AROGYA – AN INTELLIGENT AYURVEDIC HERB MANAGEMENT PLATFORM

Project ID: 2020-112

Project Proposal Report

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Bachelor of Science Special (Honors) in Information Technology

Specializing in Software Engineering

Department of Information Technology

Sri Lanka Institute of Information Technology

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(Proposal documentation in partial fulfilment of the requirement for the Degree of Bachelor of Science Special (honors) In Information Technology Specializing in Software Engineering)

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DECLARATION OF THE CANDIDATES AND SUPERVISOR

We declare that this is our own work and this project 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
Nilfa M.S. F	IT17145930	Nilfa M.S. F

The supervisor/s should certify the proposal report with the following declaration.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the Supervisor Date

…… …….

Mrs. Lokesha Weerasinghe

Signature of the Co-Supervisor Date

…… …….

ABSTRACT

Herbal remedies have been used for huge number of years like conventional medicine. In fact, herbal medicine is the establishment of modern medicine. Ayurvedic medicine prepared from the medicine are said to have no side effects. Each herb is unique in its medicinal properties with a good flavor. It acts as a perfect mechanism in bringing a balanced harmony between the mind and spirit. When compared to other synthetic drugs, ayurvedic herbal medicine works effectively fighting against various infections and diseases and thereby gaining quick recovery.

In terms of Arogya, the process of medicinal leaves identification is followed by displaying a detailed description of the identified medicinal plant such as value of it, the medicinal recipes which can be prepared from it, for what diseases it would be useful. So, to do that Arogya expect to use real time object detection with Augmented Reality. And also, users can view more information on each and every ayurvedic plant and receive a dynamic summary report on it. There is an explosive growth of information on Internet that makes extraction of relevant data from various sources, which leads tedious task for its users. Web documents can be extracted using information extraction and presented in a structured format. So, to generate a summarized report on every ayurvedic plant, information extraction along with Natural Language Processing and Deep Learning techniques proposed to be applied. Information can be extracted from structured, semi-structured, and unstructured data and needed to be summarized by using abstractive or extractive summarization methods. Apart from information visualization, geographical location of the newly identified medicinal plants also will be tracked by Arogya. In consequence people will be able to find the locations of important medicinal plants through Arogya. Since most of the people are not aware of the locations of rare medical plants, this would be a very prominent and useful function for the system as Arogya is kind of a social media platform of ayurvedic medicinal plants. The Locations will be displayed as a view of Sri Lankan geographical map with the identified medicinal plants.

Keywords: Deep Learning, Natural Language Processing, Geographical Information System, Information extraction, Abstractive, Extractive Summarization

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1 INTRODUCTION

In Sri Lanka there is an assortment of plant species that have been consumed for generations as herbal treatments, for control of diseases. Some of the diseases with complicated etiologies such as diabetes, arthritis, and cancer (for which a permanent cure is not in sight at present) have been known to be completely controlled or cured using these herbal remedies alone [1]. This traditional medicinal system, which has more than 3000 years of tested and proven efficacy, is still in use and generally the first approach for disease control by the locals, especially those who have been contracted with the stated diseases [2]. Typically, the herbs being used for medicinal purposes are evergreen in nature and are grown in the backyards of houses, and very little nurturing effort is required for their growth. Some of these herbs are even considered as weeds due to their high growth rates. Most Sri Lankans are familiar with the traditional medicinal system and are even able to identify or administer the herbs growing within their area of residence. Thus, the locals can be observed consuming these herbs to control a disease without the advice of a traditional medicinal practitioner, as they are familiar with the usage of these herbs because of the traditional knowledge, which has been passed down by their ancestors. With the arrival of western medicine, the traditional system of medicine was drastically declined to its lowest ebb. However, treatment of skeletal fractures, eye diseases, boils and carbuncles, snake bites and mental diseases remained under the preservation of a few dedicated medical men (Vedamahaththayas) who passed down these practices from generation to generation.

With these main concerns regarding Ayurveda we propose a system called Arogya is an herbal management platform which classifies, identifies and tracks the locations of ayurvedic plants in Sri Lanka through a single unit of mobile application. Since it is a kind of information sharing social media hub which can manipulates all three functionalities classification, location mapping, summary generation and visualization, in a single component. With the rise of internet, information readily available to us. If only someone could summarize the most important information for us Deep Learning is getting there. Through the latest advances in sequence to sequence

models, we can now develop good text summarization models. With the help of deep learning and sequence to sequence models summarization of information on medicinal plants will be generated.

2 BACKGROUND

In Sri Lanka there is a lot of significance on herbal and endemic medicine. Majority prefer Ayurvedic medicine over Western medicine according to versatile factors such as less or rather no side effects. The fact that Ayurvedic medical system stood the test of time sums up to its worth as an alternative course of treatment for versatile ailments. However, a major drawback in the practice of endemic medicine is the difficulty in finding ingredients in Ayurveda recipes. Some of the benefits of Ayurvedic plants are, more affordable than western medicine, easier to obtain than prescription medicine, stabilizes hormones and metabolism, natural healing, strength in immune system, fewer side effects and cost effective. Today, people are more prone to consume western medication over Ayurvedic medication for their health issues because of their daily tight schedule, they do not have much time to spend in finding required recipes as the Ayurvedic physician said. Most of the patients begin to take western medication as soon as their diagnoses are made, so Ayurvedic treatments are usually undergone alongside and/or after western medical approach.

The existing systems like PlantSnap, Plantex and MedLeaf only focus on the medicinal leaves identification process. So that the users do not have multiple features like summarized information visualization and Location access of these herbals. Actually, the proposed system is more like a social media information sharing hub related to medicinal plants. Thus, the people who are looking for ayurvedic plants will have the ability to find the rare medicinal plants as well as they can get the information on locations too. So, through Arogya users can achieve many tasks at a single point and it prevents users from wasting time.

2.1 Literature Review

2.1.1 Analysis of research papers

According to many known sources, researchers have tried many methodologies to follow up dynamic information extraction and information summarization.

Most of the present Ayurvedic based applications follows only the medicinal plants identification process. There are no smart visualization techniques used like augmented reality to display information to the users. And also, the proposed system Arogya is capable of generating dynamic summaries regarding the identified medicinal plants. So, the system has to work with the online database, whenever the web pages get updated, the generated summary also should be adjusted in order to the current version of the changed website page. Hence it is kind of a real time information extraction, users also will get updated automatically. Currently the existing systems are just managing with the offline database of their own system, so the information will not be changed according to the timeline. So, the users will not get updated with the real time information of that particular medicinal plants.

In 2016, the research paper "An Automatic Multi document Text Summarization Approach Based on Naive Bayesian Classifier Using Timestamp Strategy" [31] discusses about an automatic text summarization approach is proposed which uses the Naive Bayesian Classification with the timestamp concept. This summarizer works on a wide variety of domains varying between international news, politics, sports, entertainment, and so on. Another useful feature is that the length of the summary can be adapted to the user's needs as can the number of articles to be summarized. The compression rate can be specified by the users so that they can choose the amount of information he wants to imbibe from the documents.

The research presented in 2012, "A Semantic-Based Framework for Summarization and Page Segmentation in Web Mining" [30] introduces a framework that can effectively support advanced Web mining tools. The proposed system addresses the analysis of the textual data provided by a web page and exploits semantic networks to achieve multiple goals, the identification of the most relevant topics, the selection of

the sentences that better correlates with a given topic, the automatic summarization of a textual resource. The eventual framework exploits those functionalities to tackle two tasks at the same time, text summarization and page segmentation.

In 2017, the research paper "Text Summarization Techniques: A Brief Survey" [29] emphasizes various extractive approaches for single and multi-document summarization. It described some of the most extensively used methods such as topic representation approaches, frequency-driven methods, graph-based and machine learning techniques. Although it is not feasible to explain all diverse algorithms and approaches comprehensively in this paper, it provides a good insight into recent trends and progresses in automatic summarization methods and describes the state-of-the-art in this research area.

In 2018, the paper "Multi-Document Text Summarization Using Deep Learning Algorithm with Fuzzy Logic" [32], presented a multi-document text summarization scheme using an unsupervised deep learning algorithm along with fuzzy logic. Feature matrix with seven features from the set of sample dataset from DUC2002(Document ID: AP880911- 0016). The feature matrix is applied through the various levels of the RBM and finally the efficient text summary is generated. The result indicates that this method generates efficient text summary when compared to previous methods based on evaluation metrics.

In 2019, the paper "Deep Learning Architecture for Multi-Document Summarization as a cascade of Abstractive and Extractive Summarization approaches" [33] extends the state-of-the-art abstractive summarization architecture for multi-document summarization. The proposed architecture produces comprehensive summary on a topic by combining the Abstractive and Extractive summarization approaches in a cascade. The state-of-the-art approach for abstractive summarization using pointer-generator model is limited to single-document summarization. Summarization of multiple news articles on a topic can be handled one by one independently which results in multiple summaries for the same topic with possible redundancy. In order to avoid redundancy, the authors propose Extractive summarization of the

multiple summaries as the second phase in the proposed cascade framework. The effectiveness of the framework was established using ROUGE metric.

In 2011, the paper "Frequently Asked Questions Web Pages Automatic Text Summarization" [34] presented the preliminary results of our FAQ Web Pages automatic text summarization approach. Their approach is based on making use of the visual cues existing in the text of the questions and answers of the web page to detect Q/A segments. In addition, we devised a new combination of selection features to perform the actual summarization task. These features are namely, question-answer similarity, query overlap, sentence location in answer paragraphs and upper-case words frequency. The different document features were combined by a home-grown weighting score function. Pilot experimentations and analysis helped them in obtaining a suitable combination of feature weights. In fact, the evaluation results showed that in general this approach seems to be promising where the overall average for all pages indicates statistically significant improvements for their approach in 62% of the cases when compared with another summarization tool.

In 2004, this paper "World Wide Web Site Summarization" [35] developed a new approach for generating summaries of Web sites. The approach applies machine learning and natural language processing techniques to extract and classify narrative paragraphs from the Web site, from which key-phrases are then extracted. Key-phrases are in turn used to extract key-sentences from the narrative paragraphs that form the summary, together with the top key-phrases. The summaries are demonstrated, although not in proper prose, are as informative as human-authored summaries, and significantly better than browsing the home page or the site for a limited time. The approach should be easy to transform into proper prose by human editors without having to browse the Web site. The performance of method depends on the availability of sufficient narrative content in the Web site, and the availability of explicit narrative statements describing the site.

In consequence above reviews, Arogya acts as a single platform of resource access of multiple functionalities to overcome all these difficulties in the current products in the

market. Arogya's main goal is to be the feasible single unit of medicinal plants information hub which will satisfy all the user requirements regarding ayurvedic plants.

2.1.2. Analysis of existing systems

References	Smart Visualization	Real time Summary generation on information	Using GIS for Location tracking
H. P. Edmundson, "New methods in automatic extracting"[1]	✗	✗	✗
J. Kupiec, J. Pedersen, F. Chen, "A trainable document summarizer" [2]	✗	✗	✗
Neeraj Kumar, Peter N Belhumeur, Arijit Biswas, David W Jacobs, W John Kress, Ida C Lopez, João VB Soares, "Leafsnap: A computer vision system for automatic plant species identification" [3] research was done on Identification of plant leaf using computer vision techniques	✗	✗	✗
D. R. Radev, H. Jing, M. Stys, D. Tam, "Centroid-based summarization of multiple documents" [5], Information Processing and Management	✗	✗	✗
Arogya our proposed System	✓	✓	✓

Table 2.1.2.1 Comparing with existing system

3 RESEARCH GAP

3.1 Research Problem

Since Ayurveda is descending from generation to generation, the precious knowledge of Ayurveda is restricted for a group of specific people. So, most of the ordinary people are unable to get the information on medicinal plants. And also finding the geographical locations of the medicinal plants will be a tedious task due to this knowledge gap between ordinary people and the particular generalized group of people. In order to get the information of medicinal plants, people from urban areas have to travel back to villages to meet ayurvedic physicians (Weda Mahaththaya). In terms of proposed component, the issues we currently facing will be removed hopefully.

As mentioned in the literature review the existing systems are lack of many functionalities when compared to the proposed system Arogya. So, the problems in the existing systems will be the identified gaps which we need to satisfy through Arogya. Hence the proposed system has to cope with multiple functionalities such as visualization of the final output, generation of summary based on extracted real time web information on medicinal plants, tracking the geographical locations of the rare herbs to share with the required users.

Implementing the component as a single platform of accessing multiple functionalities, the targeted users can save their time and effort of finding other resources to fulfill their requirements related to Ayurveda.

4 OBJECTIVES

4.1 Main Objectives

The main objective of this proposed component is to cooperate extractive information summarization and location mapping with smart visualization on ayurvedic plants in Sri Lanka

4.2 Specific Objectives

•AR with smart visualization techniques

Display the information of detected medicinal plant using augmented reality

•Summary generation with the support of Deep learning, Natural Language Processing and Information Extraction

Information of detected plants will be dynamically extracted from web pages and summarized using deep learning

•Tracking Locations with Geographical Information System so, the users can get the location information of plants

5 RESEARCH METHODOLOGY

Main research area of this component is regarding dynamic information extraction and information summarization. So, in order to achieve this goal, many techniques should be followed to select the best model out of them. Thus, several existing algorithms will be analyzed, and accuracy will be tested in order to select the suitable algorithms to extract the required Information from dynamic web pages to generate a summary on medicinal plants. Here is a succinct definition to summarization according to Text Summarization Techniques, A Brief Survey, 2017, "Automatic text summarization is the task of producing a concise and fluent summary while preserving key information content and overall meaning". In general, there are two different approaches that are used for text summarization called Extractive Summarization and Abstractive Summarization. In this research Abstractive Summarization will be used as it is a very interesting approach. Here, we generate new sentences from the original existing text. In contrast, extractive approach uses only the sentences that were present in the text. The sentences generated through abstractive summarization might not be present in the original text.

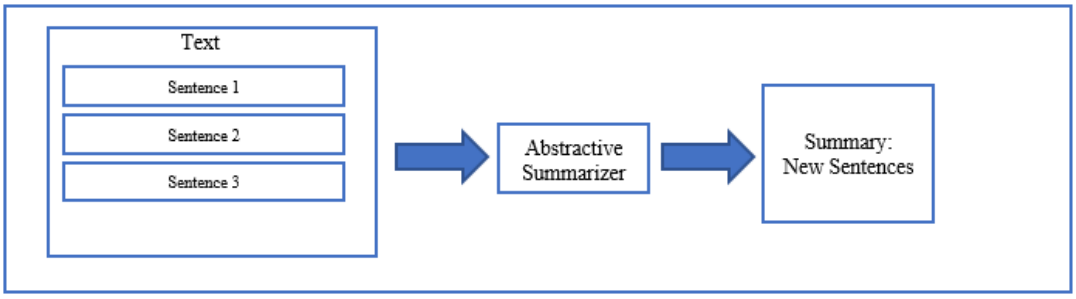

Figure 5.1: Abstraction summarization process

Our expectation is to build a text summarizer where the input is a long sequence of words extracted from web pages and the output is a short summary of sequence of words. Thus, we can model this as a Many-to-Many Seq2Seq problem. Below is a typical Seq2Seq model architecture:

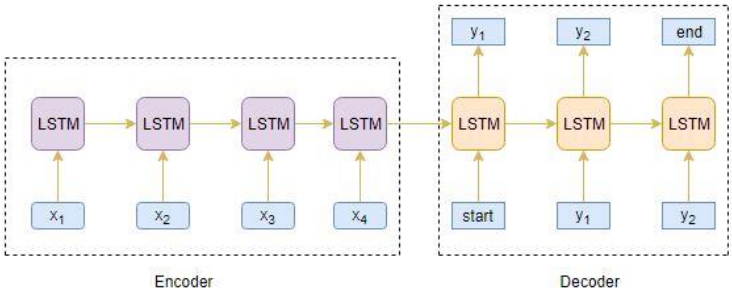

Figure 5.2: Seq2Seq model

There are two major components of a Seq2Seq model as, Encoder and the Decoder.[28]

Generally, variants of Recurrent Neural Networks (RNNs), i.e. Gated Recurrent Neural Network (GRU) or Long Short-Term Memory (LSTM), are preferred as the encoder and decoder components. This is because they are capable of capturing long term dependencies by overcoming the problem of vanishing gradient.

We can set up the Encoder-Decoder in 2 phases:

- Training phase
- Inference phase

Training phase

In the training phase, we will first set up the encoder and decoder. We will then train the model to predict the target sequence offset by one timestep. Let us see in detail on how to set up the encoder and decoder.

Encoder

An Encoder Long Short-Term Memory model (LSTM) reads the entire input sequence wherein, at each timestep, one word is fed into the encoder. It then processes the information at every timestep and captures the contextual information present in the input sequence. Below diagram which illustrates this process:

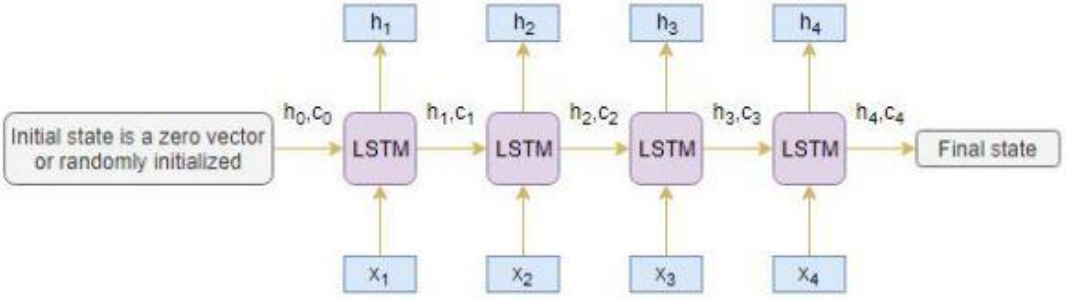

Figure 5.3 Encoder Process

The hidden state (hi) and cell state (ci) of the last time step are used to initialize the decoder. Remember, this is because the encoder and decoder are two different sets of the LSTM architecture.

Decoder

The decoder is also an LSTM network which reads the entire target sequence word-by-word and predicts the same sequence offset by one timestep. The decoder is trained to predict the next word in the sequence given the previous word.

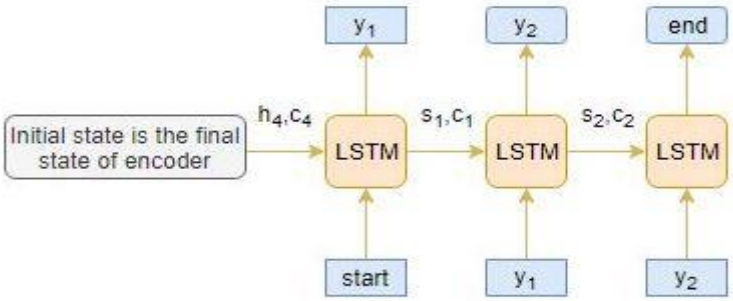

Figure 5.4 Decoder Process

<start> and <end> are the special tokens which are added to the target sequence before feeding it into the decoder. The target sequence is unknown while decoding the test sequence. So, we start predicting the target sequence by passing the first word into the decoder which would be always the <start> token. And the <end> token signals the end of the sentence.

Inference Phase

After training, the model is tested on new source sequences for which the target sequence is unknown. So, we need to set up the inference architecture to decode a test sequence:

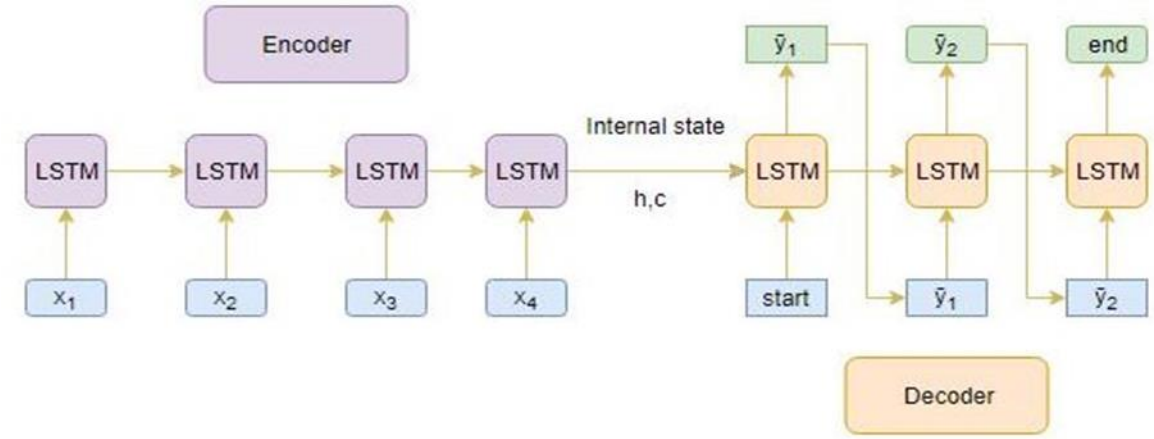

Figure 5.3: Inference Process

Here are the steps to decode the test sequence:

1.Encode the entire input sequence and initialize the decoder with internal states of the encoder

2.Pass <start> token as an input to the decoder

3.Run the decoder for one timestep with the internal states

4.The output will be the probability for the next word. The word with the maximum probability will be selected

5.Pass the sampled word as an input to the decoder in the next timestep and update the internal states with the current time step

6.Repeat steps 3 – 5 until we generate <end> token or hit the maximum length of the target sequence

So that, with the support of encoder-decoder architecture Arogya will be able to manage the summary generation functionality.

5.1 System Architecture

Arogya is consisted with four main functionalities and this component is regarding visualization and information summarization. And also, the system is capable of location tracking

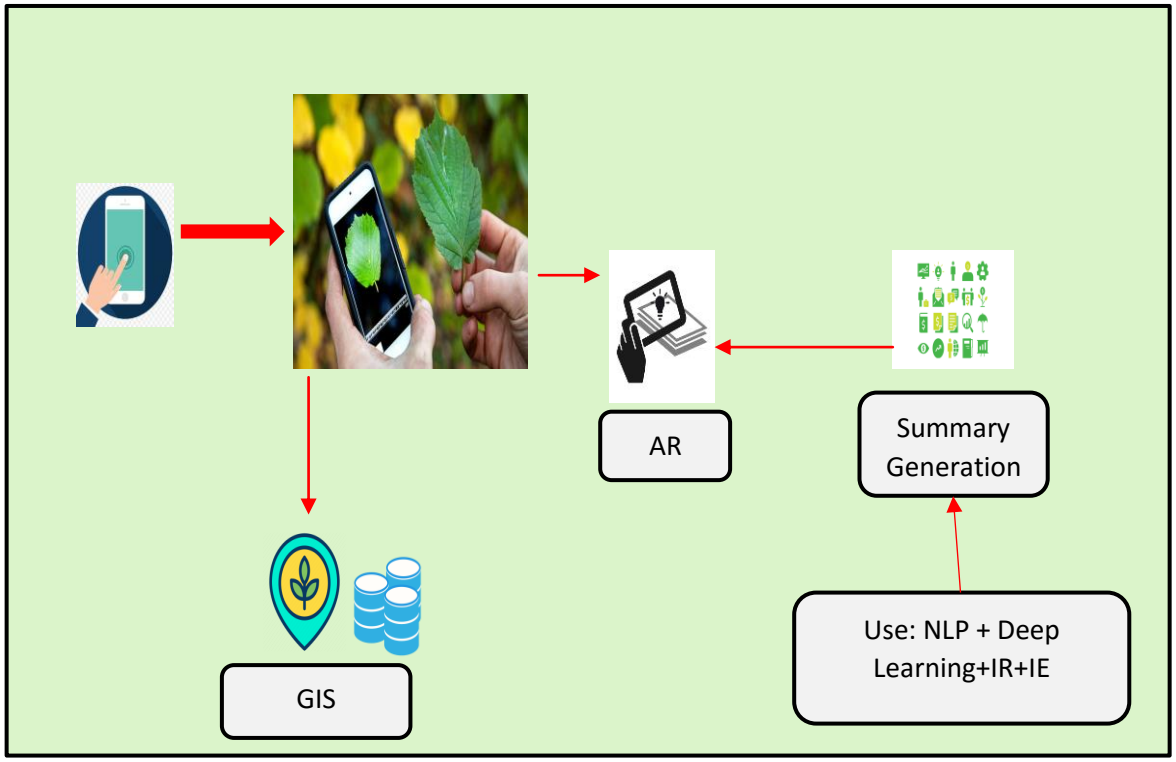

Figure 5.1.1: System overview diagram

5.2 Project Requirements

Functional	Non - Functional
Display information on top of the plant species	Application should be able to give the results as fast as possible
Summary should be generated regarding the medicinal plant	Higher Accuracy required
Application should be able to track the location of users	User friendly Interfaces should be provided
Medicinal plant’s description should be available for offline view	User Experiences should be properly managed in order to achieve a specific functionality
Locations of plants should be able to view as a Map view	

Table 5.2.1: Functional & Non-Functional Requirements

5.2.1 Expected Ways of Testing the Accuracies

Testing phase is implemented to check the efficacy of the algorithm.

S = Set of words extracted by analyzing the sentences present in each document.

There are many parameters against which you can evaluate your summarization system. like,

Precision = Number of important sentences / Total number of sentences summarized

Recall =Total number of important sentences Retrieved /Total number of important sentences present

5.2.2 Expected Wireframes for the mobile application

Following are some of the wireframes expected to be implemented according to the function of leaf classification in Arogya.

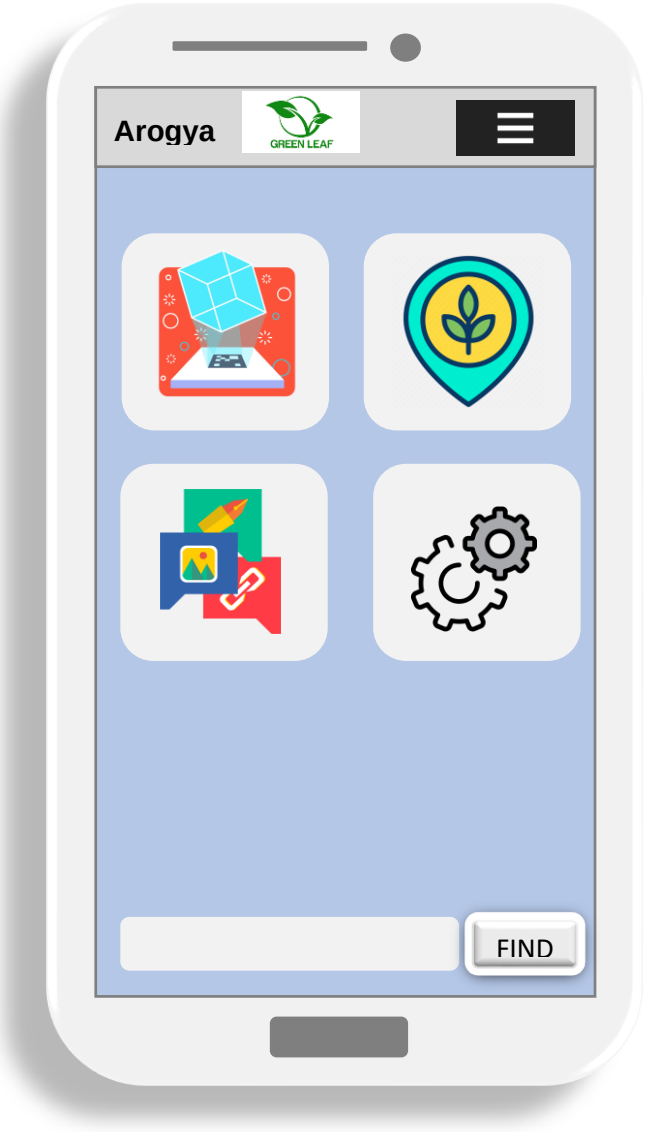

Figure 5.2.2.1: Main User Interface

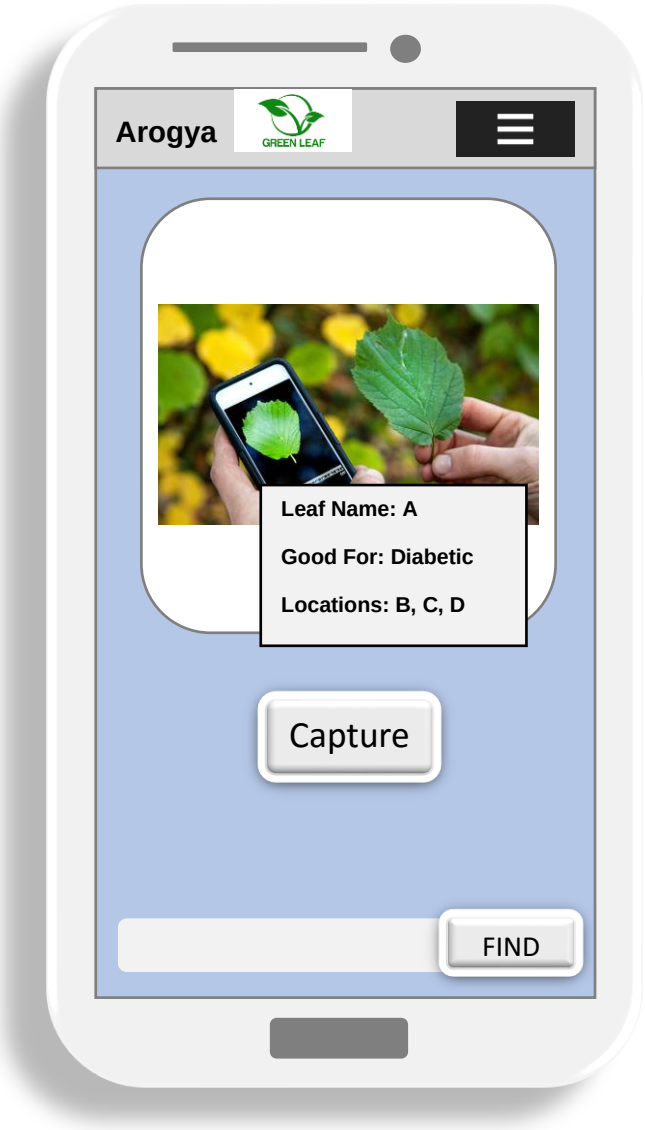

Figure 5.2.2.2: Summary on Medicinal Plant

Figure 5.2.2.3: Geographical Locations as a Map view

5.3 Gantt Chart

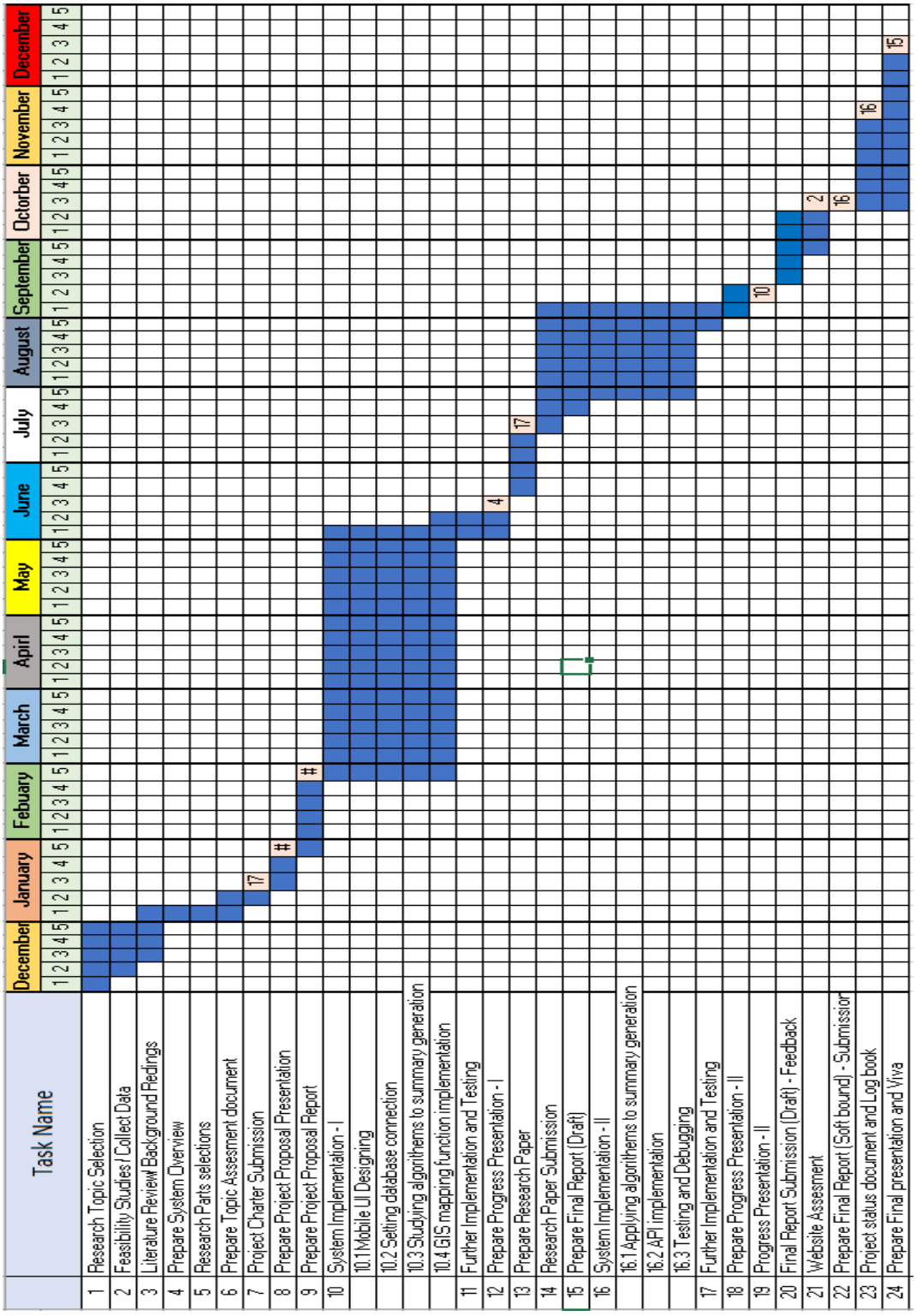

Figure 5.3.1: Functional & Non-Functional Requirements

5.4 Work Breakdown Structure

01. Problem Identification
    - 1.1 Determining information requirements

02. Information Gathering
    - 2.1 Reference online resources
    - 2.2 Reference related books

03. Analysis the System
    - 3.1 Preliminary Investigation
    - 3.2 Further Analysis

04. Designing the system
    - 4.1 Database designing
    - 4.2 Screen Design
    - 4.3 Test plan
    - 4.4 Design Results Generating

05. Develop the System
    - 5.1 Develop the User Interfaces
    - 5.2 Reports Development
    - 5.3 Validations

06. Testing and Debugging
    - 6.1 Derivation of test plan
    - 6.2 Execution of test plan
    - 6.3 Correction of errors

07. Documentation
    - 7.1 Develop the Documentation
    - 7.2 Finalize the Documentation

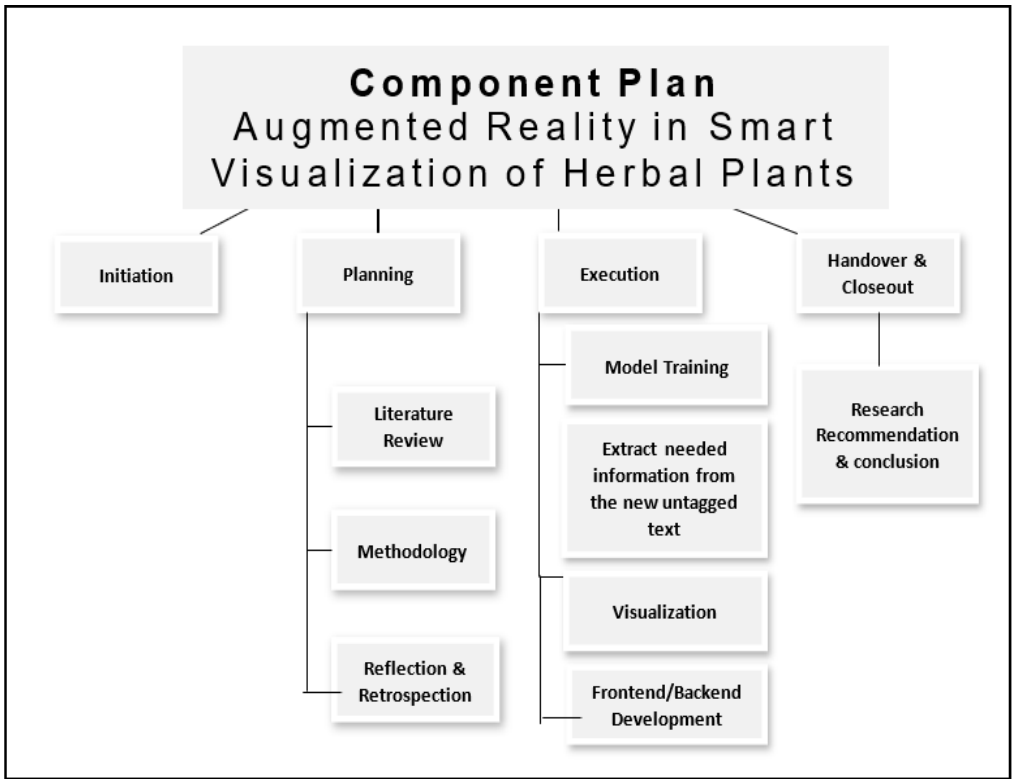

Figure 5.4.1: Work Break Down Structure

5.5 Budget & Cost Estimation

Data collection travelling charges	3,000
Internet Data charges	15,000
Mobile phone as a resource	40,000
Total Expenses:	
Target Budget	58,000

Table :5.5.1: Budget & Cost Estimation

6 DESCRIPTION OF PERSONAL AND FACILITIES

Facilitators: -

- Mrs. Lokesha Weerasinghe - Sri Lanka Institute of Information Technology (SLIIT)
- Dr. Dharshana Kasthurirathna - Sri Lanka Institute of Information Technology (SLIIT)

Facilities: -

- Navinna Ayurveda Medical Hospital
- Institute of Ayurveda
- Plant nursery of Navinna Ayurveda Medical Hospital

7 COMMERCIALIZATION

7.1 Target Audience

- People who use ayurvedic treatment
- Researchers in the field of botany, medicine, chemical structure analysis, agriculture, ayurvedic medicinal practitioners, forest department officials, those who are involved in the preparation of ayurvedic medicines and others who are concerned with plant studies
- Doctors, Students, locals and foreigners
- Ayurvedic plant sellers

7.2 Market Space

- No age limitations for the users
- No need of advance computer literacy
- No need of advance knowledge in Ayurveda field

7.3 Revenue Earning

- Through subscription fee
- Revenue via additional services
- Add click sense

REFERENCES

[1] H. P. Edmundson, "New methods in automatic extracting", Journal of the ACM, vol. 16, no. 2, pp. 264-285, 1969.

[2] J. Kupiec, J. Pedersen, F. Chen, "A trainable document summarizer", Proceedings SIGIR '95, pp. 68-73, 1995.

[3] Neeraj Kumar, Peter N Belhumeur, Arijit Biswas, David W Jacobs, W John Kress, Ida C Lopez, João VB Soares, "Leafsnap: A computer vision system for automatic plant species identification" in ECCV, Springer, pp. 502-516, 2012.

[4] ResearchGate, Current scenario of herbal medicine in Sri Lanka. Accessed on: February 22,2020. [Online]

Available:https://www.researchgate.net/publication/224771841_Current_scenario_of_herbal_medicine_in_Sri_Lanka

[5] D. R. Radev, H. Jing, M. Stys, D. Tam, "Centroid-based summarization of multiple documents", Information Processing and Management, vol. 40, pp. 919-938, 2004.

[6] S. A. Babar, P. D. Patil, "Improving performance of text summarization", Procedia Computer Science, vol. 46, pp. 354-363, 2015.

[7] S. P. Singh, A. Kumar, A. Mangal, S Singhal, "Bilingual Automatic Text Summarization Using Unsupervised Deep Learning", International Conference on Electrical Electronics and Optimization Techniques (ICEEOT)-2016, pp. 1195-1200, 2016.

[8] H. A. Chopade, M. Narvekar, "Hybrid auto text summarization using deep neural network and fuzzy logic system", 2017 International Conference on Inventive Computing and Informatics (ICICI), pp. 52-56, 2017.

[9] P. Baxendale, "Machine-made index for technical literature - an experiment", IBM Journal of Research Development, vol. 2, no. 4, pp. 354-361, 1958.

[10] Lanka, Ayurveda. Accessed on: February 20,2020. [Online]

Available: https://lanka.com/about/interests/ayurveda/

[11] Y. R. Azeez, R. A. C. P. Rajapakse, "An application of image processing techniques in identifying herbal plants in Sri Lanka", Proceedings of the 3rd International Research Symposium on Pure and Applied Sciences, 26th October 2018 - Faculty of Science, University of Kelaniya, Sri Lanka

[12] Ayurvedabansko, Benefits of ayurveda. Accessed on: February 20,2020. [Online]

Available:https://www.ayurvedabansko.com/benefits-ayurveda-and-difference-to-western-traditional-medicine/

[13] Basavaraj S. Anami, Suvarna S. Nandyal, A. Govardhan, "A Combined Color, Texture and Edge Features Based Approach for Identification and Classification of Indian Medicinal Plants", International Journal of Computer Applications (0975 – 8887) Volume 6– No.12, September 2010

[14] Robert G. de Luna, Renann G. Baldovino, Ezekiel A. Cotoco, Anton Louise P. de Ocampo, Ira C. Valenzuela, Alvin B. Culaba, Elmer P. Dadios, "Identification of Philippine Herbal Medicine Plant Leaf Using Artificial Neural Network", 978-1-5386-0912-5/17/$31.00, ©2017 IEEE

[15] Inderjeet Mani, Eric Bloedorn, "Multi-document summarization by graph search and matching", AAAI/IAAI, vol. cmplg/9712004, pp. 622-628, 1997

[16] Neeraj Kumar, Peter N Belhumeur, Arijit Biswas, David W Jacobs, W John Kress, Ida C Lopez, and João VB Soares, "Leafsnap: A computer vision system for automatic plant species identification," in ECCV, pp. 502–516. Springer, 2012.

[17] Cem Kalyoncu and Önsen Toygar, "Geometric leaf classification," Computer Vision and Image Understanding, vol. 133, pp. 102–109, 2014.

[18] Abdul Kadir, Lukito Edi Nugroho, Adhi Susanto, and Paulus Insap Santosa, “Leaf classification using shape, color, and texture features,” arXiv preprint arXiv:1401.4447, 2013.

[19] Thibaut Beghin, James S Cope, Paolo Remagnino, SarahBarman, “Shape and texture based plant leaf classification,” in Advanced Concepts for Intelligent Vision Systems, 2010, pp. 345–353.

[20] James Charters, Zhiyong Wang, Zheru Chi, Ah Chung Tsoi, and David Dagan Feng, “Eagle: A novel descriptor for identifying plant species using leaf lamina vascular features,” in ICME-Workshop, 2014, pp. 1–6.

[21] Heysem KAYA, Ilhan KEKLIK, Tolga ENSARI, Fatih ALKAN, Yagmur BIRICIK, “Oak Leaf Classification: An Analysis of Features and Classifiers”, 978-1-7281-1013-4/19/$31.00.2019 IEEE

[22] James S Cope, Paolo Remagnino, Sarah Barman, and Paul Wilkin, “The extraction of venation from leaf images by evolved vein classifiers and ant colony algorithms,” in Advanced Concepts for Intelligent Vision Systems, 2010, pp. 135–144.

[23] Jing Hu, Zhibo Chen, Meng Yang, Rongguo Zhang, and Yaji Cui, “A Multiscale Fusion Convolutional Neural Network for Plant Leaf Recognition”, 1070-9908, IEEE SIGNAL PROCESSING LETTERS, VOL. 25, NO. 6, JUNE 2018

[24] Agnieszka Mikołajczyk, Michał Grochowski, “Data augmentation for improving deep learning in image classification problem”, 17859931, ISBN: 978-1-5386-6143-7, May 2018

[25] Towards Data Science, Transfer Learning with Convolutional Neural Networks in PyTorch. Accessed on: February 20,2020. [Online]

Available:https://towardsdatascience.com/transfer-learning-with-convolutional-neural-networks-in-pytorch-dd09190245ce

[26] Medium, Leaf classification project. Accessed on: February 20,2020. [Online]

Available:https://medium.com/@inside.techlabs/leaf-classification-project-89bb5c7577f3

[27] Towards Data Science, Text Summarization using Deep Learning. Accessed on: February 20,2020. [Online]

Available: https://towardsdatascience.com/text-summarization-using-deep-learning-6e379ed2e89c

[28] Analytics Vidhya, Comprehensive guide to text summarization. Accessed on: February 19,2020. [Online]

Available:https://www.analyticsvidhya.com/blog/2019/06/comprehensive-guide-text-summarization-using-deep-learning-python/

[29] Mehdi Allahyari, Elizabeth D Trippe, Krys Kochut, "Text Summarization Techniques: A Brief Survey", 28, July 2017

[30] Alessio Leoncini, Fabio Sangiacomo, Paolo Gastaldo and Rodolfo Zunino, "A Semantic-Based Framework for Summarization and Page Segmentation in Web Mining" 17859931, ISBN: 978-1-5386-6143-7, July 2012

[31] NedunchelianRamanujam1, ManivannanKaliappan, "An Automatic Multi document Text Summarization Approach Based on Naive Bayesian Classifier Using Timestamp Strategy, 2016

[32] S.Sudha Lakshmi, Dr. M.Usha Rani, "Multi-Document Text Summarization Using Deep Learning Algorithm with Fuzzy Logic", 2018

[33] Anita Kumari Singh1, M Shashi "Deep Learning Architecture for Multi-Document Summarization as a cascade of Abstractive and Extractive Summarization approaches", 2019

[34] Yassien M. Shaalan, Ahmed Rafea, "Frequently Asked Questions Web Pages Automatic Text Summarization", 2011

[35] Yongzheng Zhang, Nur Zincir-Heywood, Evangelos Milios, "World Wide Web Site Summarizatio", 2004