



# **Motion Based Learning App For Children**

**A dissertation submitted for the Degree of Master of  
Information Technology**

**R.M.G.S.B Rathnayaka**

**University of Colombo School of Computing**

**2017**



## Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

Student Name: R.M.G.S.B Rathnayaka

Registration Number: 2014/MIT/051

Index Number: 14550516

---

Signature:

Date:

This is to certify that this thesis is based on the work of

Mr R.M.G.S.B Rathnayaka

Under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name:

---

Signature:

Date:

## **Abstract**

Gaming based Learning / Teaching applications are vastly getting recognized in the area of E Learning. Even though these applications are getting the attention they should, properly teaching children using this game based applications is still a big challenge. The common problem with teaching kids is, due to their short attention spans they lose interest quickly. In addition to traditional methods like reading, kids have a tendency towards game based activities and applications when it comes to learn something also these applications happen to keep fun and engaging atmosphere which keep children engaged. The game based applications have proven to be a trusted and convenient tool which helps change the way children learn during last decade. This application mainly focuses on providing a gesture sensitive facility (using Leap Motion Controller) attached with game based application which helps to teach the children efficiently. This application is designed in a way that enhances skills and knowledge of children who are in age between 4 and 5. The biggest advantage of using Leap motion controller instead of using mouse and keyboard is the users can use their hands to control the application which is fun, easy and effective. The games that have designed are included elementary level of educational knowledge that is crucial to a child, such as identify letters, identify numbers and very basic mathematical skills. Since this is an implementation project, it has been facilitated an environment where kids don't get bored or detached, so that they can continue learning through the application.

## **Acknowledgement**

I convey my special gratitude to Dr Enosha Hettiarachi, My supervisor who guided me and advised to achieve my objectives. Also all the children and parents who provided their valuable time to carry out the testing phase.

## Table of Contents

1	Introduction .....	1
1.1	Background Context.....	1
1.2	Problem Addressed .....	2
1.3	Aims and Objectives .....	3
1.4	How the system benefits children .....	4
1.5	Evaluation Process of a child .....	5
1.6	Scope .....	5
1.7	Related Projects.....	7
1.8	Thesis Structure.....	8
2	LITERATURE REVIEW .....	9
2.1	Effect of Computer-Based Video Games on Children.....	9
2.2	Gesture recognition in games (Leap Motion controller).....	10
2.3	Existence of similar systems .....	11
2.3.1	Skywriting Alphabets.....	11
2.3.2	Balloon Buzz.....	12
2.3.3	Animal Zoo .....	12
2.3.4	Pora ora .....	13
2.3.5	K5 Math .....	14
3	Analysis and design.....	15
3.1	Requirement Specification .....	15
3.1.1	Functional Requirements .....	15
3.1.2	Non-functional requirements .....	16
3.1.3	Hardware Requirements.....	16
3.1.4	Software Requirements.....	17
3.2	System Overview .....	17
3.3	Design Methodology .....	17
3.4	UML diagrams. ....	19
3.4.1	Class diagram.....	19

3.4.2	ER Diagram .....	20
3.4.3	State Diagram.....	21
3.4.4	Sequence Diagrams.....	23
4	Implementation.....	27
4.1	Implementation Technology. ....	27
4.2	System Features.....	28
4.2.1	Teaching Alphabet.....	28
4.2.2	Teaching Numbers.....	28
4.2.3	Teaching shapes.....	29
4.2.4	Teaching colors.....	29
4.2.5	Alphabet activities.....	29
4.2.6	Numbers Activities.....	31
4.2.7	Numbers games.....	32
4.2.8	Colors Activities.....	33
4.2.9	Sounds and graphics.....	33
4.3	How to use a leap motion controller. ....	34
5	Evaluation and testing.....	36
5.1	Integration and Testing.....	36
5.2	Unit Testing.....	36
5.3	Module Testing.....	36
5.4	Integration Testing.....	36
5.5	System Testing.....	37
5.5.1	Sample Test Cases used in the system testing.....	37
5.6	User Acceptance Testing.....	43
5.6.1	Questionnaire: Motion Based Application for Children.....	43
6	Conclusion and future work.....	45
7	references.....	46

## List of Figures

Figure 2.1- Skywriting Alphabet .....	11
Figure 2.2baloon Buzz .....	12
Figure 2.3Animal Zoo.....	12
Figure 2.4 Pora Ora.....	13
Figure 2.5 K5 Math.....	14
Figure 3.1 Leap Motion Controller.....	16
Figure 3.2Iterative Development Approach .....	18
Figure 3.3 Class Diagram .....	19
Figure 3.4 ER diagram.....	20
Figure 3.5 State Diagram .....	21
Figure 3.6State Diagram2 .....	22
Figure 3.7 sequence diagram 1 .....	23
Figure 3.8Sequence diagram resume game .....	23
Figure 3.9 Sequence Diagram Select Level.....	24
Figure 4.1 Unity Logo.....	27
Figure 4.2 Teaching Alphabet.....	28
Figure 4.3Insert Numbers .....	28
Figure 4.4 Teaching Shapes .....	29
Figure 4.5Teaching Colors.....	29
Figure 4.6Alphabet activities .....	30
Figure 4.7Alphabet activities II .....	30
Figure 4.8Crossword Puzzle .....	30
Figure 4.9Numbers Activities.....	31
Figure 4.10-Number Activities II .....	31
Figure 4.11 Number Puzzle .....	32
Figure 4.12 Number Games.....	32
Figure 4.13 Number Games II .....	33
Figure 4.14 Color Mixing .....	33
Figure 4.15-Leap Motion Controller.....	35
Figure 4.16-Leap Motion Control Panel.....	35
Figure 5.1-Test Case 1 .....	37
Figure 5.2 Test Case 2 .....	38
Figure 5.3-Test Case 3 .....	39
Figure 5.4-Test Case 4 .....	40
Figure 5.5-Test Case 5 .....	41
Figure 5.6-Test Case 6 .....	42
Figure 5.7-Hypothesis Data Set .....	44

# Chapter 1

## 1 INTRODUCTION

### 1.1 Background Context

Learning plays a major part and it does have a conservative effect on a child's development. These early interactions that children acquire at school and home directly affect how connections and patterns are made in brain. Early learning experiences are crucial to the future well-being of a child, and to establish the basis for the acquisition of knowledge and skills that will affect their learning and behavior later. Teaching children can be difficult with traditional teaching methods because children tend not to pay much attention to the things they are being taught. Development of the child individually and inability to stay on task focus by hand [1].

Fun and interactive activities that are useful to help increase the attention span of the child. The most important aspect of these activities is to attract the interest of the child first. Susan Pitman, Senior Research has indicated that children's learning process is accelerated by the video games, academic content and problem solving. It will also be helpful for children with learning problems [2].

The system is being developed for children which is to be controlled by the Leap motion controller. Leap Motion controller is a device provide gestural interaction with the computer. It will be all good for the kids to use. The idea is that the user has set up the controller and instead of having to touch the screen or use a mouse Leap motion controller tracks the movement of the hands and uses it to control a PC [3].

This application that has been developed is a gesture controlled e-learning system that interact with a child's basic gesture movement ability that provide them a pleasurable learning environment. This also helps children to improve their hand eye coordination arithmetical and logical skills.



This application is created with 2D animations. It contains number of levels to teach the basic, elementary level things for children. There are two main levels in the application, the basic level and advanced level. At the basic level user can learn the basic thing about letters, numbers, shapes and colors. By using the things one learned from the basic level the advanced level could be carried out. The advanced level will be dynamically created according to the performance of the user's basic level.

## **1.2 Problem Addressed**

Teaching children can be difficult with traditional teaching methods. Kids pay less attention and their inability to stay focus on tasks at hand, working memory, processing speed, long-term memory, visual processing, auditory processing, logical thinking and reasoning which are considered as qualities a child must possess.

The most important question is how to teach children in a way that they will be able to grasp easily. Children are favourable in physical activities more than academic activities. It is the nature of the children. In creating this application, the priority was to deliver the basic knowledge to children using an attractive method which has proven to be accepted by the children.

The application is a motion gesture based interactive learning application for kids between ages 4-5. There are number of challenging problems that has been occurred during the development of the application. First point was to identify the learning difficulties of kids. What are the things that are difficult to teach, why certain things are difficult to teach and how those problems are to be solved. The methods in the applications that are currently available in the market or the web need a reliable internet connection to work with. Also they are designed to be controlled by using a keyboard and a mouse which can be challenging and very hard to control by a child. Most of these application are not free or they are only given out for free for a trial period. This desktop application which is going to be freely available and can be installed in any personal computer and uses a leap motion controller where a child can use their hands to control the game. It is more fun and engaging than using the typical keyboard and mouse.

Early stage educators of children must work to ensure that all children should reach the same standards by the end of third grade. Teachers and parents should support the development progress of each individual child.

The studies prove clearly that the helping children in their pre education is the key to successful education. Since we are in the modern world there are many modern technological devices and electronic equipment that are available in almost all fields. So, as mentioned earlier interaction with children using modern technology devices is better support mechanism to improve the quality and standards of education.

The technology is not a total replacement for the core of quality early education, verbally rich, emotionally supporting interactions between children and adults. But technology can help improve the ability to create these types of interactions, and can help to better align with the rules and adapt them to the needs of children. This is a success. [4]

This application focuses on how to support the education of children to accelerate learning, teaching, training and communication through an effective and interactive learning for children aged three and five years with the help of modern technology.

### **1.3 Aims and Objectives**

The main objective of the project is to develop a flexible, responsive and attractive application to children in our country which helps to enhance their knowledge, attitudes, skills, behaviors and participation. This application guides the children to reach a goal while developing their skills and introducing them to a competitive environment to achieve success.

Under that the sub objectives are.

1. Provide an attractive and enjoyable environment for learning a subject or performing an activity related to it.
2. Raise the level of engagement, focus and performance of the kids by let them learning through a gaming environment.
3. Improve the logical thinking and learning skills.
4. Development of a product that will be capable of enhancing a child's educational level by providing a well-planned and well-structured application.
5. Train the child to maintain a good attention.
6. Educate a child to properly perform a certain task at a certain time.
7. Develop the games to increase concentrate level of a child.

Furthermore kids can improve their,

- Alphabetical knowledge.
- Mathematic knowledge.
- Knowledge about shapes.
- Knowledge about environment.
- Knowledge about the colors.
- Knowledge about Music.

#### **1.4 How the system benefits children**

The system has restructured the existing traditional curriculum in a way that is easy to use and attractive. Improve knowledge and skills of children by providing an attractive, fun and enjoyable gaming based learning environment.

The application contains gaming based learning activities will help to give more attention to learning among students. This will also help children to cope with failures in the entire learning process and provide feedback. The faults might help students who are learning to avoid experiencing anxiety when confronted with failure. Positive feedback failure will lead students to keep trying until you succeed and increase their level of commitment to the task.

#### **Target Audience of the system?**

- Children
- Parents
- Teachers

Parents and teachers use the system to check the child's progress and evaluation that is generated according to the algorithm.

#### **Evaluators of the system?**

- The time for a given task.
- Accuracy of a task.

#### **Main components of the system?**

- Basic level.
- Advanced level.

### **Techniques to get students attraction for learning activities?**

- Gesture controlled Gaming environment is the mainly used technique for the engagement of the kids.
- Attractive and simple graphical interfaces.
- Provide a useful hint to complete a task and tutorials.
- After finish a task user will get a reward that motivate the user.

### **1.5 Evaluation Process of a child**

Parent or teacher can register a child in the system. In fundamental level user can learn basic thing about Letters, Numbers, Shapes and Colors. In advanced level user can do exercises utilizing the things that gained from basic level. The advanced levels of the system will be given utilizing the points of interest got from the basic level. System analyze the users' behavior and change the difficulty level in the advanced level.

### **1.6 Scope**

The “Motion Based Learning App for Children” is an Educational computer game like application for kids. To control the game, system use hand gestures of the user using Leap Motion Controller. The system will be mainly based on desktop application, which contains interactive backgrounds, attractive graphics, child safe colors, images and sounds. In the dynamic mode of this application the game provides the levels, based on the interest levels such as favorite subject and favorite educational areas of a particular user. This application plays a crucial part to improve knowledge of a child. Also improves the attention of a child and logical thinking capabilities. This application also helps to improve general knowledge about the environment.

Throughout this research project, Motion based learning app for children has been developed in a way where a single kid can carry on playing the game and if that child is struggling in a particular level or having a problem with continuing the game, the parent can login and help the child to resolve it. This target is achieved by providing a separate registration and a login for the parents/teachers. The idea of allowing access to parents is, they will be able to get a clear idea of the child's knowledge and he or she can help the kid with the parts that they are struggling with.

The games that are included in this application are based on a lesson plan with an educational background like teaching Alphabet, words ,give out an idea about colors , the knowledge of basic shapes , basic knowledge of mathematics ,Identify the parts of the body, very basic knowledge of music, Lessons about our world and environment ,teach about the weather ,basic feelings and emotions , directions ,family and so on.

The application is created with 2D animated gaming modules. These games are created in a level up manner, during these levels the scale of factors is increased step by step. Firstly, a profile is created for each kid, the score a particular kid gets by playing each level is saved to the profile with the factors like whether the kid has reached the expected margin, if yes the how much time the kid spent to achieve the expected margin of each level, how many attempts did it take the kid to reach the expected margin are saved into the profile as well, Using the details saved in the profile each kid is analyzed. During this analysis the major task is to identify whether this kid has performed enough to the expected level of a typical kid in that same age category, again these details are recorded to their corresponding profiles. During this analysis the interest areas of kids, the subjects kids like most, the areas kids perform well, the areas kids does not perform well are recorded to keep track of the progress of each session.

## **1.7 Related Projects**

### **Fun Brain Website (<https://www.funbrain.com/>)**

This web site helps the child in different areas of learning. There are 25 arcade style math games to increase knowledge in math area. “Web books and Mad Libs” help the child to improve their reading skills.

A Child who may be struggling with a given subject at school can go through a number of games that helps to enhance the curiosity in children, which encourages them to learn, and to enjoy themselves while they do so. Certain activities in this site are reserved for child and parents to work together.

This web site also provides an entertainment center for kids to relax in between lesson while providing the parents valuable information on children and first-day preschool jitters, learning skills, relationships, behavior, discipline, development, and so on.

### **Zoodles**

Zoodle s ([www.zoodles.com](http://www.zoodles.com)) is committed to building the best educational experience for kids online, across smartphones, tablets, and computers worldwide. Recently acquired by famous HTC mobile company, they are a small, kid friendly team with enormous impact, already supporting over 6 million kids, and looking forward to expanding internationally.

### **Limitations of the Existing Systems**

There are number of educational computer games/programs for kids, which offer them an opportunity to indulge in various activities related to mathematics, arts, music, language, and many other skills. But many programs require access to the internet and a child has to handle computer resources by himself. To access the materials which are available on websites, children should have the privilege to access the Internet. To get hold of the educational software, the child must have the knowledge to use the computer keyboard and operate the mouse. It is not easy for a kid to perform all these activities alone unless an adult is present. Children of age 4,5 likes more aesthetically pleasing contents and tends to interact more with tangible objects rather than using just a software with mouse/keyboard. Consider that, this project focus on implementing an educational tool for children between ages 4, 5 using Leap motion controller.

## **1.8 Thesis Structure**

Section two will further describe the concepts such as, the effect of the computer based video games on children. How game based applications could be used in educating children. A detailed description of the leap motion controller which is the device that has been used in developing the application, is also available in the section two. The following section two fully describes what the technology behind the leap motion controller is and how it would be beneficial in developing applications. Furthermore, section two has a critical review of the similar systems which helped me a lot during building this application.

Chapter three includes the analysis and the design specification of the application such as requirement specification, functional and the nonfunctional requirements of this application. This chapter also includes the UML diagrams of the application such as Use Case diagram, Class diagram, and Sequence diagram. Finally the details about the design methodology used in this application is describe here.

Chapter four will describe about the implementation of the application. This chapter includes the details about the technologies used to develop the application such as the languages, platform and the framefork.This chapter also includes some of the interfaces.

Chapter five of the thesis describes the evaluation and testing process. This chapter is very important because it includes an interpretation of the data that hass been gathered from the questionnaire which is distributed among the children. Test plan and some of the test cases which is produced for the application also displayed here. Finally Chapter six concludes the thesis and describes lessons learned and the future works.

## Chapter 2

### 2 LITERATURE REVIEW

Child development emerged as a new concept in the 20th century. Children with lack of attention and stay on task, working memory, processing speed, long-term memory, visual processing, auditory processing and logical thinking and reasoning are seen as the main characteristics of children. The inability to stay on task in a sustained manner, less selective or divided attention. Difficulty staying focused and paying attention, difficulty controlling behavior, and hyperactivity occur (excessive activity) and symptoms [5] of this disorder.

Providing fun activities that allow the child to focus on for a long period of time, it is important to increase the attention span of a child. [6] Fun activities that are useful to help increase attention span of the child. The most important aspect of these activities is to get the interest of the child first. Susan Pitman, senior officer of research has indicated that the learning process is accelerated by children video games related information, academic content and problem solving. It will also be useful for children who suffer from learning problems [7]

#### 2.1 Effect of Computer-Based Video Games on Children

The use of multimedia in education has significantly changed people's learning processes. Results from a number of research studies indicate that appropriately designed multimedia instruction enhances students' learning performance in science, mathematics, and literacy [8]. Previous studies indicate that computer-assisted instruction (CAI) programs have important factors that can motivate, challenge, increase curiosity and control, and promote fantasy in children [9]. Despite the fact that computer and video games have the same multimedia capability as CAI programs, their potential learning impact is often discounted by parents and educators. Recently, computer-based video games' presence and popularity have been ever-growing, and game developers and researchers have started to investigate video games' impact on students' cognitive learning [10]. For example, Pillay commenced a study investigating the influence of recreational computer games on children's subsequent performance on instructional tasks [11].

Research results from the Kaiser Family Foundation and the Children's Digital Media Centers [12] found that children in the United States are growing up with media and are spending several hours a day watching television and videos, using computers, and playing video games. According to



the findings, today's children are starting to be exposed to technologies and media at a much younger age than previously thought. Therefore, educators' investigations has become critical concerning the impact of technologies and media on children's development.

Most previous research studies related to computer-based video games focused on the discussions of psychological study and child behavior [13]. In psychological study, research results indicated that video games can promote hand-eye coordination, visual scanning, auditory discrimination, and spatial skills [14] [15].

## **2.2 Gesture recognition in games (Leap Motion controller)**

Vision-based hand gesture recognition serves as a promising alternative to them because of its potential to provide more natural, unencumbered, non-contact interaction. However, despite lots of previous work [16], [17], [18], traditional vision-based hand gesture recognition methods are still far from satisfactory for real-life applications. Because of the limitations of the optical sensors, the quality of the captured images is sensitive to lighting conditions and cluttered backgrounds, thus it is usually not able to detect and track the hands robustly, which largely affects the performance of hand gesture recognition. Recently, [19] presented a novel dissimilarity distance metric, Finger-Earth Mover's Distance (FEMD), for hand gesture recognition approach using Kinect depth sensor, which performs accurately, efficiently and robustly on a 10-gesture dataset. FEMD metric is specifically designed for hand shapes. It considers each finger as a cluster and penalizes unmatched fingers. Finger-Earth Mover's Distance based hand gesture recognition system with traditional corresponding based matching algorithm, Shape Context. And built several Human-Computer-Interactions (HCI) applications on top of this novel hand gesture recognition system and demonstrate its potential in other real-life HCI applications.

The Leap Motion controller introduces a new gesture and position tracking system with sub-millimeter accuracy. In contrast to standard multi-touch solutions, this above-surface sensor is discussed for use in realistic stereo 3D interaction systems [20], especially concerning direct selection of stereoscopically displayed objects [21].

The Leap Motion controller is a small USB peripheral device which is designed to be placed on a physical desktop, facing upward. Using two monochromatic IR cameras and three infrared LEDs, the device observes a roughly hemispherical area, to a distance of about 1 meter (3 feet). The LEDs

generate a 3D pattern of dots of IR light and the cameras generate almost 300 frames per second of reflected data, which is then sent through a USB cable to the host computer, where it is analyzed by the Leap Motion controller software using "complex math" in a way that has not been disclosed by the company, in some way synthesizing 3D position data by comparing the 2D frames generated by the two cameras [22].

## **2.3 Existence of similar systems**

### **2.3.1 Skywriting Alphabets**

[23] This game provides a child with a way to visually associate their physical movements in an entertaining game, using the story of a baby alien, Kaju.

The Leap Motion Controller can track fingers, or kids can use hold a pencil in their hands to draw letters on the screen. Grab hold of Kaju and drop him on the cloud of your choice to navigate through the 4 main gameplay options.



*Figure 2.1- Skywriting Alphabet*

Practice Mode lets child to practice infinitely with random letters at their own pace. Time Trial Mode puts child under the clock, and measures how quickly they can draw in 60 seconds. The Scrapbook lets child visualize his/her progress with each letter - As child progresses, the colors also come back in the book. Swipe left or right to go through the scrapbook. The Video Mode lets child to watch the carefully crafted story again and again.

### 2.3.2 Balloon Buzz

[24] Control Buzz the Bee with hand, popping as many balloons as possible. Rack up the points!



Figure 2.2baloon Buzz

Balloon Buzz is a great introductory app for learning how to use the Leap Motion Controller, especially for small children. Many tiny tots who have a hard time using a mouse will have no problems controlling Buzz the Bee with their hands in this game. Balloon Buzz is the perfect combination of colorful graphics, happy music, and fun game play.

### 2.3.3 Animal Zoo

[25] It's as easy to use as putting your hand out and grabbing! Great opportunity for kids to learn more about their favourite barnyard animals while improving their hand eye coordination.

Help Little Ones Learn their Favorite Animal Sounds.



Figure 2.3Animal Zoo

### 2.3.4 Pora ora

[26] Pora Ora has been developed by Caped Koala Studios; a social-networking, immersive-learning and entertainment company with a passion for creativity in education. They are committed to developing a love of learning in young children; encouraging them to be creative, imaginative, inquisitive and social.

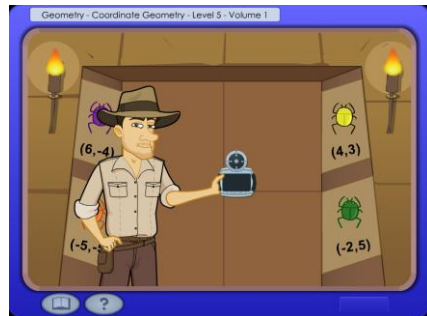
In Pora Ora, they created an engaging world for children in the primary school age range (5 - 13), which presents educational content in a compelling and immersive way. Constructed a fun, social and safe 3D environment where children are rewarded for participating in educational mini-games and quests. Rewards take the form of in-game currency which allows children to customize their avatar, buy food for their Pora Pal, decorate their home and garden, buy gifts to send to their friends and much more.



Figure 2.4 Pora Ora

### 2.3.5 K5 Math

[27] An award-winning online math program for kids. K5 Math will help children to gain skills and confidence in elementary school math. K5 Math is a comprehensive award-winning online math curriculum which has been used by thousands of kids. The program includes over 1,200 research-based online math lessons and activities.



*Figure 2.5 K5 Math*

## Chapter 3

### 3 ANALYSIS AND DESIGN

#### 3.1 Requirement Specification

##### 3.1.1 Functional Requirements

- When a user move hand over the leap motion controller a pointer should be appear on screen.
- The progress of each child must be recorded.
- Leap motion controller pointer should allow the child to move hands freely (Without blocking on screen).
- Instructions should be read out lot to the child.
- Available moves should be illuminated to the user.
- Child Should be able to start a new game at any time.
- Ability to load previous score statics.
- Correct answer should be illuminated when a child select correct choice.
- Wrong answer should be illuminated when a child select wrong choice.
- Application should have a proper navigational system.
- Application should redirect to the next level when a child complete the current level.
- The child should be able to quit game anytime.
- When a child select correct choice a bell sound will be played.
- When a child select wrong choice buzzer sound will be played.
- Child has a freedom to select any educational category they like.

### 3.1.2 Non-functional requirements

- The application should not have a loading time more than 15 seconds.
- The application must not lag or freeze.
- The child must be able to interact with the application using a leap motion controller.
- Audio files should be in a format that supports every platform.
- Child safe colors must be used in creating animations.
- Application must have attractive user interfaces.
- The maximum number of touches for any action in the application should not exceed five.
- The minimum frame rate must be twenty frames per second.

### 3.1.3 Hardware Requirements.

- At least 2GB of RAM.
- At least 512 Mb Graphics card.
- Graphic card should use 256 colors.
- A leap Motion Controller



*Figure 3.1 Leap Motion Controller*

### **3.1.4 Software Requirements**

- Windows 7 or above version of windows.
- Mac OS.
- Linux OS.

## **3.2 System Overview**

Parent or teacher can register a child in the system. In basic level user can learn basic thing about Letters, Numbers, Shapes and Colors. In advanced level user can do activities using the things that learned from basic level. The advanced levels of the game will be provided using the details *grabbed* from the basic level. System analyze the users' behavior and change the difficulty level in the advanced level.

Once completing one activity on given time successfully, the child will receive points. The idea of giving points is to motivate the child towards the application for solving the next problem. Once the child is solved a problem he/ she can hear a clap or a laughing voice or some motivation voice. All these activities are going on an attractive, graphical interface. This will engage the child more towards the application and that will increase the curiosity of the child. The curiosity will be guided the child to the next level.

Child can control the game using Leap motion controller. Kids in age 4, 5 hard to use keyboard and mouse. And they like to do some activities that involves some physical movements. So using leap motion controller they can use only their own hands to control the game.

## **3.3 Design Methodology**

The very first main task to beginning of the development of software is selecting the most suitable methodology or the development model to the software. There are some specific tasks to perform, for the success of the entire project depends on this development methodology. Advantages of selecting a suitable methodology are to make the development process easier to the developers and to improve the quality of the final product. Final result of this process is making a perfect final product easily.



Iterative Software Development Approach [28] is the development model that has been chosen to implement the application.

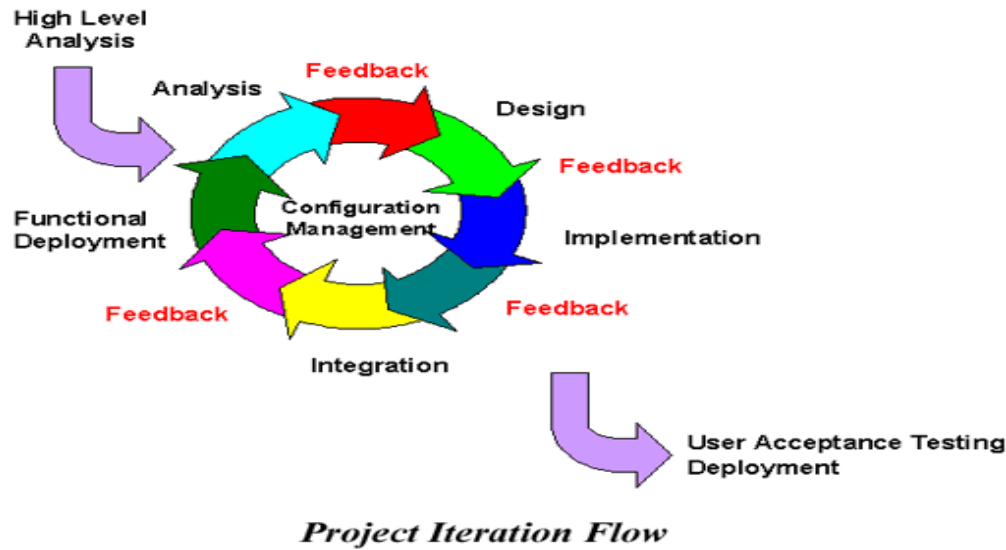


Figure 3.2 Iterative Development Approach

### Information Gathering

To develop a highly user friendly and attractive gaming environment, it is essential to know the necessary things for the system. It is important to identify what are the problems regarding the existing applications and how they tried to solve the issues mentioned above.

### 3.4 UML diagrams.

#### 3.4.1 Class diagram

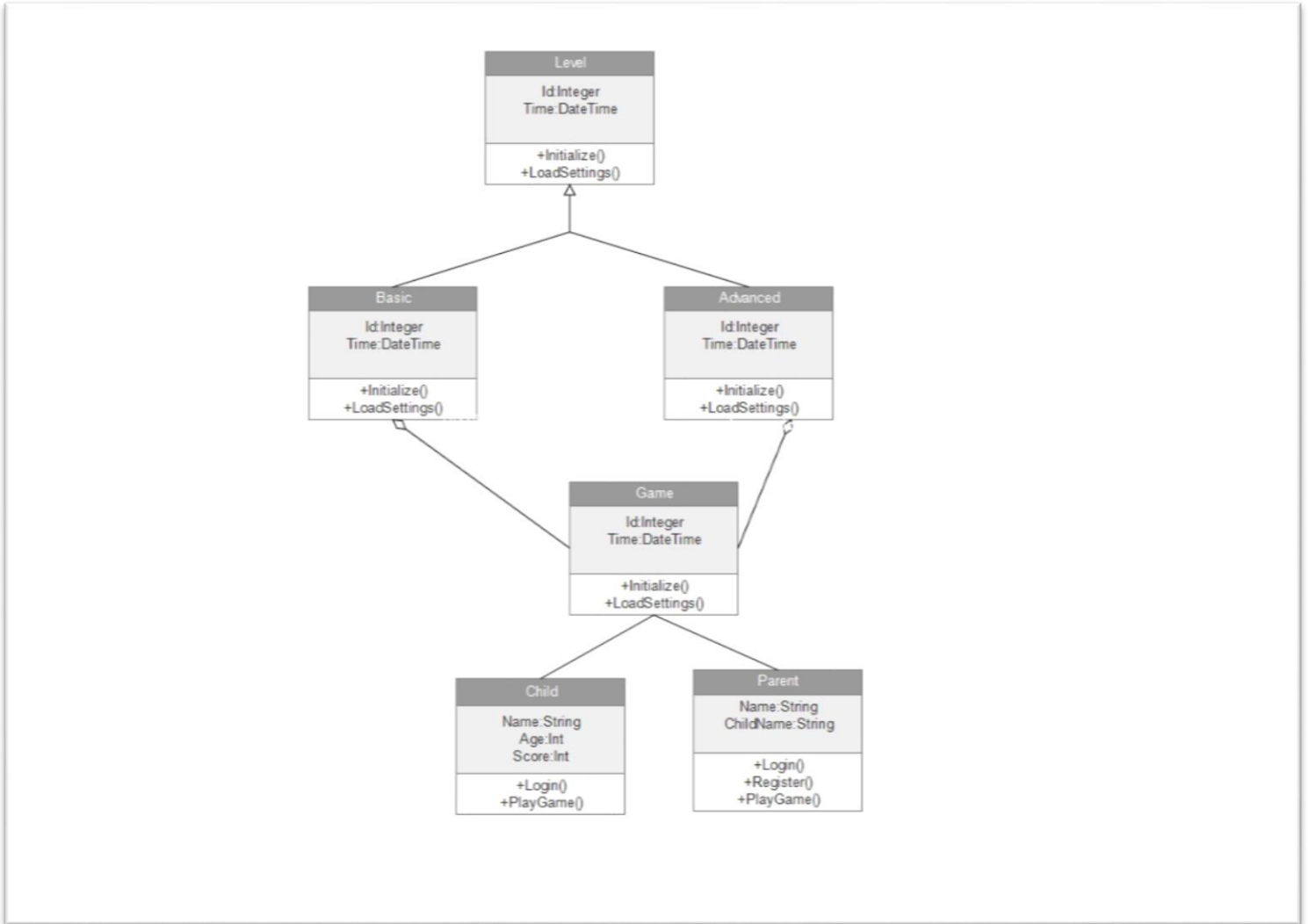


Figure 3.3 Class Diagram

3.4.2 ER Diagram

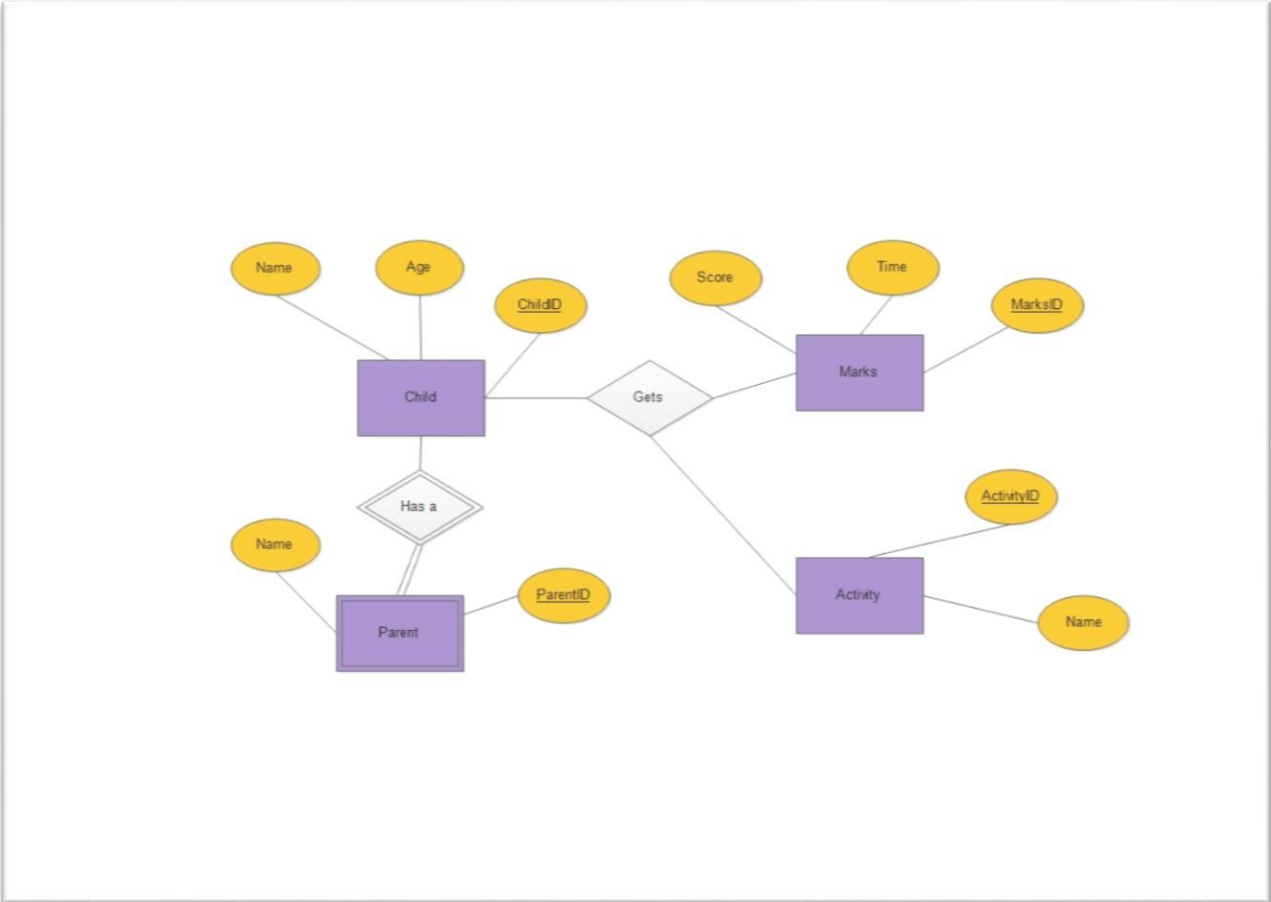


Figure 3.4 ER diagram

### 3.4.3 State Diagram

From Level Select, Level Complete, and In Game Menus in Play Level

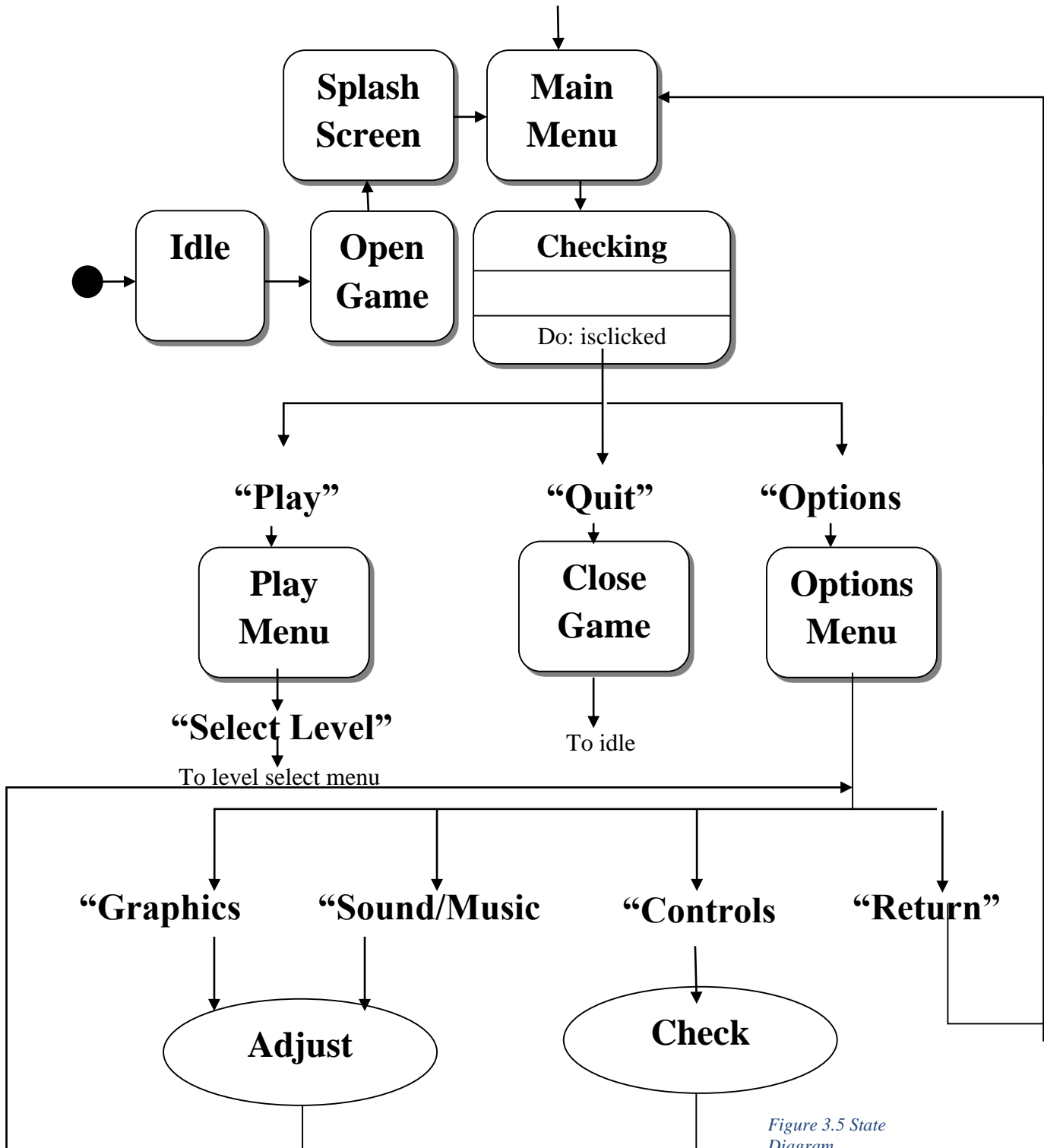


Figure 3.5 State Diagram

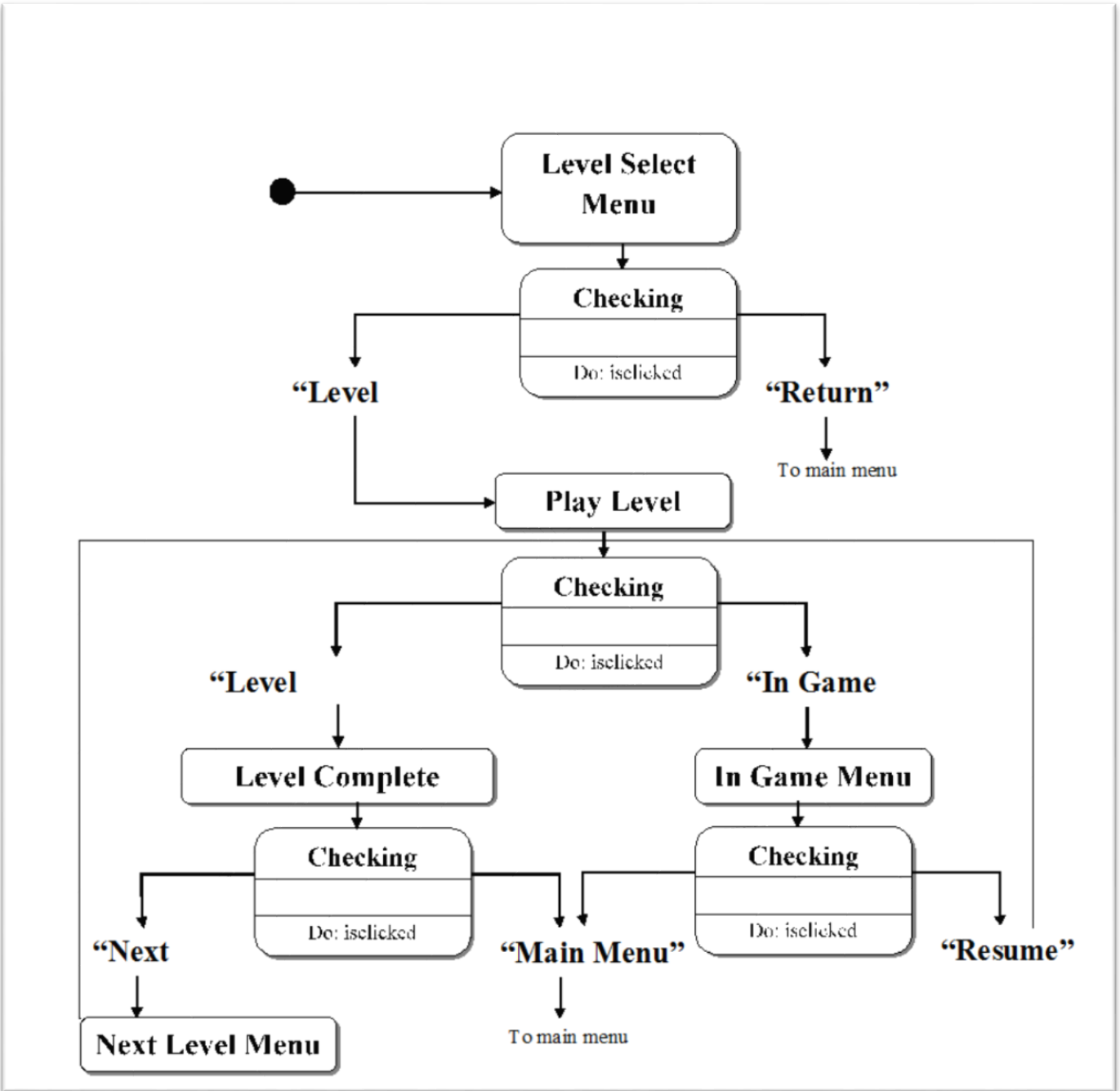


Figure 3.6 State Diagram2

### 3.4.4 Sequence Diagrams

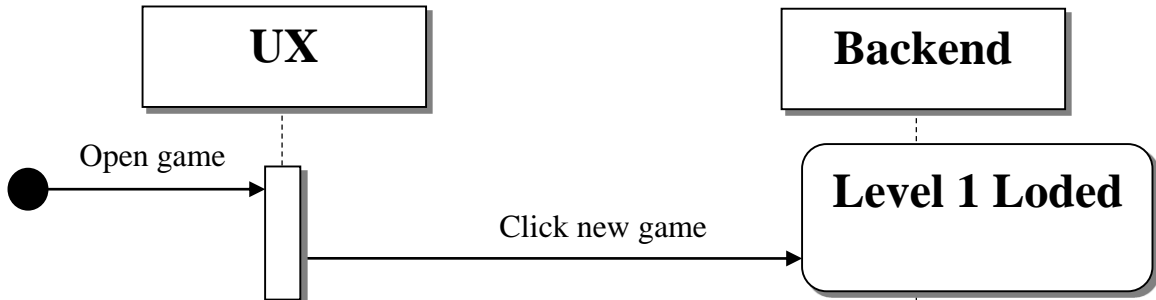


Figure 3.7 sequence diagram 1

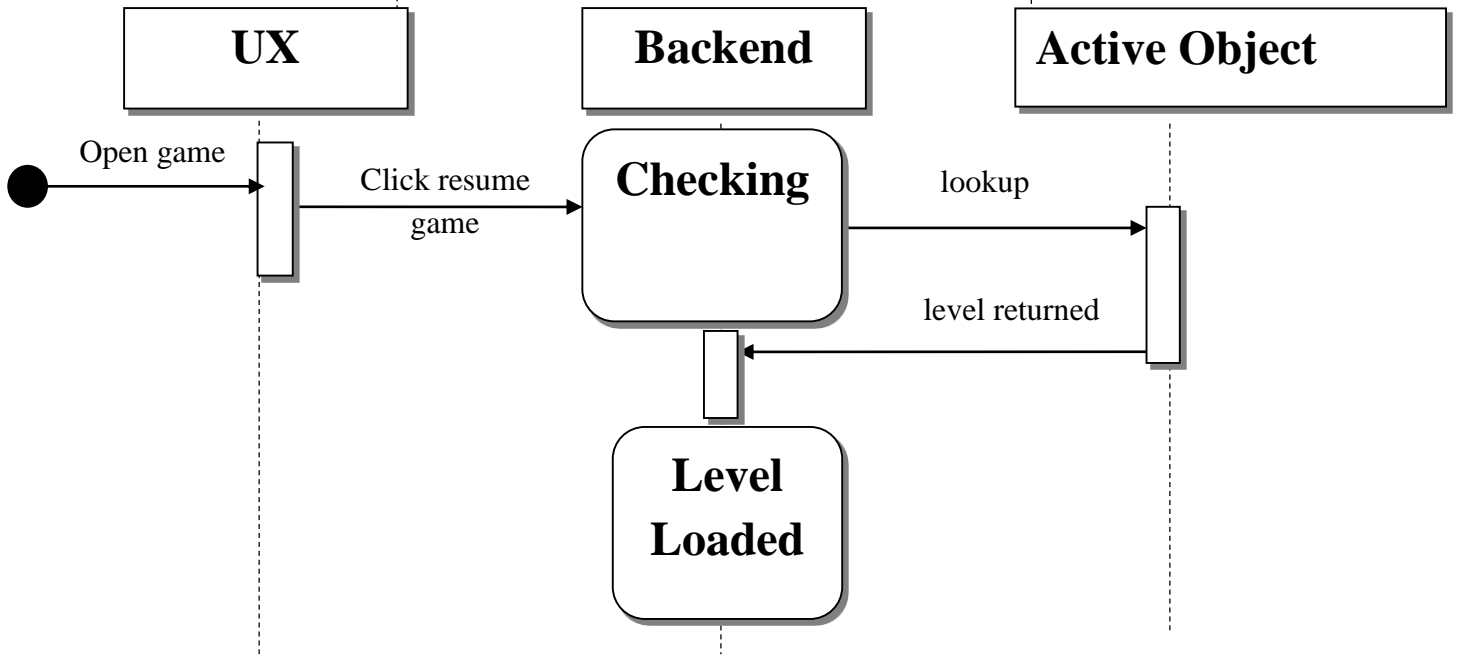


Figure 3.8Sequence diagram resume game

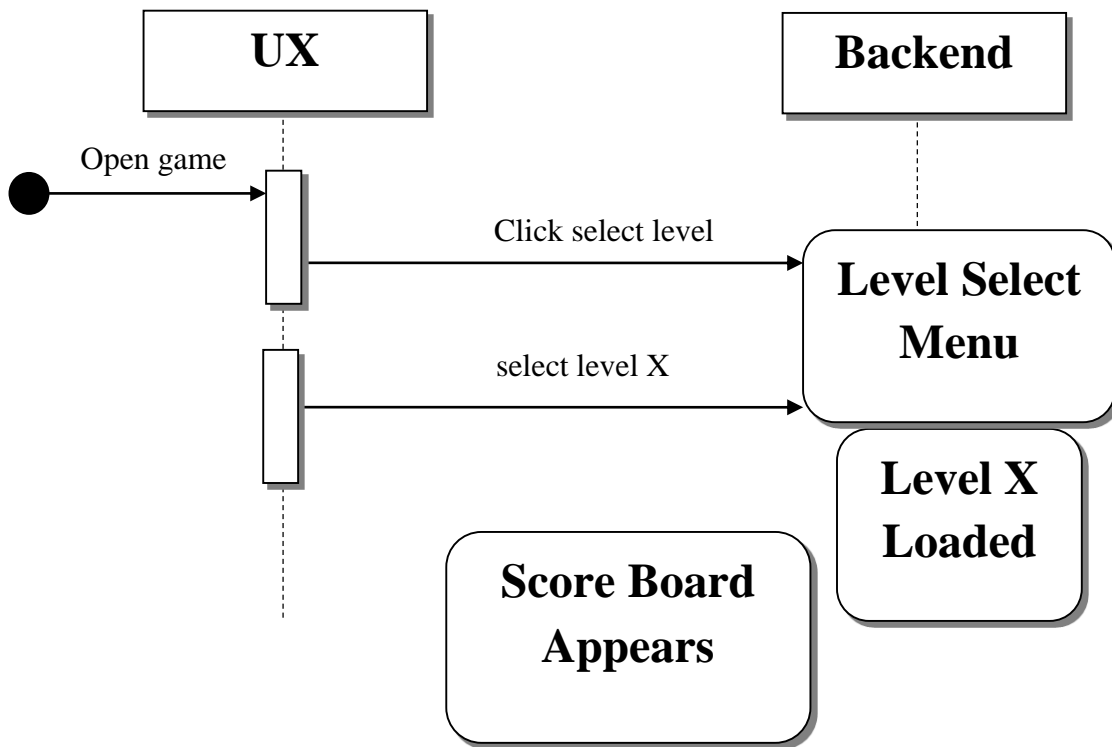


Figure 3.9  
Sequence Diagram  
Select Level

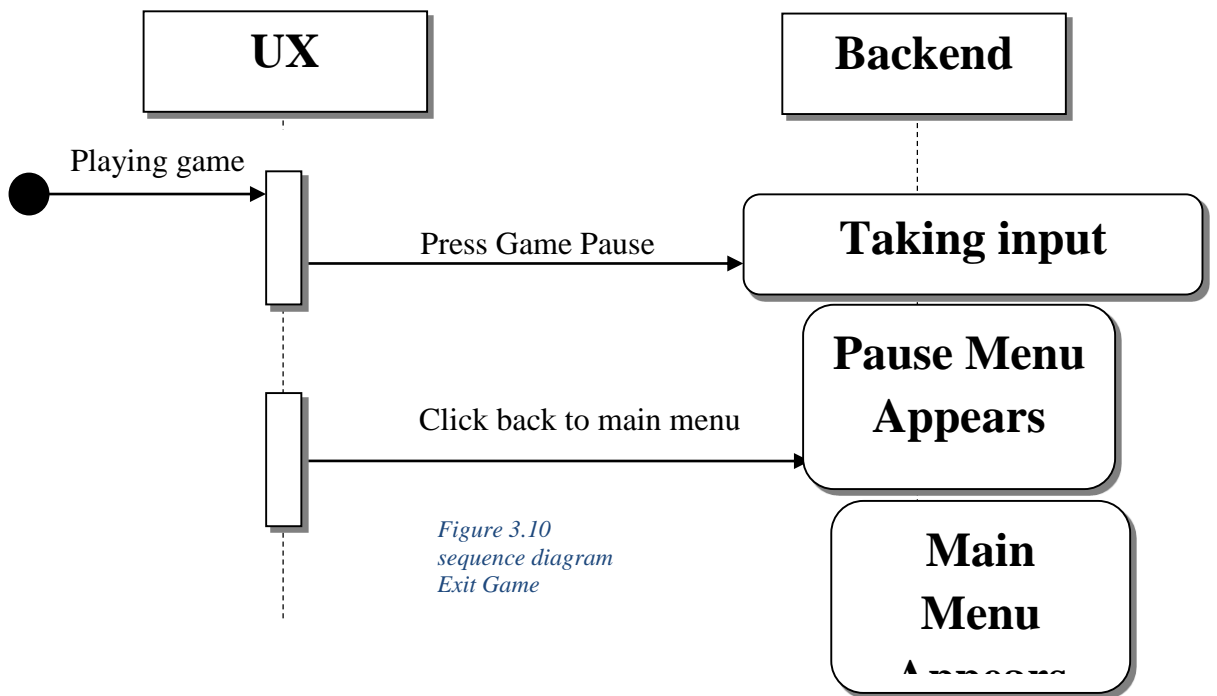


Figure 3.10  
sequence diagram  
Exit Game

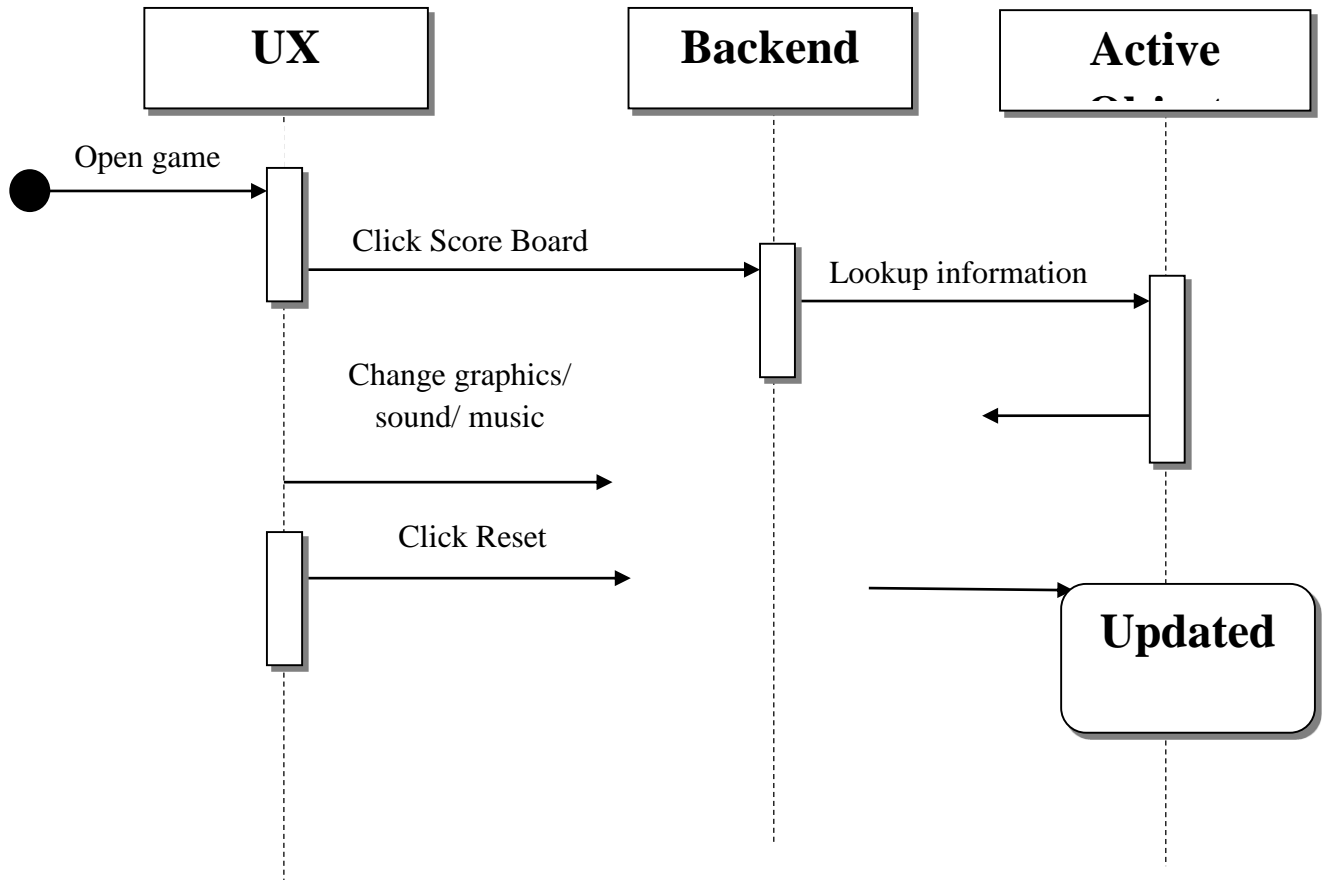


Figure 3.11  
Sequence diagram  
view and update  
scores



**Analysis**

The gathered data has analyzed carefully to identify the latest technologies, best practices and the best methodologies that can be used for application development.

**Design**

After analyzing the data and identifying the best methods for the application development the most suitable design in order to make the further work tasks much more easily.

## Chapter 4

### 4 IMPLEMENTATION

#### 4.1 Implementation Technology.

For developing this application unity 3D has been used as the main IDE(Integrated Development Environment). Unity is a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites. First announced only for OS X, at Apple's Worldwide Developers Conference in 2005, it has since been extended to target 27 platforms. Nintendo provides free licenses of Unity 5 to all licensed Nintendo Developers along with their software development kits (SDKs) for the Wii U and Nintendo 3DS Family. Unity 3d also supports c# scripts, JavaScript and native visual studio integration.

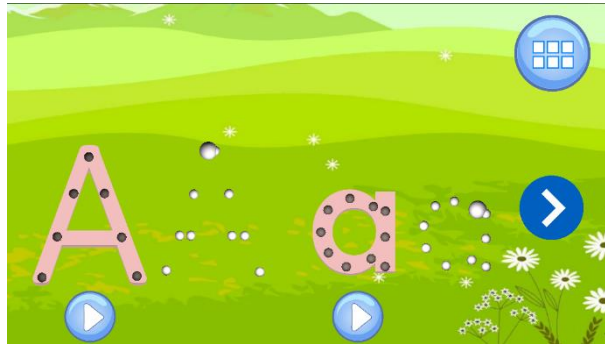


*Figure 4.1 Unity Logo*

## 4.2 System Features

### 4.2.1 Teaching Alphabet

When the scene load user can hear the voice instructions. User can see how to write a letter and then he write the letter completing dotted lines. After user write the letter he can hear a wining music and system give a reward to the user. Then user can go to write next letter.



*Figure 4.2 Teaching Alphabet*

### 4.2.2 Teaching Numbers

User can hear the voice instructions and user have to use swipe gesture. The fish in the water go to each number and say the number. When fish go to a number in the middle user can see large image of the number. User can learn numbers 0 to 10.



*Figure 4.3 Insert Numbers*

### 4.2.3 Teaching shapes

When the scene load user can hear the voice instructions. User have to drag and drop correct shape from the bottom to cover the hole in the middle.

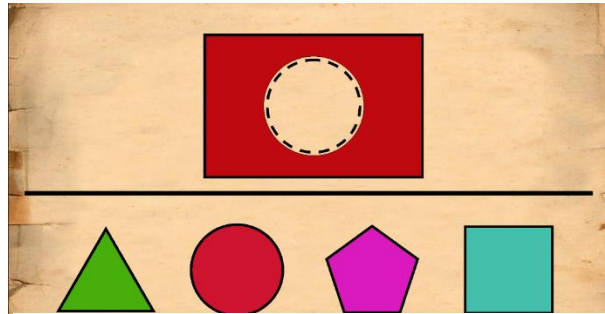


Figure 4.4 Teaching Shapes

### 4.2.4 Teaching colors

User can hear the voice instructions and user have to use swipe gesture to see the color.

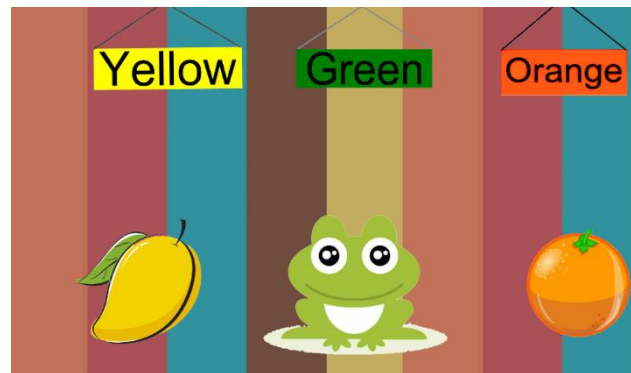


Figure 4.5 Teaching Colors

### 4.2.5 Alphabet activities

When scene start user can see moving object and name of that object moving in to the scene letter by letter. And user also can hear the voice how to spell a letter and a whole word. After complete the word user can go to the next scene clicking next button.



Figure 4.6 Alphabet activities

When user click next button on previous scene (Figure 3.6) below scene will be loaded. In here user can see the word learned from previous scene and user have to drag and drop letters in to empty boxes to make the word.

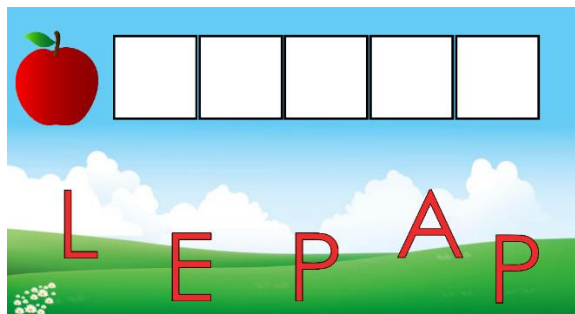


Figure 4.7 Alphabet activities II

This is another activity (Figure 3.8) for kids to practice words. This is a crossword puzzle. In this scene user can drag and drop letters to make a word in the puzzle. When user done making a word he can hear that word.

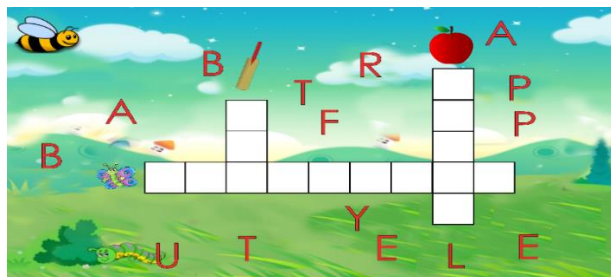


Figure 4.8 Crossword Puzzle

#### 4.2.6 Numbers Activities

In this level user can see number on the screen. Then user needs to show fingers according to the number. In this activity user can learn numbers 1 to 10.

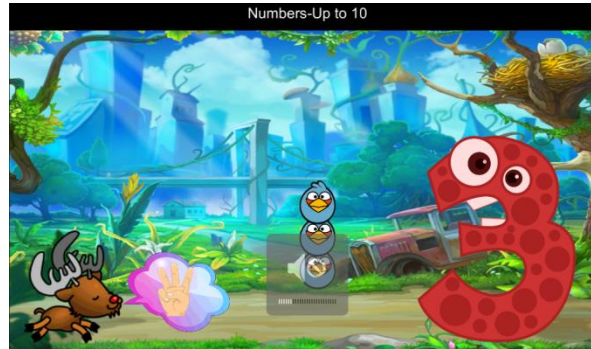


Figure 4.9 Numbers Activities

In this part user can learn addition and subtraction. User can give input using fingers. Then system automatically shows the answer.

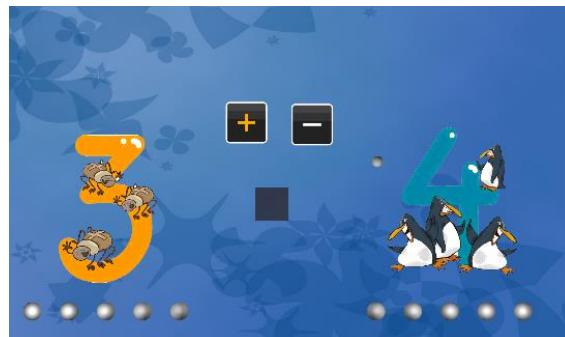


Figure 4.10-Number Activities II

#### 4.2.7 Numbers games

In this part system provide some games to use to learning numbers. Puzzle games and shooting games available on this system.



Figure 4.11 Number Puzzle



Figure 4.12 Number Games

#### 4.2.8 Colors Activities

In this level user can see color on the screen. Then user needs to select correct picture using click gesture. In this activity user can learn different colors.



Figure 4.13 Number Games II

#### Color mixing

In this level user can see color on the screen. Then user can select colors and user can create new colors using color mixing. In this activity user need to use pinch gesture to learn color mix.

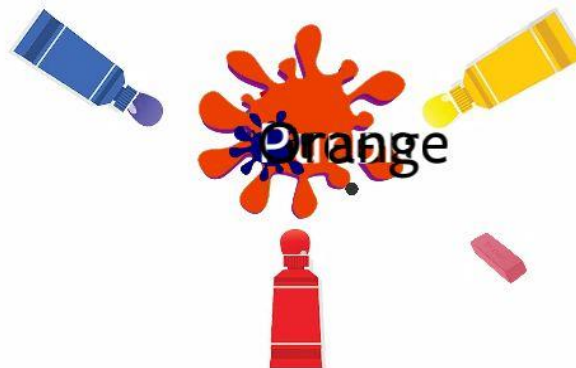


Figure 4.14 Color Mixing

#### 4.2.9 Sounds and graphics

When consider about the sound of the system all the sounds are presented in a manner that matches to the working environment and the activities of the system. Background music uses to keep the interaction on of the system. Special sound clips are used to encourage the kid, when the successful completion is done for an activities.



All the graphical interfaces are created in a manner of keeping the interaction of the kids. Sharpe colors, kid's friendly images are used to keep the interaction. For creating these stuffs the software like photo shop, coral draw are used.

### **4.3 How to use a leap motion controller.**

For almost every task achieved using a computer we are used to do it with the good old mouse and keyboard. But the leap motion is a very advanced and user friendly device which changes the ways of navigation and operating computer applications. But there are number of things to be considered when using a leap motion controller.

#### **1. Placement**

When placing a leap motion controller it can be put anywhere in front of the screen. But as many of the developers' advice the most ergonomic place to put it is the in front of the screen, to be center of the screen.

#### **2. Keep the interface smudge free**

Underneath the leap motion controller lie two cameras and an infrared sensor dust and smudges could block the functionality of these cameras and sensors. The smudges and dust could be removed simply wiping off with a delicate piece of cloth.

### 3. Optimize the leap motion Controller.

Leap motion controller comes with a software that allows to calibrate it using different set of settings. Before using the leap controller with any application it is highly recommended to calibrate and optimize the device. The calibration part is using the track ball and changing the interaction height as shown by the following picture.



Figure 4.15-Leap Motion Controller

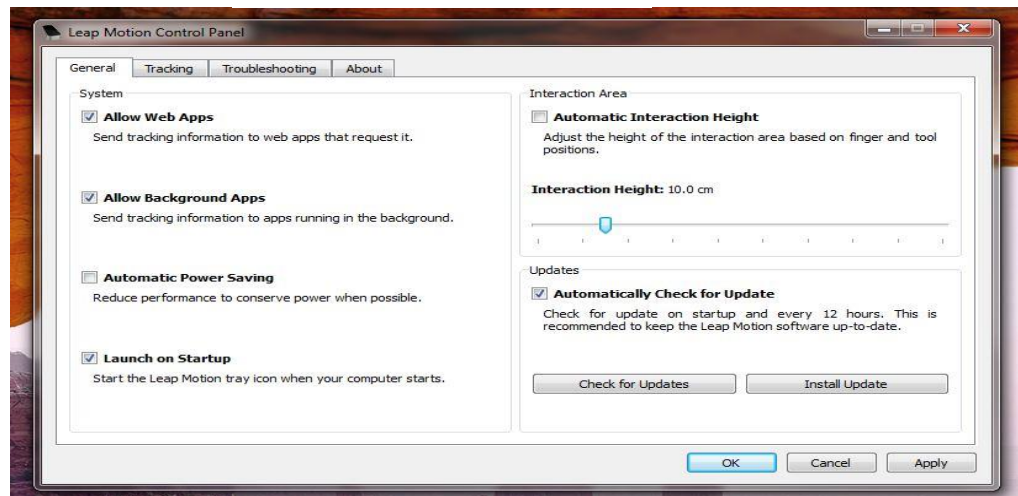


Figure 4.16-Leap Motion Control Panel

## **Chapter 5**

### **5 EVALUATION AND TESTING**

#### **5.1 Integration and Testing**

Testing phase is to happen throughout the application development starting from the requirements gathering and analysis phases themselves. The key to successful testing according to the development methodology that's being used is to complete all testing concept conceiving and test framework design before the implementation phase is over. Testing has conducted as mentioned in the implementation phase to ensure that the implementation is always in line with the requirements specification. Unit testing, Module testing, Integration testing, and System testing has done to be done. The User Acceptance is to be done by a target group of children.

#### **5.2 Unit Testing**

Unit testing is a method by which individual units of source code are tested to determine if they are fit for use. A unit is the smallest testable part of an application.

#### **5.3 Module Testing**

In Module testing, each class, file, module or component is tested.

#### **5.4 Integration Testing**

Integration testing is the phase in software testing in which individual software modules are combined and tested as a group. It occurs after module testing and before validation testing. Integration testing takes as its input modules that have been unit tested, groups them in larger aggregates, applies tests defined in an integration plan to those aggregates, and delivers as its output the integrated system ready for system testing

## 5.5 System Testing

System testing of software or hardware is testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. System testing falls within the scope of black box testing, and as such, should require no knowledge of the inner design of the code or logic.

### 5.5.1 Sample Test Cases used in the system testing

<b>Test Case ID</b>	T11	<b>Test Case Description</b> Testing the Leap Motion Functionality				
<b>Created By</b>	Gayan	<b>Reviewed By</b>			<b>Version</b>	
<b>QA Tester's Log</b>						
<b>Tester's Name</b>		<b>Date Tested</b>			<b>Test Case</b>	<b>Pass</b>
<b>S #</b>	<b>Prerequisites:</b>		<b>S #</b>	<b>Test Data Requirement</b>		
1	LeapMotion Shoule be Plugeed in		1	Show 1 finger to Leap Motion		
2	Leap Service Should be running		2	Show 2 fingers to Leap Motion		
3	Leap Vizulizer platform running		3	Show 5 fingers to leap Motion		
4			4	Show 10 fingers to leap Motion		
<b>Test Conditions</b>						
<b>Step #</b>	<b>Step Details</b>	<b>Expected Results</b>	<b>Actual Results</b>		<b>Pass / Fail / Not executed / Suspended</b>	
1	Place hand above Leap Motion Controller	Leap Visualizer display the scanned object of hand	As Expected		Pass	
2	Show 1 finger to Leap Motion	Leap Visualizer display the scanned object of 1 finger	As Expected		Pass	
3	Show 2 finger to Leap Motion	Leap Visualizer display the scanned object of 2 fingers	As Expected		Pass	
4	Show 5 finger to Leap Motion	Leap Visualizer display the scanned object of 5 fingers	As Expected		Pass	

Figure 5.1-Test Case 1

<b>Test Case ID</b>	T17	<b>Test Case Description</b> Game objects Collison				
<b>Created By</b>	Gayan	<b>Reviewed By</b>			<b>Version</b>	
<b>QA Tester's Log</b>						
<b>Tester's Name</b>		<b>Date Tested</b>		<b>Test Case</b>		<b>Fail</b>
<b>S #</b>	<b>Prerequisites:</b>	<b>S #</b>	<b>Test Data Requirement</b>			
1	LeapMotion Shoule be Plugeed in	1	game object 1 with a collider			
2	Leap Service Should be running	2	game object 2 with a collider			
3	Unity IDE should be open	3				
4		4				
<b>Test Conditions</b>						
<b>Step #</b>	<b>Step Details</b>	<b>Expected Results</b>	<b>Actual Results</b>		<b>Pass / Fail / Not executed / Suspended</b>	
1	Move game object 1 left to right	Game object 1 moves from left to right	As Expected		Pass	
2	Move game object 2 right to left	Game object 2 moves from right to left	As Expected		Pass	
3	let the object one and two crash with each other	Two objects Collide with each other	Objects overlaps with eah other		Fail	

Figure 5.2 Test Case 2

Test Case ID	T24	Test Case Description Identify Colors			
Created By	Gayan	Reviewed By	Version		
<u>QA Tester's Log</u>					
Tester's Name		Date Tested		Test Case	Pass
S #	Prerequisites:		S #	Test Data Requirement	
1	LeapMotion Shoule be Plugeed in		1	color red	
2	Leap Service Should be running		2	color green	
3	Unity IDE should be open		3		
4	Application running		4		
<u>Test Conditions</u>					
Step #	Step Details	Expected Results	Actual Results	Pass / Fail / Not executed / Suspended	
1	Move your hand over leap motion and cary the pointer to uestion icon	Pointer pointed to question icon	As Expected	Pass	
2	Voice command will produced and say select the corect color	Voice command produced select color red	As Expected	Pass	
3	select the color red	prompt successfull Message	As Expected	Pass	
4	select the color green	promptError Message	As Expected	Pass	

Figure 5.3-Test Case 3

Test Case ID	T45	Test Case Description Identify Shapes				
Created By	Gayan	Reviewed By			Version	
<u>QA Tester's Log</u>						
Tester's Name		Date Tested		Test Case		Pass
S #	Prerequisites:	S #	Test Data Requirement			
1	LeapMotion Shoule be Plugeed in	1	Shape circule			
2	Leap Service Should be running	2	color triangle			
3	Unity IDE should be open	3				
4	Application running	4				
<u>Test Conditions</u>						
Step #	Step Details	Expected Results	Actual Results	Pass / Fail / Not executed / Suspended		
1	Move your hand over leap motion and cary the pointer to uestion icon	Pointer pointed to question icon	As Expected	Pass		
2	Voice command will produced and say select the corect shape	Voice command produced select circle	As Expected	Pass		
3	select the shape circule	prompot successfull Message	As Expected	Pass		
4	select the Shape Triangle	prompotError Message	As Expected	Pass		

Figure 5.4-Test Case 4

Test Case ID	T35	Test Case Description					Make Words
Created By	Gayana	Reviewed By			Version		
<u>QA Tester's Log</u>							
Tester's Name		Date Tested			Test Case		Pass
S #	Prerequisites:	S #	Test Data Requirement				
1	LeapMotion Shoule be Plugeed in	1	Letters P A P E L				
2	Leap Service Should be running	2					
3	Unity IDE should be open	3					
4	Application running	4					
<u>Test Conditions</u>							
Step #	Step Details	Expected Results	Actual Results	Pass / Fail / Not executed / Suspended			
1	Move your hand over leap motion and cary the pointer to uestion icon	Pointer pointed to question icon	As Expected	Pass			
2	Voice command will produced and say select spell the word apple	Five text box will appear	As Expected	Pass			
3	Drag the letters to text box in a way it spells APPLE	prompt successfull Message	As Expected	Pass			
4	Drag the letters to text box in a way it spells PAPEL	promptError Message	As Expected	Pass			

Figure 5.5-Test Case 5



Test Case ID	T54	Test Case Description Mix Colours				
Created By	Gayan	Reviewed By			Version	
<u>QA Tester's Log</u>						
Tester's Name		Date Tested		Test Case		Pass
S #	Prerequisites:		S #	Test Data Requirement		
1	LeapMotion Shoule be Plugeed in		1	Color Yellow,Blue, Red		
2	Leap Service Should be running		2			
3	Unity IDE should be open		3			
4	Application running		4			
<u>Test Conditions</u>						
Step #	Step Details	Expected Results	Actual Results	Pass / Fail / Not executed / Suspended		
1	Move your hand over leap motion and cary the pointer to uestion icon	Pointer pointed to question icon	As Expected	Pass		
2	Voice command will produced and say select combination makes	Voice command produced make the color green	As Expected	Pass		
3	Select color blue and Yellow	prompt successfull Message	As Expected	Pass		
4	Select color Red and Yellow	promptError Message	As Expected	Pass		

Figure 5.6-Test Case 6

## 5.6 User Acceptance Testing

After performing the system testing, the bugs that occurred are developed. Then the target group (children, parents and teachers) performed the user acceptance testing. The target group consists of selected parents teachers and children. They thoroughly went through the system features and came up with some more modification to the requirements. The basic functionalities of the system has already been tested with a 5 years old kid.

The following questionnaire handed out to 20 parents and asked them to fill it regarding their child. Furthermore two tests Test A and Test B, conducted to get an idea about how did the kids perform. Test A had a concept taught to kids by using traditional teaching methods and test B had the same concept but it was taught using leap motion controller.

### 5.6.1 Questionnaire: Motion Based Application for Children (To be filled by a parent)

Please rate the following questions with 1 to 5 With 1 being the lowest rate and 5 being the highest rate.

1)	How tech savvy is your child	
2)	How much attention does your child pays to school work	

3) Does your child has previous experience with Computer based e learning applications?

(Please answer yes or No)

4) What does your child prefer more? Traditional teaching methods or game based e learning applications

5) How much time does your child spend on school work / homework?

- 0-1 hour
- 1-2 hours
- 2-3 hours

6) After the test that is conducted using traditional method (Test A) and the test is performed using leap motion controller (Test B), to which test the child scored more marks?

7) Do you believe it is possible to make a game that is educational but still hold a child's attention? If possible, explain how you think this might be accomplished.

This is the dataset that I gathered from the questionnaire

	Hours	TechSawy	PreviousExperience	Preference	Marks
1	One hour	Not Tech Savy	Yes	Traditional	Test B
2	Two Hour	Somewhat Tech Sawy	No	Leap Motion	Test A
3	One hour	Somewhat Tech Sawy	Yes	Traditional	Test A
4	One hour	Moderately Tech Sawy	No	Traditional	Test B
5	Three Hours	Tech Savy	No	Leap Motion	Test A
6	Two Hour	Somewhat Tech Sawy	No	Leap Motion	Test A
7	Two Hour	Somewhat Tech Sawy	Yes	Leap Motion	Test A
8	One hour	Not Tech Savy	No	Traditional	Test B
9	Three Hours	Very Tech Savy	Yes	Leap Motion	Test A
10	Two Hour	Somewhat Tech Sawy	Yes	Leap Motion	Test A
11	One hour	Somewhat Tech Sawy	Yes	Traditional	Test B
12	One hour	Moderately Tech Sawy	No	Traditional	Test A
13	Two Hour	Moderately Tech Sawy	No	Leap Motion	Test A
14	Three Hours	Tech Savy	No	Leap Motion	Test A
15	Three Hours	Tech Savy	No	Leap Motion	Test A
16	One hour	Somewhat Tech Sawy	Yes	Traditional	Test B
17	One hour	Moderately Tech Sawy	No	Traditional	Test B
18	Two Hour	Moderately Tech Sawy	No	Leap Motion	Test A
19	Three Hours	Moderately Tech Sawy	No	Leap Motion	Test A
20	Two Hour	Tech Savy	Yes	Leap Motion	Test A

*Figure 5.7-Hypothesis Data Set*

## **6 CONCLUSION AND FUTURE WORK**

Child education is a very difficult subject for adults and should be perfectly planned and done because, the mind of a child is very different and sensitive. They do not get things in a serious mind set. Therefore, child education is one of the important parts of a child and it has to be done in a very careful manner. Development in one domain influences development in other domains. For example, a child's language skills affect his or her ability to engage in social interactions. Therefore, developmental domains cannot be considered in isolation from each other. The dynamic interaction of all areas of development must be considered.

## 7 REFERENCES

- [1] J. Paxton, T. Shoemake, “Fun Ways to Increase Children’s Attention Span”, Presentation to the (ACEI) Annual International Conference and Exhibition (2007)
- [2] S. Pitman, “The impact of media technologies on child development and wellbeing”, Oz Child (August, 2008).
- [3] “Leap Motion controller”, [Online], Available <https://www.leapmotion.com>. [Accessed: February 2, 2014].
- [4] “Early Education Technology”, [Online] , Available, <http://www.newamerica.net/blog/early-ed-watch/2008/making-most-early-education-technology-1597> [Accessed: February 10, 2014].
- [5] “Home Health & Education Publications”, Attention Deficit Hyperactivity Disorder (ADHD) [Online], Available: <http://www.nimh.nih.gov/health/publications/attention-deficit-hyperactivity-disorder/complete-index.shtml> [Accessed: February 06, 2014]
- [6] J. Paxton, T. Shoemake, “Fun Ways to Increase Children’s Attention Span”, Presentation to the (ACEI) Annual International Conference and Exhibition (2007)
- [7] S. Pitman, “The impact of media technologies on child development and wellbeing”, Oz Child (August, 2008)
- [8] Gee, J. P. (2003). What video games have to teach us about learning and literacy (1st Ed.), New York: Palgrave Macmillan.
- [9] Tzeng, S.-C. (1999). Optimizing challenges and skills in the design of an educational computer game and exploring adolescents’ gaming beliefs, Unpublished PhD thesis, University of Georgia, USA.
- [10] Vaupel, C. A. (2002). The effects of video game playing on academic task performance and brain wave activity, Unpublished PhD thesis, The University of Tennessee, USA.
- [11] Pillay, H. (2002). An investigation of cognitive processes engaged in by recreational computer game players: Implications for skills for the future. *Journal of Research on Technology in Education*, 34 (3), 336–350.

- [12] Rideout, V. J., Vandewater, E. A., & Wartella, E. A. (2003). Zero to six: Electronic media in the lives of infants, toddlers and preschoolers. Retrieved February 26, 2014, from <http://kff.org/other/report/zero-to-six-electronic-media-in-the/>.
- [13] Provenzo, E. F. (1991). Video kids: Making sense of Nintendo, Cambridge, MA: Harvard University Press.
- [14] Johnson, J. E., Christie, J. F., & Yawkey, T. D. (1999). Play and early childhood development (2nd Ed.), New York: Longman.
- [15] Lisi, R. D., & Wolford, J. L. (2002). Improving children's mental rotation accuracy with computer game playing. *The Journal of Genetic Psychology*, 163 (3), 272–282.
- [16] C. Chua, H. Guan and Y. Ho, Model-based 3d hand posture estimation from a single 2d image', *Image and Vision Computing*, vol. 20, no. 3, pp. 191-202, 2002.
- [17] N. Shimada et al, Eds., *Face and Gesture Recognition.: Hand gesture estimation and model refinement using monocular camera-ambiguity limitation by inequality constraints*, 14-16 April, 1998, Nara. Japan: IEEE, 1998.
- [18] B. Stenger et al, Eds., *Computer Vision.: Filtering using a tree-based estimator*, 13-16 Oct, 2003, Nice. France: IEEE, 2003.
- [19] Z. Ren, J. Yuan, and Z. Zhang, Eds., *ACM international conference on Multimedia Robust hand gesture recognition based on finger-earth mover's distance with a commodity depth camera*, 28-30 Nov, 2011, Arizona. USA: ACM, 2011.
- [20] Chng E. *New Ways of Accessing Information Spaces Using 3D Multitouch Tables*. *Proceedings of the International Conference on Cyberworlds (CW)*; Birmingham, UK. 25–27 September 2012; pp. 144–150.
- [21] Bruder G., Steinicke F., Stuerzlinger W. *Effects of Visual Conflicts on 3D Selection Task Performance in Stereoscopic Display Environments*. *Proceedings of IEEE Symposium on 3D User Interfaces (3DUI)*; Orlando, FL, USA. 16–17 March 2013; pp. 1–4.

- [22] “Leap Motion controller”, [Online], Available <https://www.leapmotion.com>. [Accessed: February 2, 2014]
- [23] “Skywriting Alphabets”, Available: <https://airspace.leapmotion.com/apps/skywriting-alphabets/windows> [Accessed: February 27, 2014].
- [24] “Balloon Buzz”, Available: <https://airspace.leapmotion.com/apps/balloon-buzz/windows> [Accessed: February 27, 2014].
- [25] “Animal Zoo”, Available: <https://airspace.leapmotion.com/apps/animal-zoo/osx> [Accessed: February 27, 2014].
- [26] “Poraora”, [Online], Available: <http://www.poraora.com/> [Accessed: February 27, 2014].
- [27] “K5 Math”, [Online], Available: <http://www.k5learning.com/math/> [Accessed: February 27, 2014].
- [28] “Iterative Waterfall Model”, [Online], Available: <http://www.ianswer4u.com/2011/11/waterfall-model.html#axzz2KntXtadx>. [Accessed: February 6, 2014]