PERSONALIED APPLICATION FOR DEMENTIA PATIENTS IN CONGNITIVE REHABILITATION WITH CONTINUOUS MONITORING

Project Id: 2020-017

Project Proposal Report

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DECLARATION

I declare that this is my 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.

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The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

Name of supervisor: **Dr. Dharshana Kasthurirathna**

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Signature of co-supervisor: Date:

ABSTRACT

Sri Lanka has one of the world's fastest ageing populations [1]. According to the recent predictions, 20% of Sri Lankans will become over 60 years in 2020[1]. It is not easy to cure from the disease like Dementia since there is no specific medicine for mending from it. Assisting the Dementia patients in the mild and moderate stages will be only considered during this application by slowing down the symptoms gradually. To rehabilitate the patients under the different cognitive functionalities of Dementia will be a kind of a help to minimize those symptoms because there is no precise medication for Dementia. There are number of minds repairing application including different types of games. But there isn't a proper application for the Dementia considering the cognitive functionalities on different stages on predicting the next levels by learning from the user. Language skill is a cognitive functionality of Dementia. Due to the impairment of reading, writing, comprehension, and communication skills under the Language skills of Dementia patients will be caused to different kinds of Language problems in the day-to-day life of those patients. The implementation of Language component of this application will be considered about decreasing the Language impairments of Dementia patients using Voice to text communication along with the supervision and recommendation from a Consult Psychiatrist in Sri Lanka.

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LIST OF ABBREVIATIONS

CNN	Convolutional Neural Network
ASR	Automatic Speech Recognition
RNNs	Recurrent Neural Networks
HMMs	Hidden Markov models
GMMs	Gaussian Mixture Models
CTC	Connectionist Temporal Classification
SER	Speech Emotion Recognition
MMSE	Mini-Mental State Examination

1. INTRODUCTION

With the development of the Machine Learning techniques among the society, most of the application are included this Machine Learning technology. Generally, the first phases of Dementia like mild and moderate stages, mobile phones can make the Dementia patients independent and socially engaged and there are some mobile applications containing the mind exercises. One in every three senior citizens dies with some form of dementia with the percentages on the rise [2]. Since there is no special medication for Dementia, only the way is to rehabilitate the patients using some exercises practically. Due to the frequent usage of smart devices in the current society, implementation of a mobile application will be beneficial. Under the Language cognitive functionality of Dementia, reading, writing, comprehension and communication will be improved through this proposed system by slowing down the impairments of those skills. The games and activities related to this component will be implemented on voice to text communication using NLP, CNN. The most important thing about this application is that the patients can play these games during the time that they are spending at home. When the patient is away from the doctor, the patient is assisted to decrease the symptoms of Dementia by using this application.

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2. BACKGROUND AND LITERATURE SURVEY

2.1. Background

Dementia is a syndrome that is affected for human memory. There are so many Dementia caring applications in different languages for practicing different games. There are some self-monitoring applications which is helped for Dementia patients. But those are for the save Dementia patients indoor and outdoor using safety monitoring mechanisms [3].

Dementia patients has physical, mental, social problems and losing their actual family bonds, society connection. As well as loss of memory, not having sensor with time and place are main effects of Dementia. Because of these things, patients are suffering a lot. There are stages of Dementia,

1. Mild

3. Moderate

3. Severe

When considering about these stages, it is difficult to recover a patient from these stages. Except severe stage, the symptoms of Dementia on mild and moderate stages can be slowed down. For that, practical exercise is the only way to slow down the symptoms. According to some applications, there are some activities for the Language cognitive functionality. But there isn't an application to correctly guide the patient according to the Sri Lankan culture and languages. This disease has a history a long ago. According to the history of Dementia, most of the patients has died due to not having a specific medication for this. As an example, in 1906, the first Dementia patient has died. Since there are number of researches has done about the medication for this disease, there is no exact medication to recover from this. There will be a way to offer a help for those patients using this proposed system.

2.2 Literature Survey

2.2.1. Mobile Applications for Dementia patients

One in every three senior citizens dies with some form of dementia with the percentages on the rise. This population is often forgotten, but research shows the elderly can be stimulated with technology as evidence with music and memory programs. Combining advancement in computer science and technology to design and develop products that can facilitate the lives of many senior citizens was found important. The combination of computer science and real-world situation is a good way to stimulate students in getting their hands on the problems our society is facing. Programming in support of real-world social issues causes the students to relate in various ways, invigorates students not only to learn programming skills, but also acquire knowledge beyond the typical level and pace. Developing a mobile app for Android and iOS platforms as a team including usability for a documentary called Alive Inside, created to help those with Alzheimer's disease and dementia improve their quality of life. This mobile app will stimulate the memory of those suffering of Alzheimer and dementia through music of their youth. This paper will report on student experiences, techniques, products delivered, and overall outcomes [8].

1.2.2. Speech recognition using Deep Neural Network

Over the previous decades, a huge amount of research has been done on the use of machine learning for speech processing applications, especially speech recognition. However, in the past few years, research has focused on utilizing deep learning for speech-related applications. This new area of machine learning has yielded far better results when compared to others in a variety of applications including speech, and thus

became a very attractive area of researches. Deep learning models can also operate as a greedy layer wise unsupervised pre-training. This means that it will learn hierarchy from extracted features from each layer at a time. Feature learning is achieved by training each layer with an unsupervised learning algorithm, which takes the features extracted from the previous layer and uses it as an input for the next layer. Deep learning algorithms have been mostly used to further enhance the capabilities of computers so that it understands what humans can do, which includes speech recognition. Speech being the main method of communication among human beings, received much interest for the past five decades right from the introduction of artificial intelligence. The conventional speech recognition systems are based on representing speech signals using GMMs that are based on HHMs.This is since a speech signal can be considered as a piecewise stationary signal or in other terms a short time stationary signal. In this short time scale, the speech signal can be approximated as a stationary process, thus it can be thought of as a Markov model for many stochastic processes [4]. However, the CNNs have shown effectiveness when used in computer vision or image recognition tasks. Also, with some appropriate changes in the CNN for image analysis purposes such that it incorporates speech properties, the CNN can be utilized in speech recognition as well. RNNs are considered as a class of deep networks for the use in unsupervised learning in the cases where the depth of the input data sequence can be as large as the length since RNNs allow parameter sharing through the different layers of the network. The RNN is very prevailing when it comes to modeling sequence data such as speech or text [4].

State-of-the-art ASR systems map the speech signal into its corresponding text. Traditional ASR systems are based on Gaussian mixture model. End-to-end ASR systems are gaining much popularity due to simplified model-building process and abilities to directly map speech into the text without any predefined alignments. Three major types of end-to-end architectures for ASR are attention-based methods, connectionist temporal classification, and CNN-based direct raw speech model. End-to-end model may take raw speech signal as input and generates phoneme class conditional probabilities as output. The three major types of end-to-end architectures

for ASR are attention-based method, CTC and CNN-based direct raw speech model [5].
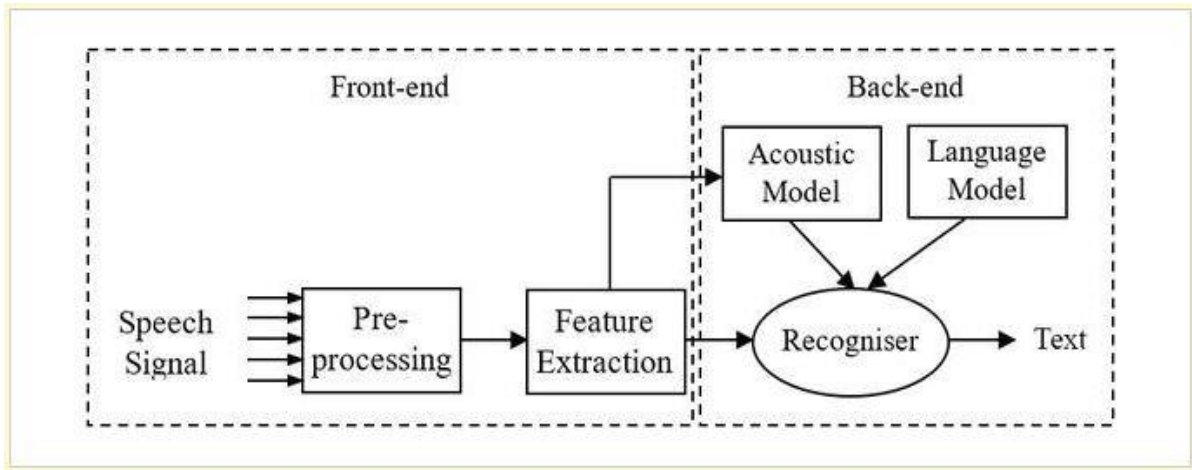

Figure: 1.1. General framework of automatic speech recognition system.

Speech has not been used much in the field of electronics and computers due to the complexity and variety of speech signals and sounds. However, with modern processes, algorithms, and methods we can process speech signals easily and recognize the text. android platform using eclipse workbench. Our speech-to-text system directly acquires and converts speech to text. Speech recognition is done via the Internet, connecting to Google's server. The application is adapted to input messages in English. Speech recognition for Voice uses a technique based on HMM. It is currently the most successful and most flexible approach to speech recognition. Process involves the conversion of acoustic speech into a set of words and is performed by software component. Accuracy of speech recognition systems differ in vocabulary size and confusability, speaker dependence vs. independence, modality of speech (isolated, discontinuous, or continuous speech, read or spontaneous speech), task and language constraints. Dictionary is used to connect acoustic models with vocabulary words. Language model reduces the number of acceptable word combinations based on the rules of language and statistical information from different texts. Speech recognition systems based on hidden Markov models are today most widely applied in modern technologies [6].

Deep learning methods are being applied in various recognition tasks such as image, speech, and music recognition. CNN especially show remarkable recognition performance for computer vision tasks. In addition, RNNs show considerable success in many sequential data processing tasks. Investigating the result of the SER algorithm is based on CNNs and RNNs trained using an emotional speech database. Deep learning involves hierarchical representations with increasing levels of abstraction. By traversing sequentially constructed networks, the results corresponding to each selected audio frame are classified using a sum of probabilities [7].
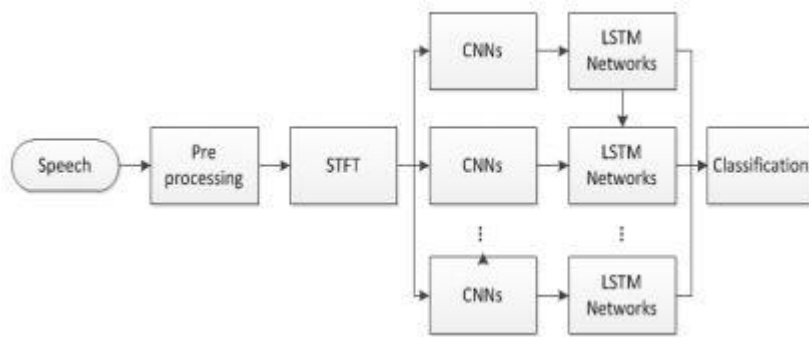

Figure: 1.2. Block diagram of our time distributed network-based SER method

3. RESEARCH GAP

Research gap for this component will be vital for whole research project that is going to be implemented. When comparing the other systems for Dementia, Language functionality of the proposed system is supported for the Sri Lankan Culture. In addition to that, the proposed system uses voice inputs and voice to text communication to improve the reading, writing, comprehension, speaking abilities of Dementia patients using a mobile application rather than other systems which are popular among people.

Table:3.1. Comparison between existing application and proposed system

Features	Lumosity	Brain Games	Elevate	Proposed System
Take voice inputs	✕	✕	✕	✓
Games in Sinhala language	✕	✕	✕	✓
View daily report	✓	✓	✓	✓
User can use the proposed application without a payment	✕	✕	✕	✓

4. RESEARCH PROBLEM

With the development of the ageing population, the number of Dementia patients will be increased gradually because most people under adults' range are facing to this syndrome as well as the number of dementia patients will be nearly increased double in every year globally. The reality is that there is no special medication for Dementia syndrome to be fully recovered rather than slowing down the symptoms step by step. According to current situation of Dementia, brain training activities are needed for those patients. It is easy to use a mobile application which is included mind developing activities for the cognitive functionalities of patients. But there is not relevant application to improve the Language skills under the reading, comprehension etc. The main aim is to give a solution for the impairment of the language skills of Dementia patients using speech to text communication activities to make their day-to-day life easier.

5. OBJECTIVES

5.1. Main Objectives

When considering about Dementia syndrome, the cognitive functionalities of the Temporal Lobe and Frontal Lobe are under a low level for the patients who suffer from Dementia. There are four main cognitive functionalities. Language skill is a one of the cognitive functionalities. Reading, writing, comprehension and communication are the main categories under Language skills. Through this component, it is mainly focused on bringing out an electronic based solution including different types of games and activities by giving the doctor recommended score and checking the progress level by level for decreasing the impairment of Language skill categories.

5.2. Specific Objectives

- Implement a game to minimize the impairment of reading, writing, comprehension and communication skills.
- Make both patients and caregivers life easier.
- Slow down the moving of one stage to another stage of Dementia.
- Rehabilitating the patients with continuous monitoring
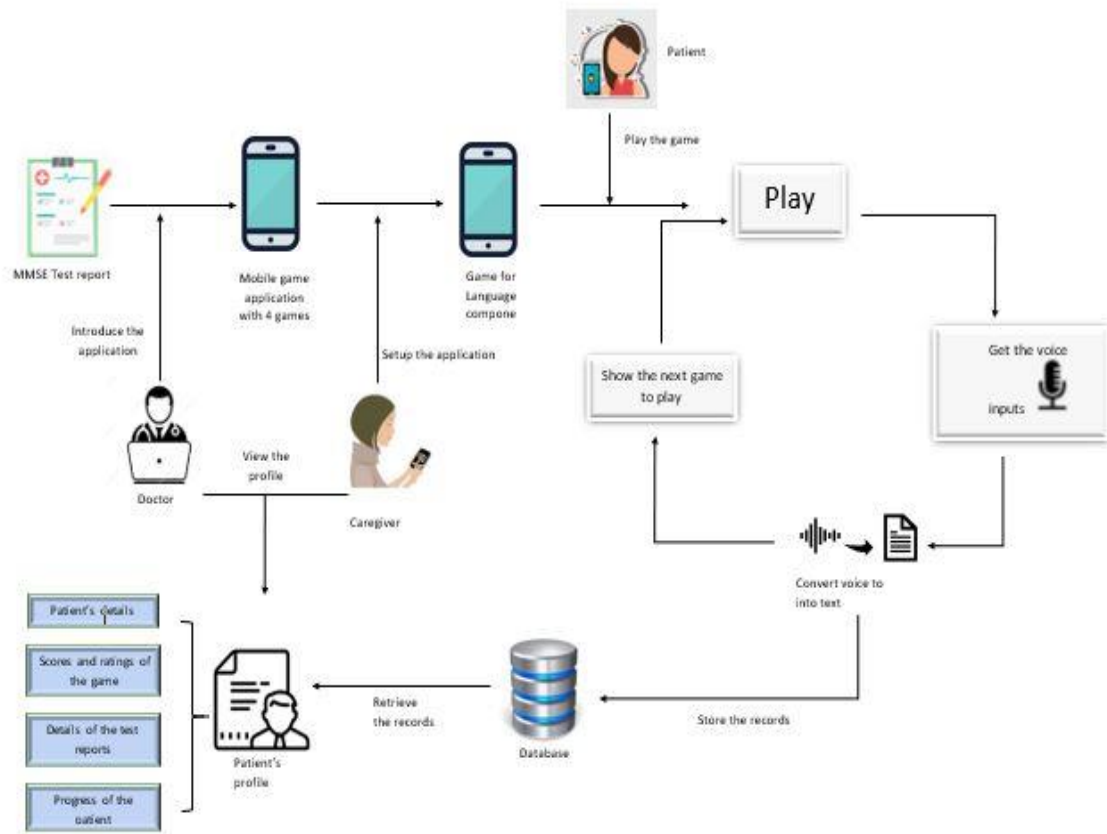
6. METHODOLOGY

6.1. System Overview

Figure:6.1. System Overview Diagram for Language

The main outcome of the proposed system is to build a mobile application for Dementia patients which includes different types of mobile games or activities using Reinforcement Learning and Speech to text communication to rehabilitate those patients in cognitive way. As well as, through this component, implementing mobile games and activities under the Language functionality is mainly focused to corporate to build up the proposed system.

The doctor will do the MMSE testing for the patients who meet the doctor (relevant Psychiatrist). According to the MMSE test result, patients will be categorized into some stages. Only the patients under the mild and moderate stages will be selected to

use this application. Through the other diagnose tests of patient for Dementia, the doctor will be selected the game functionality name for the patient to and if the patient is recommended to do the game under the Language skills,

1. First, patient should register with the system and create a profile (This can be done by the caregivers also).
2. When the patient logging into the system, they should select the relevant functionality to play.

Implementation of the Language component:
- Get the voice inputs for activities
- Convert speech into text using CNN
- Develop the related activities or games using speech to text communication

3. Store all the records of each game level inside the database.
4. After playing the games or activities, patient can see the score that they have gained and see the progress report which is stored in the database. As well as the Doctor can see the progress report of related patients.
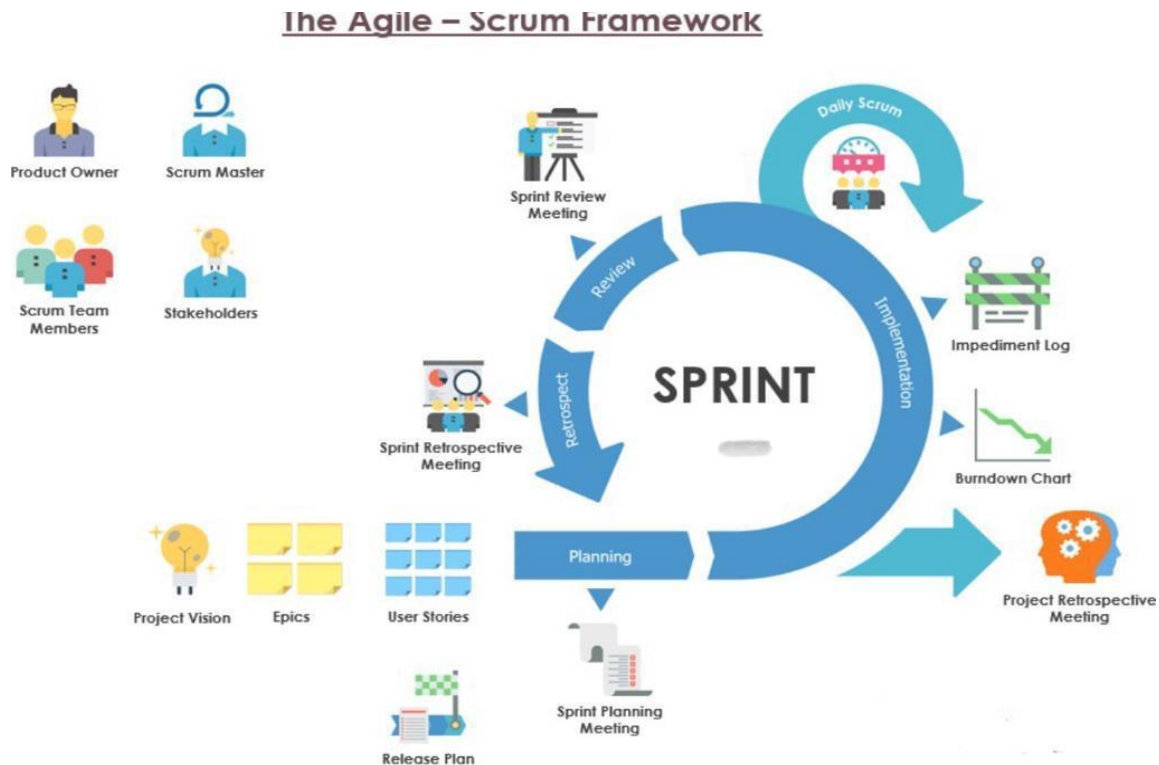
6.2. Software Development Life Cycle

Figure:6.2. Agile Scrum Framework

The software development methodology which will be utilized the Agile Scrum Process. The developers will be provided lots of features to build up a system in an adaptive manner. As well as it is easy for system developers to fulfill the new requirements of the customer. When considering about this propose system, there are lots of changes to be done in the future while implementing the system. It is suitable when comparing to processes like Waterfall model etc. Scrum process is mostly focused on task management within a time-based environment. This process is supported for team performance and solved the problems individually since this project is going to be done among four members. Having daily scrum meetings will help to understand the updates of all members of their research area.
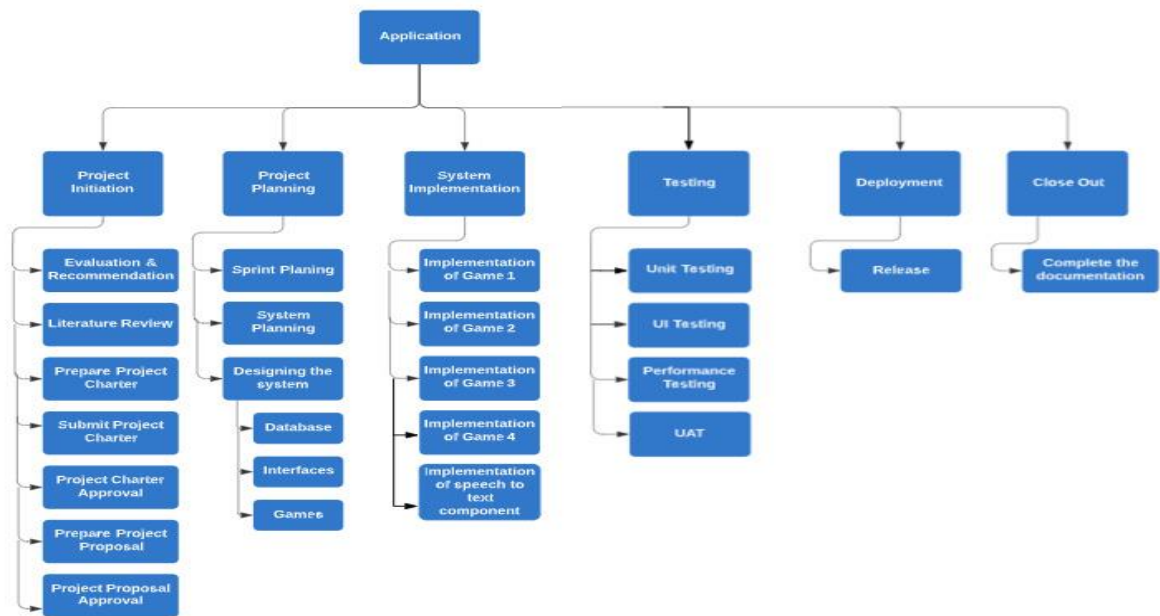
6.3. Work Breakdown Structure

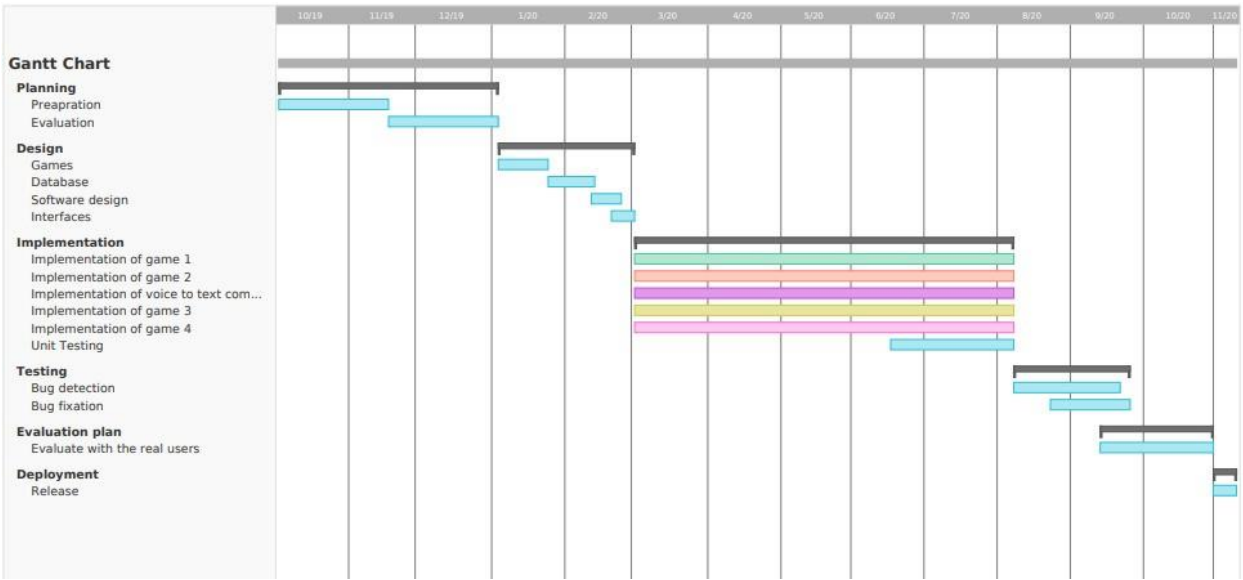Figure: 6.3. Work Breakdown Chart

6.4. Gantt Chart

Figure: 6.4. Gantt Chart

7. PROJECT REQUIREMENTS

Real world requirement is given by consultant psychiatrists Dr. Chathurie Suraweera at National Hospital of Colombo.

7.1. Functional Requirements

This component is included the games and activities under the Language functionality.

- The proposed system should be supported both English and Sinhala languages with the Dementia patient.
- Get voice inputs of the user to continue the game or activity.
- The Language component should be included games and activities for both Sinhala and English Languages to improve those languages.
- The proposed system should be able to maintain history of games or activities under Language component
- The proposed system should be allowed doctor to view progress report of the Dementia patient and the report should be included the progress of Language component separately.

7.2. Non-functional Requirements

- The proposed system should be able to give the accurate progress of Language component report accurately to the doctor.
- Usability of Language component of the proposed system.
- Performance of the relevant games and activities should be good.
- History of the level of the game such as scores history data to the relevant Language component should be available to the Dementia patient and for the doctor at any given time.
- Games and activities should be user-friendly.

8. REFERENCES

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