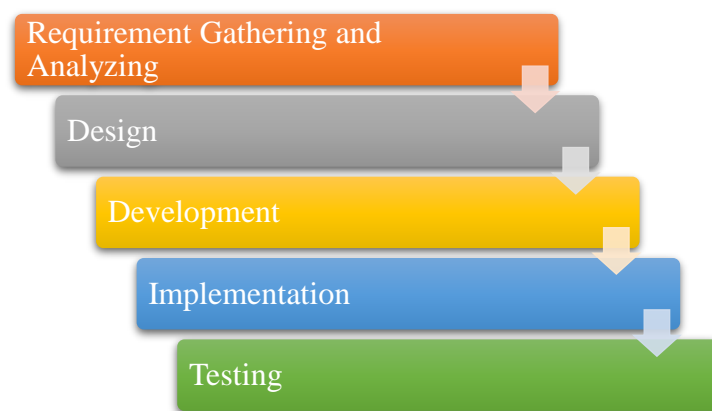


Figure 6.1 Software Architecture

For this research, the most relevant model is the waterfall model. It describes on how one phase reflects on the results on the next phase [8].it is the systematic process of travelling through phases. Each phase should be done carefully in

order to go to the next. About each phase and how the phases are affected to the research component is described below.

5.4.1 Requirement Gathering and Analyzing

Requirement gathering is the most important action which needs to do carefully before starting any research. All possible requirements needed to start and continue the project needs to be collected through all possible methods. With the team effort we did a requirement gathering and analyzing before starting the research. One of the main advantages of we had at the beginning was that, all four members of our team are directly or indirectly was working in the graphic fields and in the media field. With that experiences, we were able to know the specific requirements that we needed. We conducted the research in different methods.

1. Conducting brainstorming sessions with the team members.
2. Contacting different channel's graphic designers and interviewing them.
3. Gathering the research papers done regarding the research topic.
4. Examine news items daily
5. Gathering the news items which can be used in our research.

Data needed for the research are collected from selected general public, news channel's designers, through research papers and social media.

5.4.2 Design

During this phase, the system was designed and planned on how to divide the four main components in the system which can achieve the final goal intended. The necessary technology needed to develop this system and the hardware components needed are discussed during this phase. Having a proper plan in the design stage is very important to achieve the goal in the given timeline. With the

guidance of both supervisors we were able to finalize the four major components of the system. During this phase, organization of all our resources, documentations and technology stacks are collected and designed the overall system architecture.

5.4.3 Development and Implementation

In the previous stage, all the necessary details and resources were collected and designed the plan for this system. With that system design, small units of the program will be developed and will be integrated at the final step of the implementation phase. To integrate the system properly, all these individual components need to be well matched and should be able to be integrated without any complications. To reduce these complications in the integration, a strong communication between the team members is needed as well as a proper guidance from the supervisors. Proper selection of the technology and tools are very important. After each other's components are completed and integrated into a final product, the system is then sent to the testing phase.

In this paper, it is discussed on the components that will be developed for the data visualization process which contribute attractive and correct visual elements into a daily news delivery.

Part	Technology
Creating the interface	Electron
Creating 3D element	SVG (Scalable Vector Graphics) [17]
Creating back end	Python Language

Table 2.1 Technologies used

5.4.5 Commercialization

Lumoz can be commercialize as whole system tool which can be used as day to day Augmented reality and 3D based effects for digital media productions. This system can be commercialized among digital media creators, such as mobile journalists, television productions, live productions and social media productions such as YouTube creators and Facebook creators. According to the buyer, this tool can be introduced as free trail with less functions at the beginning and with the demand we can either make it as a subscription-based production or free trial turn to a premium paid system.

This tool will be cost effective considering other tools in the media field. As this tool can be used in daily and live productions, customers should afford the cost.

In Sri Lanka, such tool for 3D creations and Augmented Reality based creations are very less and the available systems are much expensive to use in a daily production. This is one of the best advantages of our tool to be easily commercialized. Selling this tool might not gain much capital, but the digital media world is a vast area with many sub sections. So, targeting the whole area of digital media world will provide much expansion to our product to be commercialized.

5.5 Gantt Chart

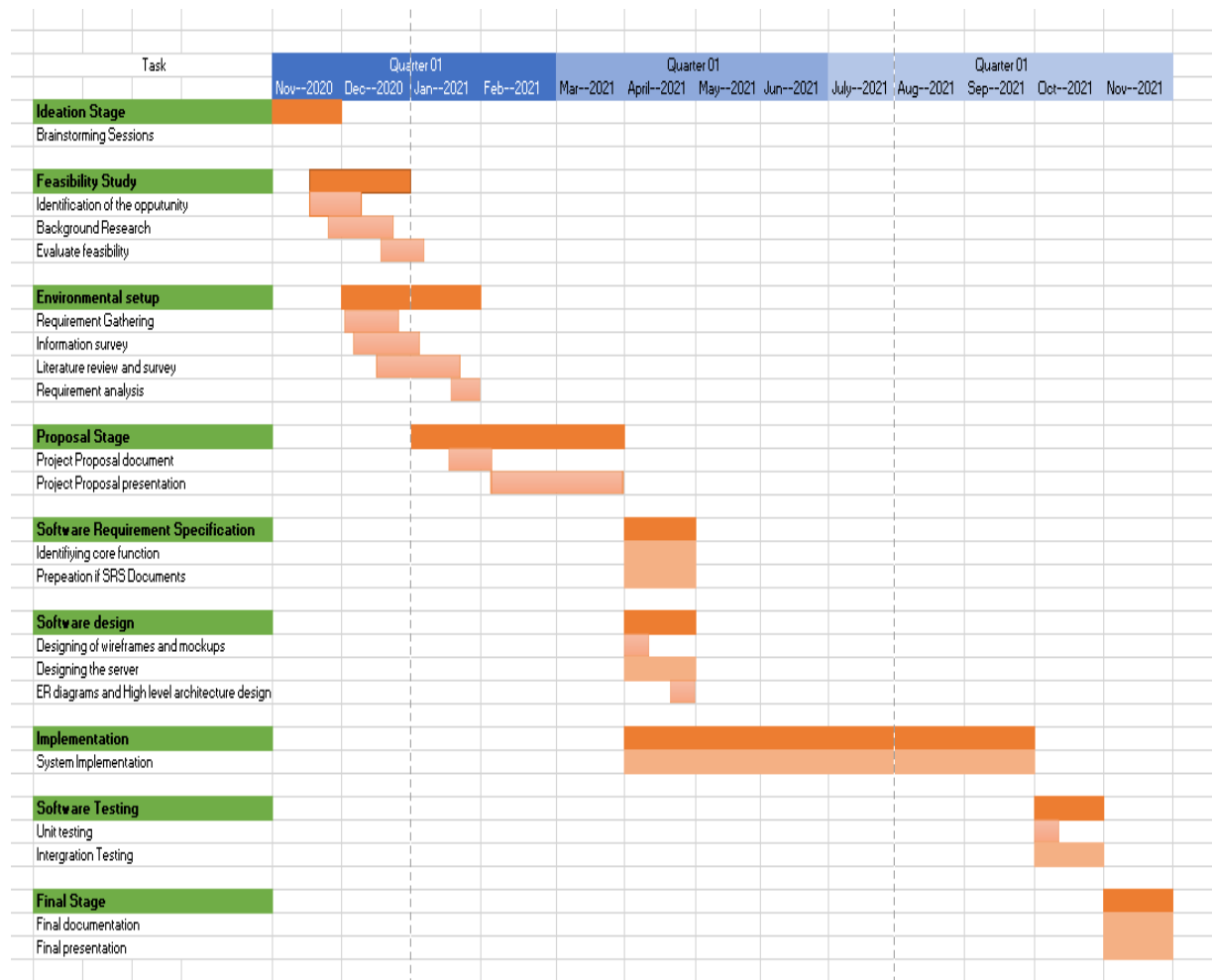


Table 3.1 Gantt Chart

6 Project Requirements

In this research project, the main requirement needed is to have better knowledge in 3D elements and Augmented reality technology. Proper backup needed to store all necessary data and documents. The purpose of this project is to build better Data Visualization among media productions and avoid the risk of creating misleading and incorrect visual elements.

6.1 Functional Requirements

- ✓ Inserting data to the system.
- ✓ Creating the visual elements according to the data inserted.
- ✓ Choosing proper visual element model.
- ✓ Choosing proper color theme to the visual element created.
- ✓ Creating 3D object for the visual elements created according to the data.

6.2 User Requirements

- ✓ Ability to handle a user interface.
- ✓ Knowledge in IT field and graphic designing.
- ✓ Having a good sense of creativity.

6.3 System Requirements

- ✓ Good processing speed.
- ✓ Ability to handle high graphic work.
- ✓ Enough storage capacity.

6.4 Nonfunctional Requirements

- ✓ Usability –better and user-friendly interface which provide all functionalities which needs in order to create correct and attractive visual elements.
- ✓ Performance – the creation of visual elements with less time and easily manageable interface.
- ✓ Availability – 24*7 availability. Once the system is installed to the hardware, it will be available in any time.
- ✓ Reliability – correct visual elements will be created once the data are inserted to the system.

6.5 Use Cases

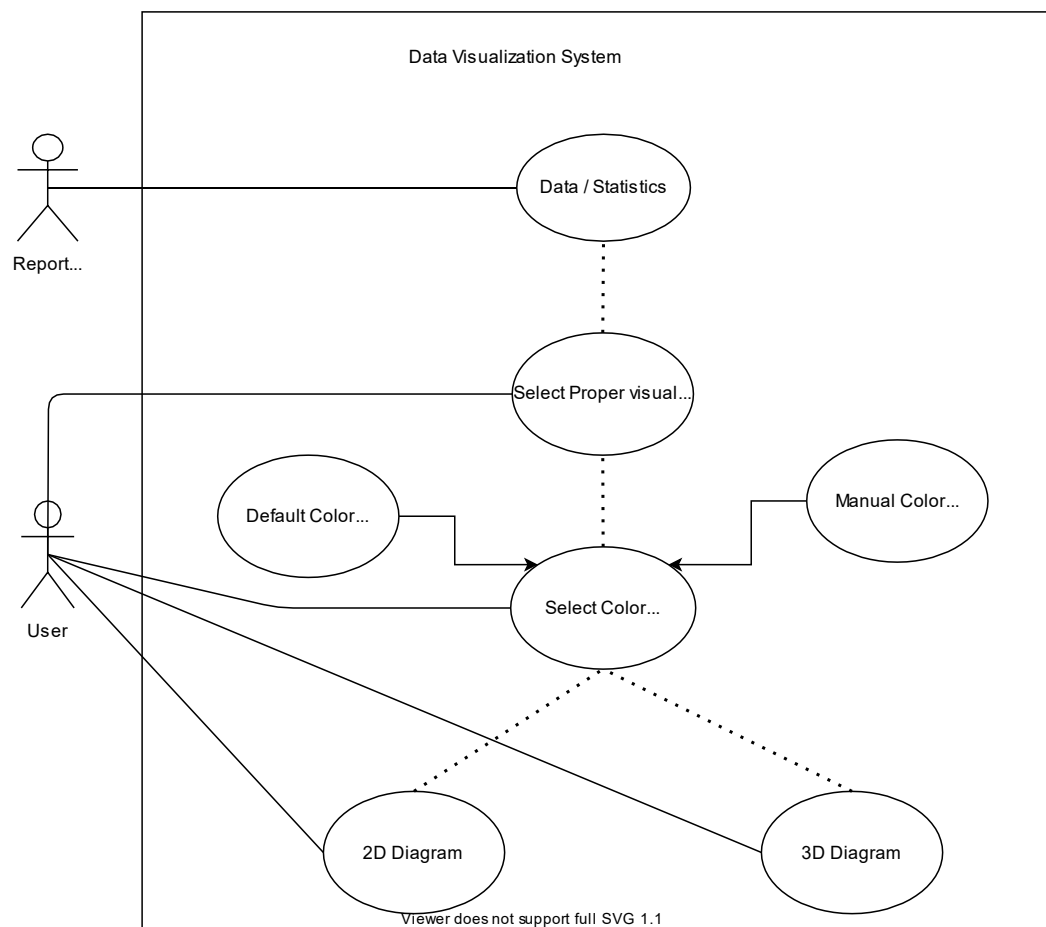


Figure 7.1 Use Case Diagram

6.6 Test Cases

Test Case Id	Test Scenario	Steps	Test Data	Expected Results
Test01	Get the data into the system	Take data directly from the reporter or from the database.	Analyzed data of a news item.	Success message of getting data to the system
Test02	Showing a list of data visualization elements	1. Get data. 2. Show suitable models of the graphs and charts.	Visual element models such as graphs and charts.	Correct visual element according to the data inserted.
Test03	Converting the 2D model into the 3D model.	Get the 2D model of the visual element after adding the data. Convert it to the 3D object. Send the final 3D model to the object placement component.	2D model with correct representation of the visual element.	3D object of the visual element.

Table 4.1 Test Cases

6.7 Wireframes

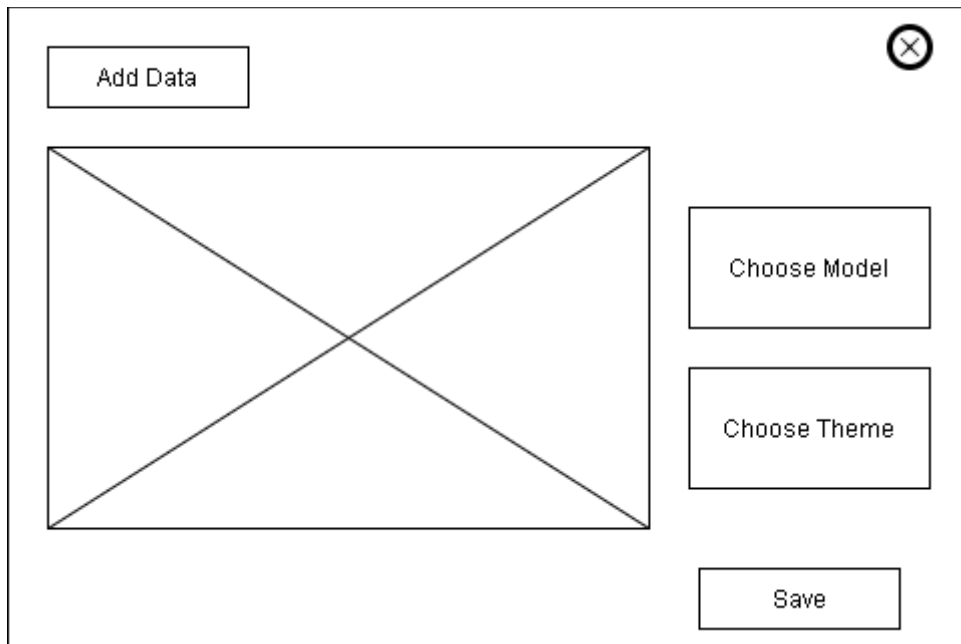


Figure 8.1 Wireframe 01

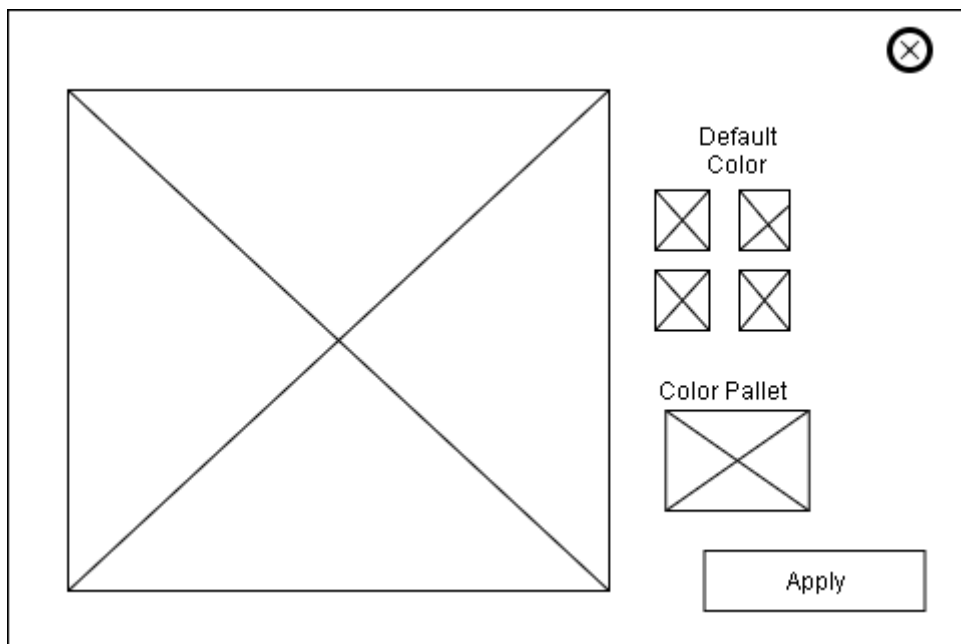


Figure 9.1 Wireframe 02

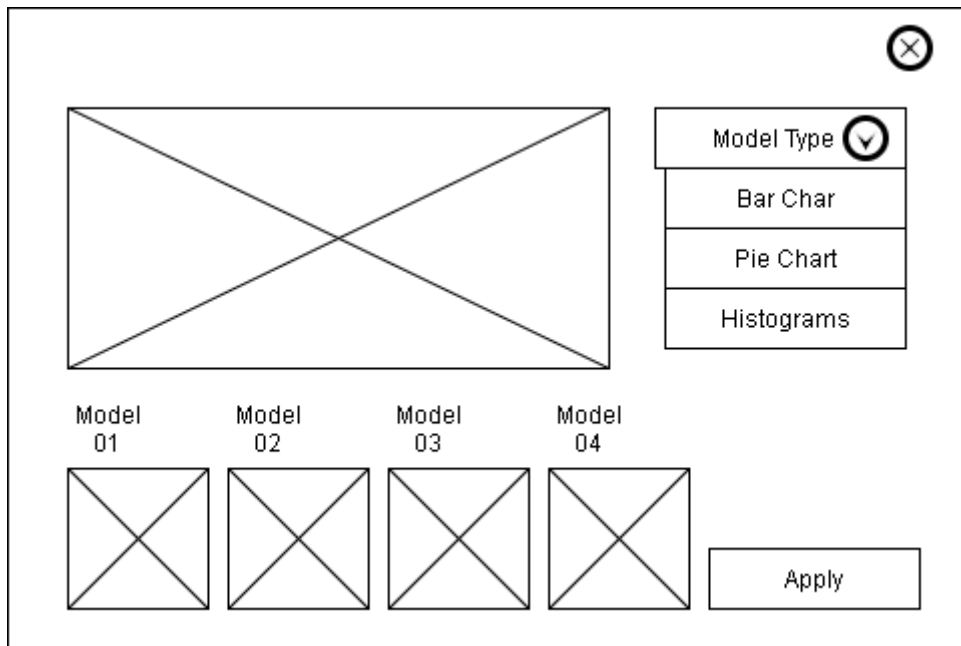


Figure 10.1 Wireframe 03

6 Budget

Resources	Price (LKR)
Electricity	3,000
Stationary	3,000
Internet	5,000
Communication	1,000
Paper Publish Cost	4,000
Software Purchasing	2,000
Total	18,000

Figure 11.1 Budget

7 Reference List

- [1] Yang, B., Vargas Restrepo, C., Stanley, M. and Marsh, E., 2021. *Truncating Bar Graphs Persistently Misleads Viewers*.
- [2] Qin, X., Luo, Y., Tang, N. and Li, G., 2021. *Making data visualization more efficient and effective: a survey*.
- [3] https://www.researchgate.net/profile/Martin-Theus/publication/5142809_Interactive_Data_Visualization_Using_Mondrian/links/0046353a45ba147e0b000000/Interactive-Data-Visualization-Using-Mondrian.pdf
- [4] D. Swayne, D. Temple, A. Buja, and D. Cook. Ggobi: Xgobi redesigned and extended. In Proceedings of the 33th Symposium on the Interface: Computing Science and Statistics, 2001
- [5] Luo, W., 2021. *User choice of interactive data visualization format: The effects of cognitive style and spatial ability*.
- [6] Library.oapen.org. 2021. [online] Available at: <<https://library.oapen.org/bitstream/handle/20.500.12657/22273/9789048543137.pdf?sequence=1#page=170>> [Accessed 26 February 2021].
- [7] Nadig, A., 2021. *Visualization of social media data in disaster recovery*. [online] Csus-dspace.calstate.edu. Available at: <<http://csus-dspace.calstate.edu/handle/10211.3/216042>> [Accessed 26 February 2021].
- [8] <https://mediaweb.saintleo.edu/Courses/COM430/M2Readings/WATEERFALLVs%20V-MODEL%20Vs%20AGILE%20A%20COMPARATIVE%20STUDY%20ON%20SDLC.pdf>
- [9] S. Rose, “Return on Information : The New ROI Getting value from data.,” SAS Inst. Inc. U.S.A, 2014.

- [10] Toasa, R., Maximiano, M., Reis, C., & Guevara, D. (2018). *Data visualization techniques for real-time information — A custom and dynamic dashboard for analyzing surveys' results. 2018 13th Iberian Conference on Information Systems and Technologies (CISTI)*. doi:10.23919/cisti.2018.8398641
<https://ieeexplore.ieee.org/abstract/document/8398641>
- [11] MICROSOFT CORPORATION, WASHINGTON, “Large scale data visualization with interactive chart ,” U.S. Patent 3 624 125, Jul. 16, 1990.
- [12] Jayaweera, D., 2020. *Bad Graph !!! Hope This Will Be Corrected By Ada Derana With An Apology ..* [image] Available at: < <https://www.facebook.com/dilith.jayaweera/posts/10157995591750977> > [Accessed 19 April 2020].
- [13] <https://onlinelibrary.wiley.com/doi/full/10.1046/j.1525-1497.2003.20703.x> (research Problem)
- [14] Channel Africa, e., 2020. *The Race 2020 / Details From The US Presidential Election*. [video] Available at: < <https://youtu.be/NLl07fgpyH8?t=286> > [Accessed 22 January 2021].
- [15] (N.d.). Retrieved March 22, 2021, from Springeropen.com website: <https://journalofbigdata.springeropen.com/articles/10.1186/s40537-015-0031-2#Sec8>
- [16] Thomas, B. H., Marner, M., Smith, R. T., Elsayed, N. A. M., Von Itzstein, S., Klein, K., ... Suthers, T. (2014). Spatial augmented reality — A tool for 3D data visualization. *2014 IEEE VIS International Workshop on 3DVis (3DVis)*, 45–50. IEEE.
- [17] w3.org/TR/2001/REC-SVG-20010904/, T. V. H. (n.d.). Scalable Vector Graphics (SVG) 1.0 Specification. Retrieved March 22, 2021, from Wwww.w3.org website: <https://www.w3.org/TR/2001/REC-SVG-20010904/REC-SVG-20010904.pdf>
- [18] Retrieved March 22, 2021, from Researchgate.net website: https://www.researchgate.net/profile/James-Vallino/publication/48304573_Interactive_Augmented_Reality/links/550d8e190cf2ac2905a7dfb9/Interactive-Augmented-Reality.pdf

Appendices

Appendix A: Plagiarism Report

Submission date: 22-Mar-2021 04:48AM (UTC-0700)

Submission ID: 1539251240

File name: IT18063738.txt (37.63K)

Word count: 5344

Character count: 32660

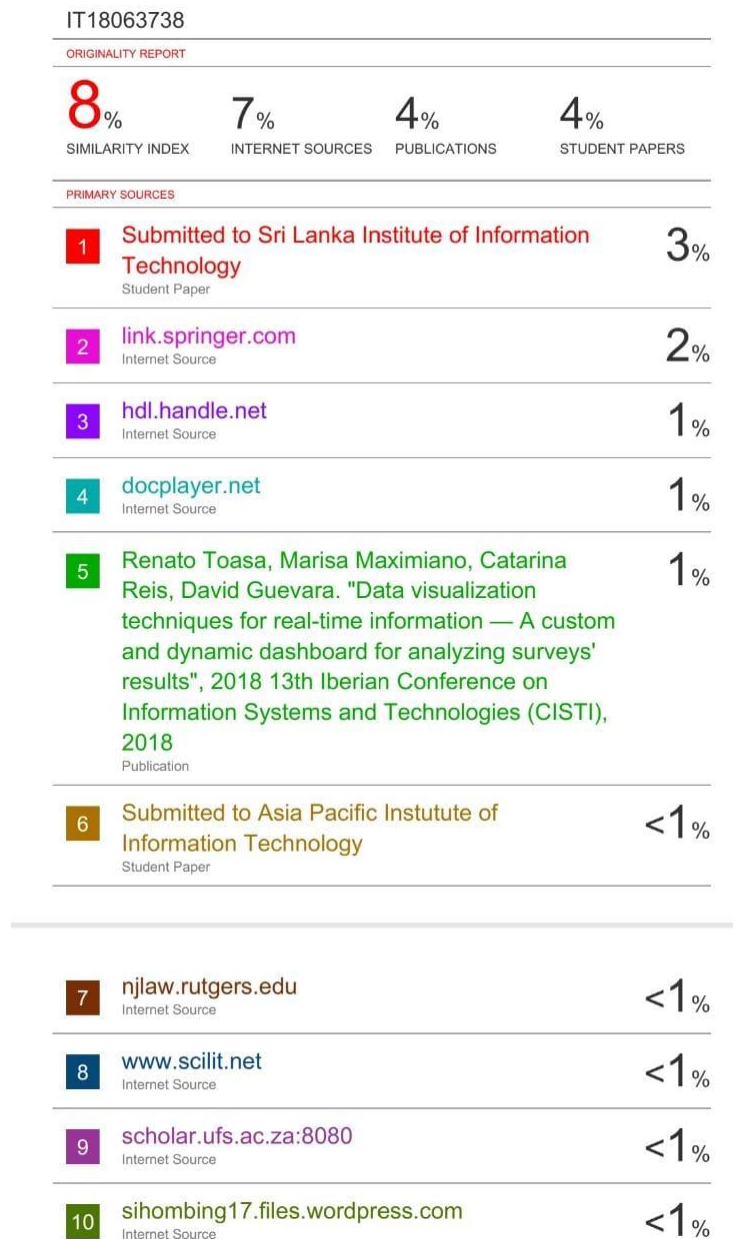


Figure 12.1 Appendix