PERSONALIZED APPLICATION FOR DEMENTIA PATIENTS IN COGNITIVE REHABILITATION WITH CONTINUOUS MONITORING

Project Id: 2020-017

Project Proposal Report

Silva S. R. R. M

B.Sc. (Hons) Degree in Information Technology specializing in Software Engineering

Department of Software Engineering

Sri Lanka Institute of Information Technology

February 2020

PERSONALIZED APPLICATION FOR DEMENTIA PATIENTS IN COGNITIVE REHABILITATION WITH CONTINUOUS MONITORING

Project Id: 2020-017

Project Proposal Report

Silva S. R. R. M – IT17100076

Supervisor: Dr. Dharshana Kasthurirathna

B.Sc. (Hons) Degree in Information Technology specializing in Software Engineering

Department of Software Engineering

Sri Lanka Institute of Information Technology

February 2020

DECLARATION

I 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
Silva S. R. R. M	IT17100076	

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.

Name of supervisor : Dr. Dharshana Kasthurirathna

Name of co-supervisor : Mrs. Thilini Jayalath

Signature of the supervisor : Date:

Signature of the co- supervisor : Date:

ACKNOWLEDGEMENTS

I would take this as an enormous opportunity to express appreciation and gratitude to our supervisor Dr. Dharshana Kasthurirathna, co-supervisor Mrs. Thilini Jayalath and CDAP team of Sri Lanka Institute of Information Technology. Last of all, would like to glad to thankful to the Consultant Psychiatrist Dr Chathurie Suraweera at National Hospital of Colombo, for giving appropriate information concerning this research study and the valuable time and respectable consideration on this research.

ABSTRACT

Dementia is a wide-ranging term which used to describe, several symptoms cognitive failure, which is mainly causes loss of brain functionalities due to brain injury or brain diseases. Further explain, Dementia is not just a single disease, but it is kind of collection of huge categories of brain disorders, which can be deteriorated human's memory, their language and decision making and problem-solving skills etc. As a human, none of people would like to damage or loss memory at any cost, this theory is applicable for people who named as Dementia patients. Since there is no way to prevent from Dementia, additionally to medicine that's why doctors are advised patients to go through mind games or some of people called those brain games, in order to diminish the influence of Dementia.

Though, there are lots of brain games or mind, memory games were introduced, this research study area is mainly focused on develop a gaming application which aim on temporal lobe of human brain, to gain or protect human's memory and specially which is focused on senior citizens' culture in Sri Lankan as most of the adult people in Sri Lanka is not familiar with English Language. Reinforcement learning is used as research component, level of game is predicted by using Deep Q Learning algorithm which helps to make personalized game to Dementia patient.

Until this time period there were many mind or brain game applications introduced, this research field is focused into ways of applying above mentioned procedures to give the best solution for Sri Lankan Dementia patients.

Keywords: Dementia, Dementia patient, Reinforcement Learning, Cognitive

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

RL	Reinforcement Learning
MMSE	Mini- Mental State Examination
AD	Alzheimer Dementia

1. INTRODUCTION

1.1 Background

Dementia is collective term for assemblage of diseases which mainly focuses on frontal lobe and temporal lobe from the cerebral cortex of the human brain and which can be affected to on human's memory, cognitive abilities and personal behaviours which help to maintain their diurnal activities in lifetime. People with Dementia is impaired or harmed their brain cells and nerve cell due to degeneration in the cerebral cortex. Further, mutilation which is affected on human's frontal and temporal lobes due to that Dementia grounds to person's communication, decision making, language skills and loss of memory overtime which will impact destructively of peoples' living style.

Since until now there is no way to no cure or stop dementia, doctors are gone through some of non-drug therapies and drug treatment which can help alleviate indications of Dementia. Additionally, to that Dementia patients are advised by doctors to take themselves through software application such as memory games which known as mind or brain games where they can prevent or recover their disorders by keep practice on those games.

When it is come to Dementia Patiens in Sri Lanka, though there are lots of memory gaming applications in the worldwide none of them are hundred percent sutie for Sri Lankan culture. Reseason for that is most of Dementia patients in Sri Lanka is fallen to eldery generation and those patients are not proficiency with English language and there is another problem cause due to charaterictics of Dementia, patient to patient charaterictics of Dementia disase can be varied due to that, gaming applications were introduced to the world can be not actually support for Dementia Patients.

To overcome above metioned problems, develop a system which is mainly fouces in Sri Lankan Dementia patients and which is personalized game for each and every patients using Reinforcement Learning (RL) and support on both Sinhala and English Languages and to make good interaction with game and patient get the usage of voice to text communikcation. Ensuing sectors are discussed on with literature survey, objectives and methodology etc.

1.2 Literature Survey

1.2.1. Dementia

Dementia is one of the most well-known sicknesses in the old, with unrefined commonness rates between 5.9%–9.4% for subjects matured more than 65 in the European Union [5]. The least and sexual orientation explicit administration of all-causes dementia detailed in the writing is 61.1% among ladies aged100 or more prominent so the inquiry "on the off chance that we live long enough, will we as a whole be unbalanced?" is turning into a gravely intermittent one. Dementia influences day by day life and regular individual exercises are frequently connected with social side effects, character change, and various clinical confusions, it builds the risk for urinary incontinence, hip crack, and most uniquely reliance on nursing care. Therefore, it isn't amazing that the expenses of care for patients with dementia are huge [6].

1.2.2. Reinforcement Learning

Szepesvári, C has stated that Reinforcement learning is a learning paradigm concerned with learning to control a system so as to maximize a numerical performance measure that expresses a long-term objective [3], further **Ahmad Hammoudeh** has discussed that reinforcement learning is different from other branches of machine learning both supervised and unsupervised learning and consider it as third model of machine learning, at the edge of unsupervised learning and supervised learning [4]. Further open-handed to consideration to explanation of RL, will be learning through the communication with a situation by taking various activities and encountering numerous disappointments and victories while attempting to augment the gotten rewards.

1.2.3. Existing Products and Researches

Innovation can help cross over any barrier among patients and staff to improve the personal satisfaction for the subjectively impeded. Innovation instruments, for example, iPods, help invigorate those with dementia. This examination centres around inventive gadgets, for example, iPads and tablets, which are standard and simple to utilize, can't just assistance decide phase of dementia, yet additionally give incitement to improve subjective working. In a time where Alzheimer's and dementia in more seasoned grown-ups are expanding, parental figures are looking into new answers for interceding the emergency. One of these new arrangements is the utilization of cell phones to animate the perception of more established grown-ups and patients experiencing AD. New research has demonstrated that the utilization

of cerebrum, memory, and taking care of issue games help invigorate the mind and diminish the side effects of AD. The utilization of the cerebrum games and other PC based incitement treatment has given new light to medicinal services experts, guardians, and the patients themselves [1].

1.3 Research Gap

In fact, moving on with mobile application which helps Dementia patients, take through about research gap is most vital for forthcoming researches. While in a conversation about mobile applications that were introduced for Dementia patients mainly supported for English Language, as per **Christina Yamagata et al.** have discussed that further efforts will focus on developing apps to help caregivers and individuals reveal early warning signs of dementia and future work will include cross-campus teams and more focus on creating apps to detect early symptoms of dementia and over the summer, students collaborated with a community partner to develop an app that helped clinicians quickly determine level of dementia[1] however none of these researcher are mentioned developing apps for Dementia patients which is supported for multi languages, rather developing apps which are supported for only English Languages. In that case novelty of this proposed research component is focused on developing a mobile gaming application to improve or recover memory of Sri Lankan Dementia patient which is supported both Sinhala and English languages. Moving on furthermore, **Kiho kang et al.** have stated that "Serious Game to Help Prevent Dementia" is mainly played through finger tapping and touch [2]. Nevertheless, proposed research component is used speech/ voice to text communication component to make memory related gaming application more interactive with Dementia patients.

Features	Lumosity	Brain Games	Elevate	Eidetic	Proposed System
Learning from the user and personalize it	✗	✗	✗	✗	✓
View the daily report	✓	✗	✓	✓	✓
Doctor can view the progress of the patients	✗	✗	✗	✗	✓
Games in Sinhala language	✗	✗	✗	✗	✓
View the history	✗	✓	✓	✓	✓
Suitable for elderly people	✓	✗	✓	✗	✓
Take voice inputs	✗	✗	✗	✗	✓
Based on many functionalities	✓	✗	✓	✓	✗

Figure 1: Comparison between Existing System and Proposed Research Component

1.4 Research Problem

Now a days, worldwide ageing population is faced with most noteworthy health complications. Crack attention moving frontward to term called Dementia, can be named as one of most significant problematic area in medical science. Human can be affected with memory loss, corrosion in thinking capacity, humans' behaviour and general daily actives. Even though Dementia is principally affected on older people, that is not evidenced on the statement "Dementia is a normal part of ageing". According to the statement which is demonstrated by **Christina Yamagata et al.** is illustrated that the estimated current prevalence of Dementia is 47.5 million worldwide and that given numeral value will nearly double in every 20 years globally[1]. Though, preliminary discussion is turned around into worldwide, this research study is mainly enquired on Dementia patients in Sri Lanka. Dementia is a condition which is not cured by medicines. However, there are medications such as mental and behavioural treatments that help to slowdown the increment of the sickness where Dementia patient could have to completed treatments during the treatment time of the period. Some of Dementia patients are recommended to use brain training games which are affected in to improve or recover their memory loss therefore there are many numbers of brain games were introduced. But problem is occurred when it is come to Sri Lank, many of Dementia patients are fallen under ageing population is not really conscious of English language, therefore introduced memory/ brain training gaming applications are not suited for Sri Lanka and also already existing memory related applications are not personalized for patient to patient.

As in a summary of this research study following can be addressed as main research problem.

- How to introduce a personalized gaming application for Sri Lankan Dementia patients which will be mainly based on human memory ?

2. OBJECTIVES

2.1 Main Objective

The main objective of the proposed research component is to develop a personalized mobile interactive gaming application for Dementia patients to improve or recover all aspects of their memory, and this application is implemented mainly converging on elderly Dementia patients in Sri Lanka.

2.2 Specific Objectives

The main objective is covered with the aid of the resulting specific sub-objectives which will be used with the succour .

- Sub-Objective 1: Design a memory related personalized game each Dementia patient using RL
- Sub-Objective 2: Measure memory weakness and strengths of the Dementia patients
- Sub-Objective 3: Identify the progress of Dementia patient memory continuous monitoring.
- Sub Objective 4: Motivate Dementia patients to keep tracking on their daily progress of memory skill.

3. METHODOLOGY

proposed research component is mainly focused to develop a game/ activity which is tried to improve or recover Dementia patients' memory. Under memory it will coverup all aspects of memory such as,

- Registration

  Ability to memorize set of values in given little time period.
- Recall

  Ability to memorize or registered list of value after the given time period.
- Recognition

  Ability to identify already registered list of values among of another set of values.

3.1 System Overview

The main outcome of the proposed research component is to build a mobile application for Dementia patients which includes memory specific mobile game or activity using RL and voice/ speech to text communication to rehabilitate those patients in cognitive way.

Operational feasibility study for the proposed research component

The proposed research component is demonstrated a solution to help or prevent Sri Lankan Dementia patients. Proposed research component will help Dementia patients to recover their memory loss as well it will help them to improve their memory and Dementia patients who are under mild stage of this disease can be prevent from fallen to moderate or severe stages on Dementia by keep practice on this game. Proposed research component has understanding about both Sinhala and English languages and when predict the next level of the memory game has capacity to identify plus and minus points of the patient.

Gathering and analysis of the Requirements

Under the supervision of consultant psychiatrists Dr. Chathurie Suraweera at National Hospital of Colombo, all the information which was related for the proposed research component was gathered and going through the online resources, research papers, articles information which related to the component has gathered.

Pre- requirement

As first step, the relevant consultant Psychiatrist must do the Mini- Mental State Examination (MMSE) test for the patients who meet the doctor. According to the MMSE test result, patients will be categorized into some stages ether tested patient is fallen into which stage of Dementia. Only the patients under the mild and moderate stages will be recommended to use this gaming

application. Through the other diagnose testing of patient for Dementia, from there if doctor is selected patient need to focus on their memory, in that case patient can practise on this memory game.

Functional Flow

In order to involve patient into the game caregiver must able register patient self into entire system by providing all personal data when the stage of proving data caregiver must provide correct data upon that all the preparation and progress reports are generated. After the patient's registration patient should able to view on home of the application which will contain 4 different gaming categories. Under that patient should select memory game with the doctor recommendation, go through the game, keep track of all score earned by patient. Based on scores earned by patient, doctor and caregiver accessed to view on progress of the patient.

Implementation

Maintain the registration, recall, recognition of human's memory

- Design game/ activity which is covered above mention all aspects of human's memory
- Connect speech/ voice to text communication component which is implemented as another research area is connected to designed game/ activity to make rehabilitate Dementia patients in cognitive way.
- Apply RL algorithm (Q learning, or Deep Q learning will be taken as RL algorithm base on further investigation)
- Predict the next level of the game which is personalized patient to patient.

3.2 System Architecture

The System Architecture shown below mainly illustrates the flow of proposed research component, design a game/ activity which relates to speech/ voice to text communication component to make interaction between Dementia Patient and the designed game, and predict the next level of the game using RL algorithm.

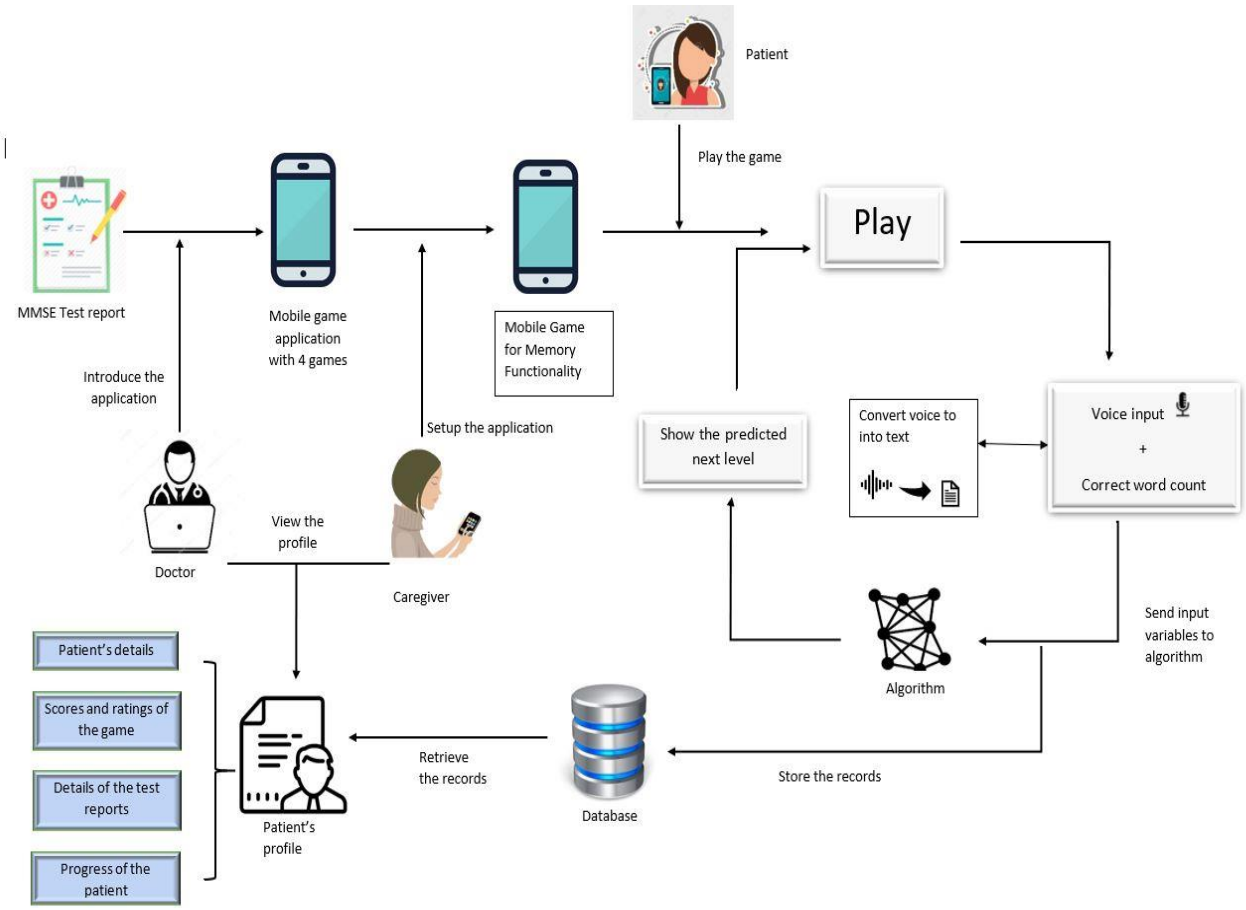


Figure 2: System Architecture

3.3 Software Development Life Cycle

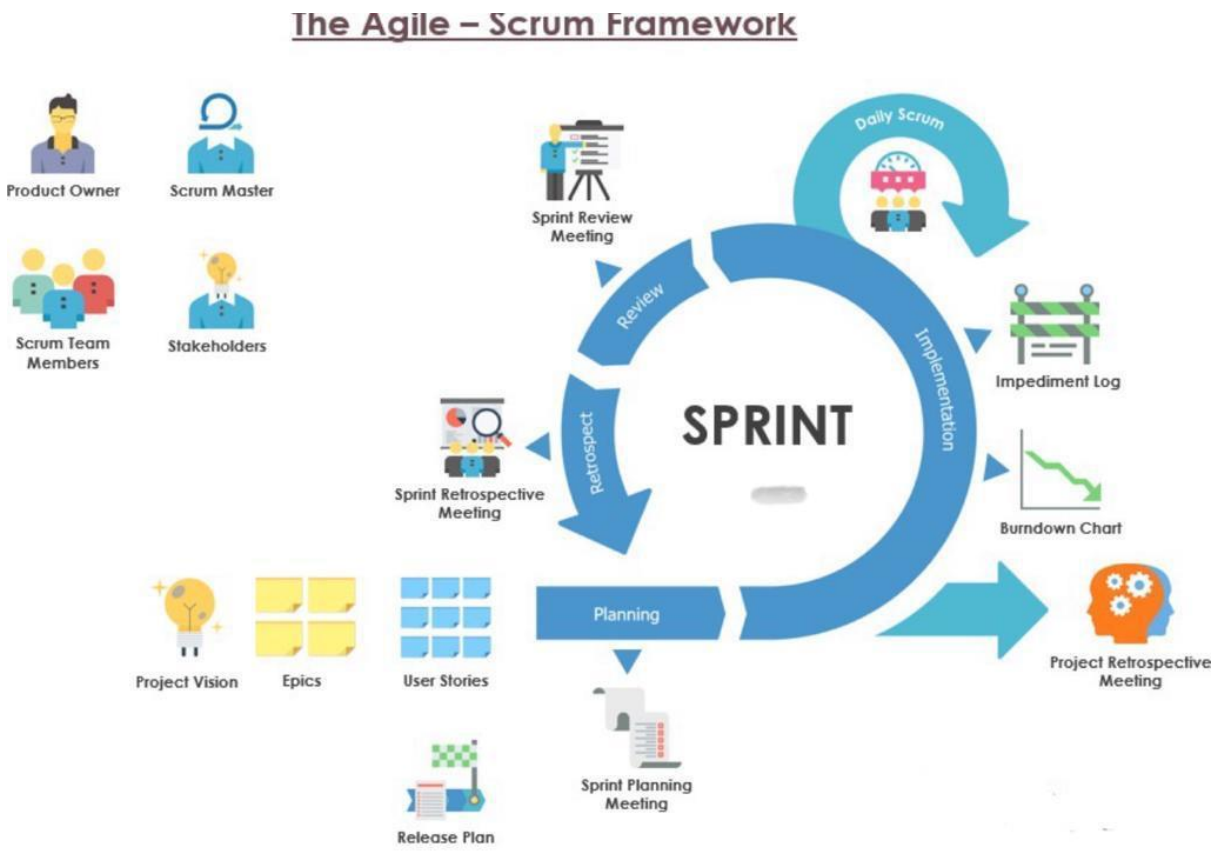


Figure 3: Agile Scrum Process

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 fulfil the new requirements of the customer. When considering about this research project, 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.

4. PROJECT REQUIREMENTS

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

4.1. Functional Requirements

The proposed research component should be containing memory games which can coverup all aspects of memory such as registration, recall and recognition.

- The proposed research component should contain should be maintain logged history in order track the detail of Dementia patient.
- The proposed research component should be supporting both English and Sinhala languages with the Dementia patient.
- The proposed research component should be communicated with patient by using speech/ voice to test component.
- The proposed research component should be contained two or more that levels in it and it should be learning from user via RL algorithm in order to predict the functionality of the next level of the game.
- The proposed research component should be able maintain history related to the level of the game.
- The proposed research component should be allowed doctor to view progress report of the Dementia patient regarding their memory improvement progress.

4.2. Non- Functional Requirements

- The proposed research component should be able to give the progress report accurately to the doctor.
    - It should be recognizing the behaviour of the patient and predict the next level of the game very correctly.
- Usability of the proposed research component.
    - The patient should be fingered the proposed system with effortlessness
- Availability
    - History of the level of the game such as scores history data should be available to the Dementia patient and for the doctor at any given time to measure their progress level of memory improvement.

5. DESCRIPTION OF PERSONAL AND FACILITIES

Student Name	Component	Tasks
Silva S. R. R. M	Mobile Game to Improve/ Recover Memory Skills	• Design the game and stages of the game • Use RL algorithm in to designed game • Predict personalized gaming level • Get the connection between speech/ voice to text communication component

Table 5.1 Description of Personal and Facilities

6. BUDGET AND BUDGET JUSTIFICATION

The given budget is calculated according to the rough estimation and it can be changes due to requirements and decision which are made further, through the project. Below mentioned cost will be bear by all members related to the research project throughout the project. This will not give any economical approximation on maintaining and placement of the entire application.

Related Activates	**Amount (Rs.)**
Travelling	10000.00
Internet Connection (per month)	7500.00
Hospital Charges	15000.00
Web Hosting	40000.00
Total	72500.00

Table 6.1 Budget Estimation

7. REFERENCES LIST

[1]. Yamagata, C., Kowtko, M., Coppola, J. and Shannon Joyce (2013). "*Mobile app development and usability research to help dementia and Alzheimer patients" - IEEE Conference Publication*.[online] Ieeexplore.ieee.org. Available at: https://ieeexplore.ieee.org/abstract/document/6578252 [Accessed 25 Feb. 2020].

[2]. Kang, K., Choi, E. and Lee, Y. (2020). "*Proposal of a Serious Game to Help Prevent Dementia"*. [online] Available at: https://link.springer.com/chapter/10.1007/978-3-319-50182-6_38 [Accessed 23 Feb. 2020].

[3]. Szepesvári, C. (2010). "*Algorithms for Reinforcement Learning. Synthesis Lectures on Artificial Intelligence and Machine Learning", 4(1), 1–103*

[4]. Hammoudeh, A. (2018). "*A Concise Introduction to Reinforcement Learning*", [online] Available at: https://www.researchgate.net/publication/323178749 [Accessed 25 Feb. 2020].

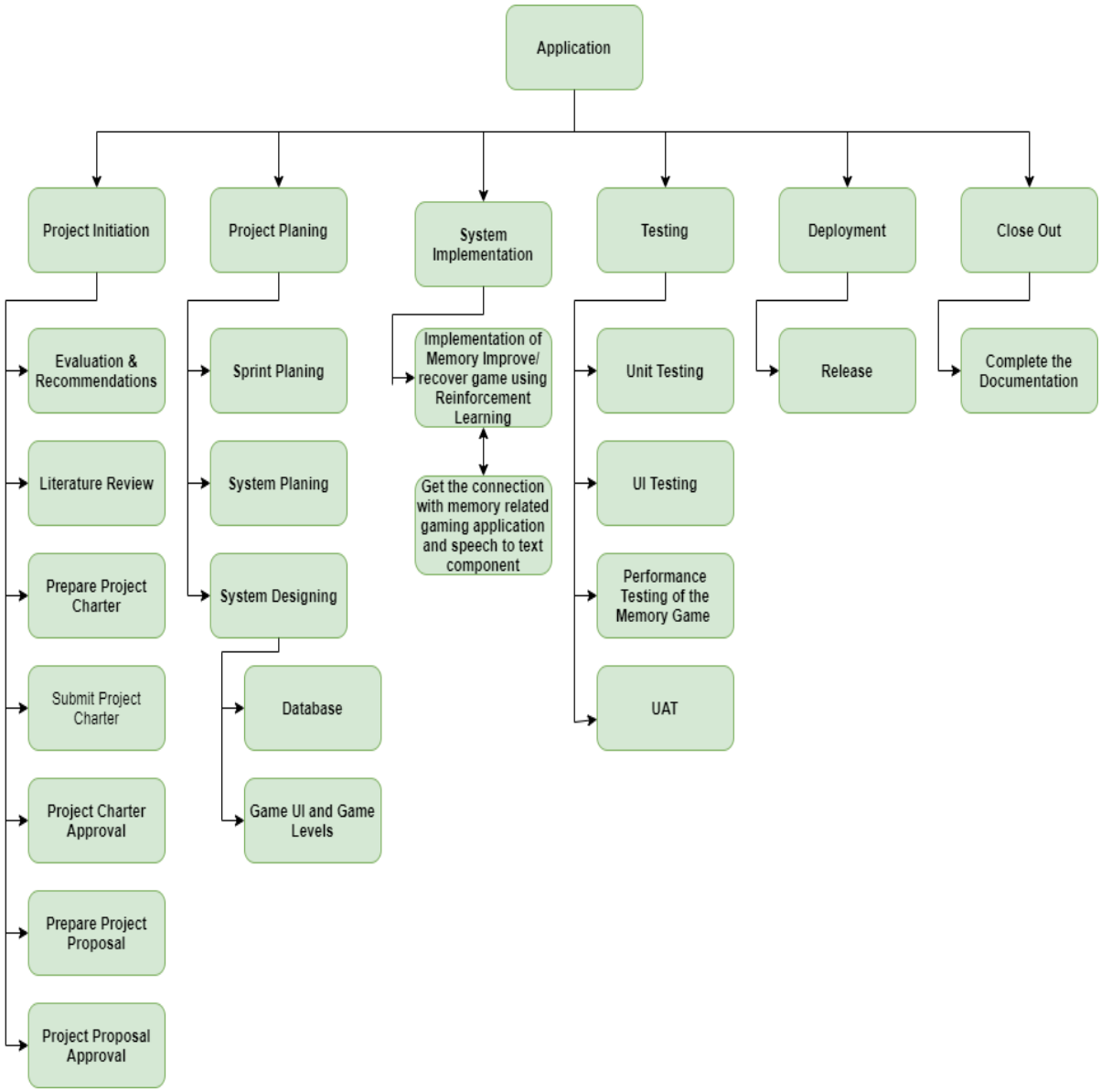
[5]. Berr, C., Wancata, J., & Ritchie, K. (2005). "*Prevalence of dementia in the elderly in Europe. European Neuropsychopharmacology", 15(4), 463–471*, [online] Available at: https://www.ncbi.nlm.nih.gov/pubmed/15955676.

[6]. Polidori, Maria Cristina & Nelles, Gereon & Pientka, Ludger. (2010). "*Prevention of Dementia: Focus on Lifestyle*". International journal of Alzheimer's disease. 2010. 10.4061/2010/393579.

8. APPENDICES

8.1. Appendix- A

Work Breakdown Structure



8.2. Appendix- B

Gantt Chart