# PERSONALIED APPLICATION FOR DEMENTIA PATIENTS IN CONGNITIVE REHABILITATION WITH CONTINUOUS MONITORING

Project Id: 2020-017

Project Proposal Report

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## DECLARATION

We 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**

**Name of co-supervisor: Mrs. Thilini Jayalath**

Signature of supervisor: Date:

Signature of co-supervisor: Date:

# ABSTRACT

Sri Lanka has one of the world's fastest ageing populations. According to the recent predictions, 20% of Sri Lankans will become over 60 years in 2020 [1]. Therefore, illnesses like Dementia will become more prevalent in the community. The current medicine can't cure this Disease [2]. However, during the early stages like mild or moderate in Dementia, there are several ways to assist those patients to keep their brain active by slowing the symptoms of one stage to the next stage for a little longer.

Due to the frequent usage of smart devices at present and according to the requirements of the doctors, the implementation of new application including games and activities for help the Dementia patients in their daily life activities. Even though there are mobile applications in the world that could be useful to develop human concentration, but there isn't suitable mobile application for Sri Lankan culture because most of the dementia patients in Sri Lanka are senior citizens and they are not proficiency with the English language and also the available current applications are not free and the users must pay a fee for using those applications. The people who are experiencing early signs of dementia or the patients in mild or moderate stages in dementia can use this application step by step and boost their condition with continuous monitoring. Also, the Doctor of those patients could be used to check the patient's records which include the score that they have gained and the performance of the levels that they have passed.

The implementation of the game will be including different levels. Using the algorithms in the Reinforcement learning predict the next level for the user. The game will be designed along with the supervision and recommendation from a Consultant Psychiatrist in Sri Lanka.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ML | Machine Learning |
| RL | Reinforcement Learning |
| MMSE | Mini Mental State Exam |
| AD | Alzheimer Dementia |
| SARSA | State Action Reward State Action |
| | |
| | |

# 1. INTRODUCTION

Dementia is a disease which describes a collection of symptoms such as decrease the ability to think and remember, emotional problems, problems with language, behavior and the ability to perform everyday tasks. This caused due to damage in the brain cells. This disease is affected enough to interfere with a person's normal social or working life. And this is a long-term disease that can be diagnosed from the Cognitive testing or Mini-Mental State examination. Since there is no special medicine and the Treatment that can be given is supportive care. So, this has a significant effect on the caregivers of the patients. Attention and concentration take prominent place from the mentioned symptoms, which results in being distracted easily, difficulties in focusing, thinking or the processing takes longer than usual.

With the current technologies, the new proposed system includes the game which can help the patients to increase the cognitive function required to maintain some level of Attention and Concentration. Carrying out simple tasks will be increased in complexity, will be introduced to the patients with the game. The game will be very simple at the initial stage and level by the level game will be started to change. And finally, up to a considerable level with continuous monitoring with the caregiver and the doctor.

This game will be implemented using reinforcement learning, which helps to make the game more specific to each patient. The most important of the application is to follow the advancement during the time that they are spending at home. While the patient is away from the doctor, the patient can increase the attention and concentration from their own by using this application. This will be an incredible assistant for the patients since there is not a suitable cure for Dementia.

## 1.1 Background

Dementia describes a collection of symptoms that caused due to the disorders affecting the brain. It influences thinking, conduct and the capacity to perform regular undertakings. And, this influence can meddle with the individual's ordinary social or working life. The vast majority with

dementia is more seasoned, however, it is essential to recollect that not every single more established individual get dementia. Dementia can transpire; however, it is progressively basis after the age of 65 years. Individuals in their 40s and 50s also can have dementia. The early indications of dementia are extremely unpretentious and obscure and may not be quickly self-evident. Some basic manifestations may include:

- Progressive and frequent memory loss
- Confusion
- Personality change
- Apathy and withdrawal
- Reduce the ability to perform everyday tasks.

When we are looking back the history of Dementia, many decades ago, first diagnosed Dementia patient was found in Germany. During the late 1890s, the common symptoms in Dementia such as loss of memory, no sense of time and place, delusions were shown. After many years later she became completely demented. She died in 1906 April. After passing nearly century her case was examined again with the modern medical technologies and found the reason for the disease.[3] Since then the different types of researches were done to find a solution for the Dementia problem, but still, there is no specific medication for this syndrome.[2] In any case, much can be offered to help and improve the lives of individuals with dementia and their cares and families.

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## 1.2 Literature Survey

### 1.2.1 Dementia

Dementia is the greatest worldwide challenge for health and social care in the 21st century. It happens to the people older than 65 years, so increments in numbers and expenses are driven, around the world, by expanded life span coming about because of the welcome decrease in individuals passing on rashly. The Lancet Commission on Dementia Prevention, Intervention, and Care met to unite the tremendous steps that have been made and the developing information concerning what we ought to do to forestall and oversee dementia. Comprehensively, around 47 million individuals were living with dementia in 2015, and this number is anticipated to significantly increase by 2050. Dementia influences the people with the condition, who continuously lose their capacities, just as their family members and different supporters, who need to adapt to seeing a relative or companion become sick and decrease, while reacting to their requirements, for example, expanding reliance and changes in conduct. Furthermore, it influences the more extensive society since individuals with dementia additionally require wellbeing and social consideration. The 2015 worldwide expense of dementia was evaluated to be US$818 billion, and this figure will keep on expanding as the quantity of individuals with dementia rises. About 85% of expenses are identified with family and social, as opposed to clinical, care. It may be that new clinical consideration later, including general wellbeing measures, could supplant and conceivably lessen a portion of this expense.[4]

### 1.2.2 Mobile Applications for Dementia patients

In 21st Century, everybody is running on exchange plant of life. Right now, rivalry, Dementia/Alzheimer can be tousled result of such upsetting life. Alzheimer is most basic sort of dementia. For the most part it occurs at an age of 65 or more noteworthy.[5] In our nation, dealing with patients who have been experiencing this infection is troublesome. Larger part of them have been admitted to the psychological clinic by their relative or they must be detained at home. With the assistance of this application, we have attempted to fill the hole among patient and guardians. The thought behind the execution of it on "Android" is, these days android is generally acknowledged and open source working framework. Lion's share of helpful devices is

being bolstered by it like Tablet, Wristwatch, Cell Phone and so forth. This application has a few essential usefulness like "GPS Navigator", "Fall Detection System", "Brain Games", "Specialist Finder" and "Crisis". With the help of clinical experts like researcher and scientist's future improvement can be conceivable.

### 1.2.4. Reinforcement Learning for Dementia

Right now, informatics, it has gotten foremost to give customized proposals to moderate the impacts of data over-burden. This area of biomedical and medicinal services informatics is as yet undiscovered most definitely. The vast majority of the current recommender frameworks have, somewhat, not had the option to address sparsity of information and non-linearity of client thing connections among different issues. Profound fortification learning frameworks can upset the proposal structures as a result of its capacity to utilize non-straight changes, portrayal learning, grouping displaying and adaptability for the usage of Wellbeing industry, for the most part, manages long haul issues. Customary recommender frameworks neglect to consider the long-haul impacts, henceforth neglecting to catch dynamic opinions of individuals. This methodology regards the procedure of proposal as a successive choice procedure, which addresses the previously mentioned issues. It is evaluated that more than 700 million individuals will have wearable gadgets that will screen each progression they take.[6] Information gathered with these savvy gadgets joined with different sources like Electronic Health Records, Nutrition Data and information gathered from studies can be prepared to utilize Big Data Analysis apparatuses and took care of two suggestion frameworks to create alluring proposals. The activity, state pair is taken care of to the pundit arrange, which produces a prize related to the activity, state pair. This prize is utilized to refresh the arrangement of the Actor organizes. The pundit arrange picks up utilizing a pre-characterized Expected Reward.

### 1.2.5 Different techniques of Reinforcement Learning

In games, machine learning can be utilized for different purposes. It very well may be utilized to acquire the greatest scores, win the game at the base time conceivable, get most collectibles, or improve survivability. As we don't think a lot about the games, it is ideal to actualize the

reinforcement learning technique as it can take in without anyone else from its surroundings. Reinforcement learning has its choice of systems, for example, Q learning, SARSA, DQN, and DDPG [7].

There are two kinds of algorithm model which are model-based and model-free. In the model-based algorithm, the model will learn the transition probability T. The agent will realize how to enter a and activity space develops; the model-based algorithm will turn out to be more impractical. The model-free algorithm refreshes its information by depending on the experimentation technique. In this way, the blend of states and actions shouldn't be put away in another space. Instances of the model-free algorithm are Q-learning and SARSA.

### 1.2.6 Q-learning

Q-learning is a type of model-free reinforcement learning. It works by steadily refreshing the normal estimations of activities in states. For each conceivable state, every conceivable activity is assigned out a worth which is a component of both the immediate reward for making that move and the normal award later dependent on the new express that is the consequence of making that move. This is communicated by the one-advance Q-update condition [1].

$$Q(s, a) = Q(s, a) + \alpha [r + \gamma \max_{a'} Q(s', a') - Q(s, a)] \quad (1)$$

Q – expected value of performing action
s – state vector
a – action vector
r – reward
α – learning rating which controls convergence
γ – discount factor

The discount factor makes rewards earned before more important than those got later. This technique learns the estimations of all things considered, as exposed to simply finding the ideal procedure. This information is costly in terms of the measure of data that must be put away, yet it brings benefits. Q-learning is investigation insensitive; any activity can be completed whenever, and data is picked up from this experience [7].

### 1.2.7 Q-learning algorithms for games

Correlated-Q learning, a multiagent learning calculation that learns harmony strategies in Markov games, similarly as Q-learning figures out how to ideal approaches in Markov choice procedures. Correlated learning is named for associated equilibria (Amann 1974)[8], which sum up Nash equilibria by taking into consideration potential conditions in vital decisions. A Nash harmony is a vector of autonomous likelihood dispersions over activities, in which all specialists streamline concerning each other's probabilities. An associated balance is a likelihood appropriation over the joint space of activities, in which all operators enhance regarding each other's probabilities adapted all alone. As of late, there have been a few endeavors to structure a multiagent learning calculation that combines to balance arrangements all in all total Markov games. Hu and Wellman (1998) propose a calculation called Nash-Q that joins to Nash harmony strategies in limited classes of Markov games.

## 3. RESEARCH GAP

In fact, moving on with mobile games 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, novelty of proposed system is supported both Sinhala and English language which can be mainly suited for elderly population of Dementia.

| Features | Lumosity | Brain Games | Elevate | Proposed System |
|---|---|---|---|---|
| Attention and Concentration | ✓ | | ✓ | ✓ |
| Suitable speed for game | ✓ | | | ✓ |
| Different scores for Attention and Concentration | | ✓ | | ✓ |
| Suitable colors for interfaces | ✓ | | | ✓ |
| Suitable font size | | | ✓ | ✓ |

TABLE 3.1 – COMPARISON BETWEEN EXISTING SYSTEMS AND PROPOSED SYSTEM

## 4. RESEARCH PROBLEM

Dementia is one of the most significant problems facing with the increase in the ageing population. The estimated current prevalence of dementia is 47.5 million worldwide [1]. This number will nearly double in every 20 years globally [1]. As well as the same problem has occurred in Sri Lanka. Dementia is basically a syndrome which can't be cured by medicines. In any case there are medications that help to slow down the movement of the sickness. There are medications just as mental and behavioral treatments that help. But a patient could be performed that treatments during their treatment sessions only. And, doctors can't get the history of treatments of each patient regularly. According to the requirements of the doctors, the use of a brain training application could be better than medicine. There are number of brain training mobile applications in the world that could be useful to develop human concentration, attention and all sorts of brain activities but there isn't suitable mobile application for Sri Lankan culture because most of the dementia patients in Sri Lanka belong to the old generation and mostly they are not proficiency with the English language and also the available current applications are not free even at the first stages and the users must pay a fee for using those applications. And, the activities in the existing application are with similar colors which difficult to identify separately, small fonts which difficult to read and the speed also very high in a way as healthier person can't even play. In some application instructions are not clear enough to follow. According to the resources, developing this application is an actual global requirement for dementia patients.

# 5. OBJECTIVES

## 5.1. Main Objectives

The proposed game has an ability to overcome those issues. It has games and activities to improve the cognitive functionalities for the attention and concentration for Frontal lobe from the Cerebral cortex. There are two main subcategories under them as Attention and Concentration. This game consists of different levels. Reinforcement Learning is used in this game in order to predict the best level for the users. This game is designed with user friendly interfaces specially for the elder people and in a way suitable for our culture. And the patients can view their progress with the score level as well as the doctor of the relevant patient via a report. Implementation of the application will take over throughout the year.

## 5.2. Specific Objectives

- Implement a game to help to increase the Attention and Concentration level of patients.
- Only the patient, caregiver and the doctor can view the patient details and scores.
- Make both patients and caregivers life easier.
- Slow down the moving from one stage to another stage of Dementia.
- Giving rehabilitation with continuous monitoring.

# 6. METHODOLOGY

## 6.1. System Overview

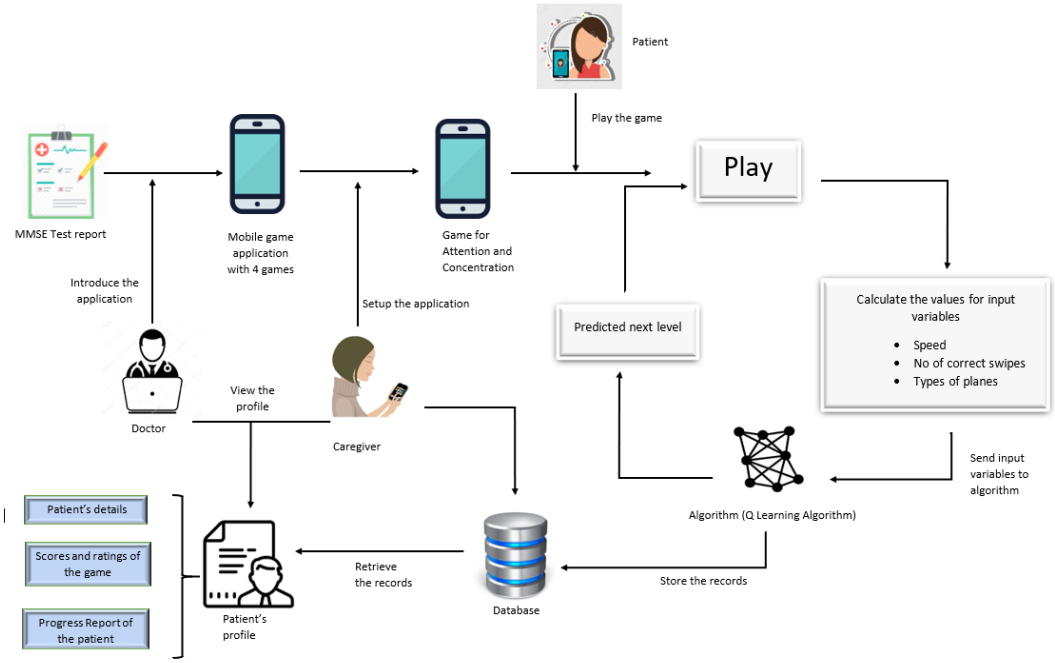


*Figure 6.1: System Overview Diagram*

The main outcome of the research is to build a mobile application for Dementia patients which includes a mobile game using Reinforcement Learning and to rehabilitate those patients in cognitive way.

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 recommended to practice the game which is most suitable for that patient and once they are finished a level they can see the progress of their own for that level.

Maintain Attention and Concentration of Dementia Patients

- Develop the related activities or games

- Apply RL algorithm
- Predict the next level

### 6.2. Software Development Life Cycle

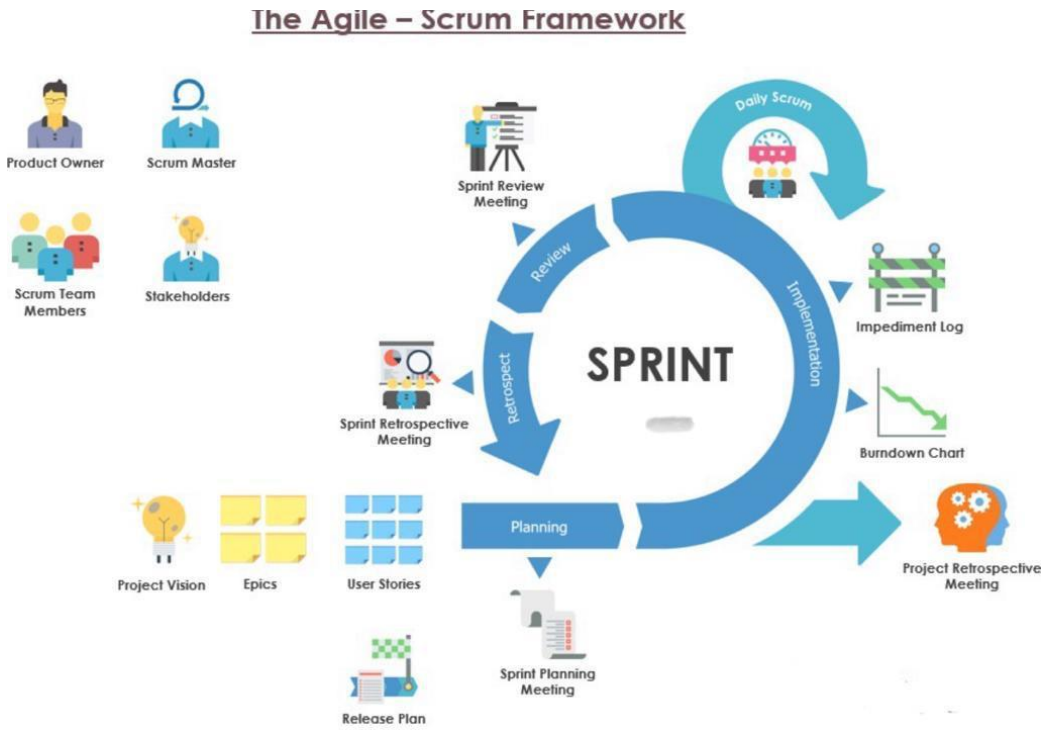


*Diagram 6.2: Software Development Life Cycle*

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 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.

## 6.3. Gantt Chart

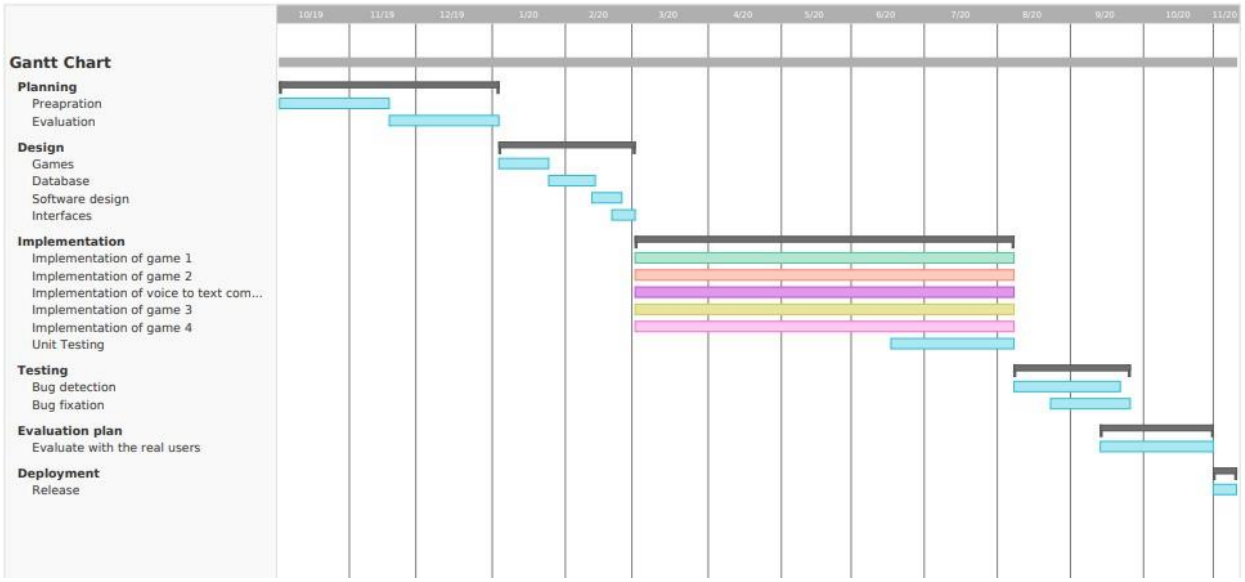


*Diagram 6.3: Gantt Chart*

## 6.4. Work Breakdown Structure

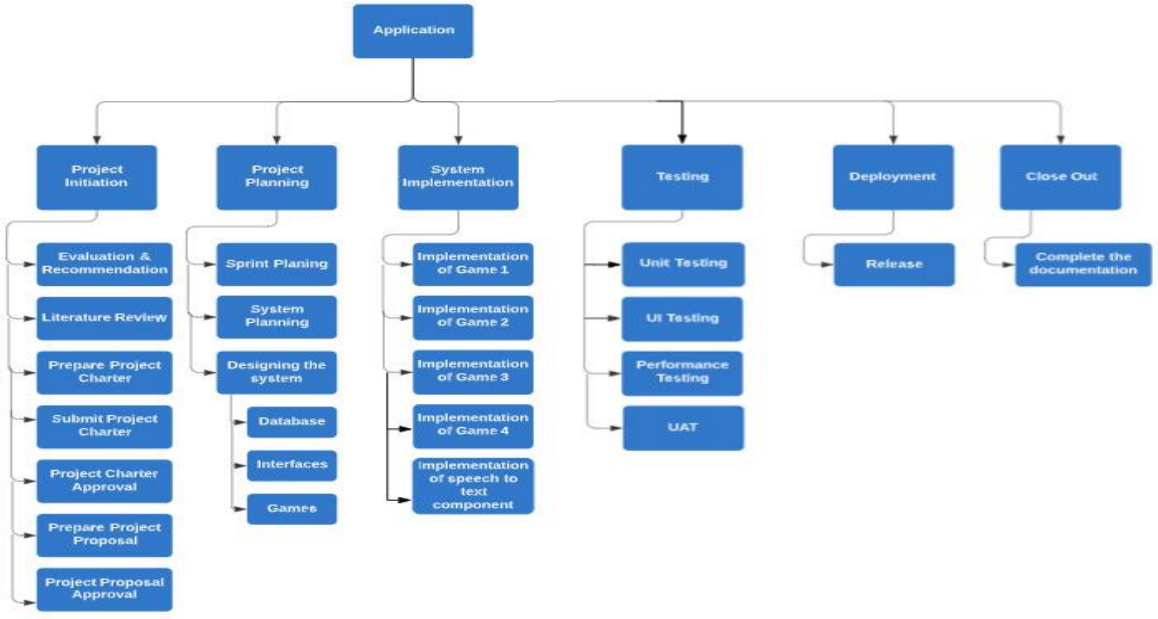


*Diagram 6.4: Work Breakdown Structure*

# 7. PROJECT REQUIREMENTS

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

## 7.1. Functional Requirements

The proposed system should be containing Attention and Concentration.

- The proposed system should have the ability to measure the progress of Attention and Concentration level separately.
- The proposed system should have small tutorial for the game.
- The proposed system should be learning from user and predict the functionality of the next level of the game.
- The proposed system should be able maintain history related to the level of the game.

## 7.2. Non-functional Requirements

- Usability of the game.
    - The patient should be able to play the game with effortlessness
- Availability
- Performance
- Scalability

## 8. BUDGET & BUDGET JUSTIFICATION

| Item | Cost (Rs) |
|---|---|
| Travelling | 10 000.00 |
| Internet | 7 500.00 |
| Hospital Charges | 15 000.00 |
| Web Hosting | 40 000.00 |
| **Total** | **72 500.00** |

TABLE 8: BUDGET

# 9.APPENDICES

## 10.REFERENCES

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