

SCIENCE APP FOR O/L STUDENTS USING AUGMENTED REALITY – HUMAN ANATOMY

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Dissertation submitted in partial fulfilment of the requirements for the B.Sc. Degree
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DECLARATION

I declare that this is my own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my 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 candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor:

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Ms Uthpala Samarakoon

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Date

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Mr. Nelum Amarasena

.....

Date

ABSTRACT

Science is a main subject and being a complicated subject relative to the other subjects in the local G.C.E ordinary level syllabus and recognized that there is a decrement of results of the science on past two three years. Through the survey which held by researchers, recognized that students have problems in human anatomy section in the science syllabus because structure, functions and diseases in each system presented as text- based explanations with figures. Therefore there're problems arise in conceptualization of the idea each concept regarding to human anatomy. Hence most of students prefer to memorize without clear comprehension of the topics. Nowadays education sector gets beneficial from the technological advancement through combine the theoretical and practical learning methods within the modern technologies, and it improves student's enthusiasm for learning and helps enhance student's performance. As a solution with introducing a new method to learning in interactive and attractive way helps to improve results and avoid aforementioned occurred problems. Augmented reality (AR) is a modern technology and it has ability making virtual learning environments and it support learning and make students more interesting in learning. Augmented reality has capability on turning two dimensional objects into their three dimensional version. Finally this research developed a 3D mobile application based on AR technology which cover the human anatomy with an animal cell, digestive system and urinary system. The purpose of this mobile application is to provide 3D support on studying system overview, processes and diseases regarding to digestive and urinary systems.

Keywords: Augmented Reality, 3D mobile application, G.C.E Ordinary Level

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1 INTRODUCTION

1.1 Background literature

Science is most important and compulsory subject and it complicated than the other major subjects in the G.C.E Ordinary level curriculum. According to the statistics issued by national department of examination there is a decrement on the results of the science subject compared to the other subjects and even most of passing students passed by getting average marks [1]. Since 2016 new syllabus introduced by education department and it has become more advance than previous syllabus and it categorized into three major sections there are biology, chemistry and physics. And the science syllabus come up with deep concepts of science. Therefore it results students to getting less interest and getting low results in science subject.

To find a solution to aforementioned issues we conducted a survey though a questionnaire. According to the results it's depicts that they have problems regarding to Science subject. And found that students has issues with human anatomy.

Biology has its subcategories as plant bodies, human anatomy, and biosphere cycles. Human anatomy becomes main and important section in the science subject because it describes tissues in human body, human body system structures, the position of the organs, relationships between organs, functions, diseases and disorders regarding to systems. Those are explained using text – based and figures.

After the analysing the results of the survey we realized that they would like to have an effective and interactive way to study the subject manners, and it will be helps to improve the results of them. Nowadays education sector gets beneficial from the technological advancement through combine the theoretical and practical learning methods within the modern technologies, and it improves student's enthusiasm for learning and helps enhance student's performance than the traditional classroom methodologies. F. K. Algarawi, W. A. Alslamah, A. A. Alhabib, A. S. Alfahaid and D. M. Ibrahim states that the use of modern learning tools in education assists students to their study, Quality of learning and improve the educational experience of students [9].

Augmented reality (AR) is a modern technology and it uses by various fields like medicine, tourism, gaming, transportation, architecture, construction fields, business field and education [5]. Augmented reality has capability on turning two dimensional objects into their three dimensional version so it makes better understanding of the real object through it by visualizing as a virtual object. These virtual objects demonstrate even small details of the objects than analyse real objects. And it increases the engagement and interaction and provides richer user experience. Nowadays in online marketing make easier to customer to buy anything from shopping centres without a doubt, because most of online shopping mobile applications developed based on augmented reality and it makes very easy to customer to check the product that they are expecting to buy before make an order. AR increases the perceived products and the brands.

AR has an ability making virtual learning environments so it supports learning in attractively, make students more interesting in learning and enhance teaching skills of teachers. It maximize the time spending in study and through this augmented reality mobile application enhances self – learning experience. Maria Fuchsova, Lilla Korenova states that the use of mobile AR technology applications allows the work of educators to be made more effective and in addition, it enables pupils to become actively involved in the educational process. Visualization can help students to improve their understanding of the subject.

In present, technology has become part of our life and its everywhere. Mobile phones are a part of life of people and they keen to embrace new technologies. Therefore a solution come up with a mobile application with augmented reality motivates student in learning. So it is a way to provide to access the study materials through online and it makes students convenient in learning anywhere anytime. Most of learning materials available in form of book and some kind of materials can use only within the laboratory [5]. Mobile applications which developed based on augmented reality has ability to deliver a blended learning experience created from mixing of virtual and real world objects [5]. Augmented Reality has an ability to effects people to delivery of educational materials in effective and interesting way. Maria Fuchsova, Lilla Korenova states that the use of mobile AR technology applications allows the work of

educators to be made more effective and in addition, it enables pupils to become actively involved in the educational process. Visualization can help students to improve their understanding of the subject.

This research done to improve interesting in learning of students and make easy to learn about human biology using augmented reality mobile application. Audio visualization and visuals are the best ways to influence student's interesting in learning. This is a way to gain more knowledge and understanding and ultimately increase their interesting to the subject. Therefore currently research carried out to provide support to learn about animal cell, digestive system and urinary systems. Cell overviews, body structures, functions regarding to each systems and diseases and disorders occurs in each system implemented using 3d models displaying with audio explanations, video explanations, text based descriptions and provide accesses to online tutorials.

1.2 Research Gap

Below table shows the comparison between science augmented reality mobile application and existing systems. Web based augmented reality application for human body anatomy learning is only describe about lungs, nose, faring, larynx, trachea, bronchus, bronchioles, and alveolus using marker based augmented reality only within 3D animations. But there is only 3D interaction no other sounds, videos or audios. The research not describe about the any human body anatomy as well as diseases and disorders occurs in the human body.

Internal Organs in 3D (anatomy) only describe about internal organs in the human body within texts and 3D animations. But not describe any human body anatomy as well as diseases and disorders occurs in the human body.

Human body (male) educational VR 3D describes about selected Human Body systems using 3D animations and Texts. But there is no description about diseases and disorders occurs in the Circulatory system.

“Augmented Reality to teach human heart anatomy and blood flow” describe about human heart and blood circulation in using 3D animations, texts and sounds. But there is no description about diseases and disorders occurs in the circulatory system.

““ARESS” augmented reality for the human respiratory system” is only describe about the process of respiration using 3D animations. There is no description about system overview as well as diseases and disorders occurs in the System.

But in the current research going to represent the animal cell overview, human body anatomy with its overview, functions and diseases and disorders occurs in the each systems. Therefore our science augmented reality mobile application will be assistance to the learner to go for a higher grade.

Existing Researches and applications	3D view of Animal Cell	3D Demonstration of System Overviews	3D Demonstration of Functions	3D Demonstration of Diseases and disorders
Web based Augmented Reality Application for Human Body Anatomy Learning	✗	✓	✗	✗
Internal Organs in 3D (Anatomy)	✗	✓	✗	✗
Human body(male) educational VR 3D	✗	✓	✗	✗
Augmented Reality to Teach Human Heart Anatomy and Blood Flow	✗	✓	[Only Animations]	✗
“ARESS” Augmented Reality for the human respiratory system	✗	✗	✓	✗
Science Augmented Reality Mobile application	✓	✓	✓	✓

Table 1: Current research comparison within existing researches

1.3 Research Problem

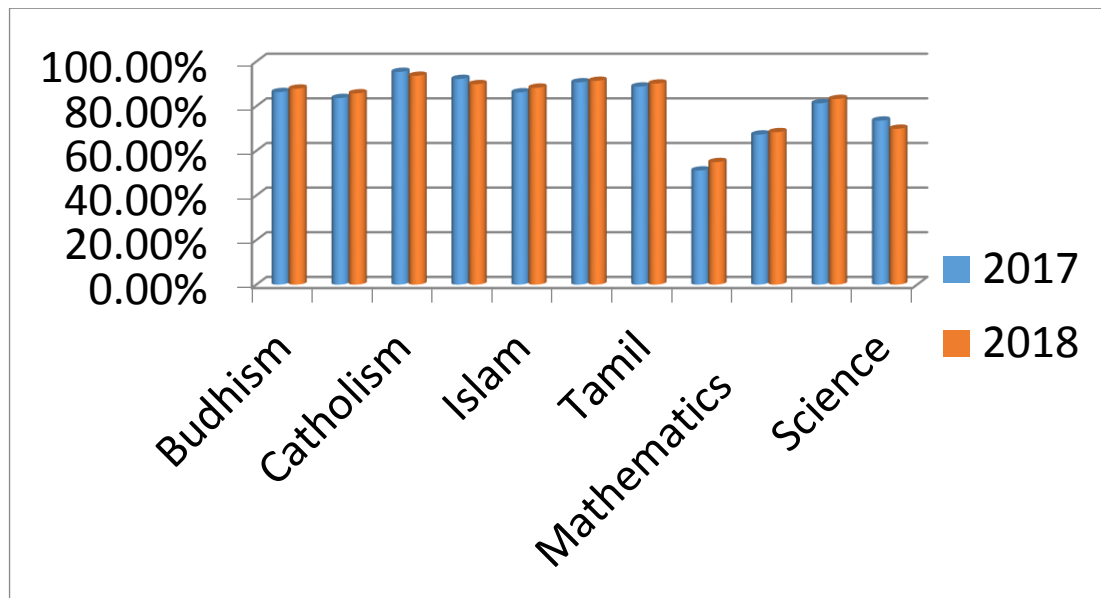


Figure 1: Passed percentage of compulsory subjects during previous two years [1].

According to the statics of the examination department figure 1 depicts that the amount of students who have passed science is somewhat low than other major subjects.

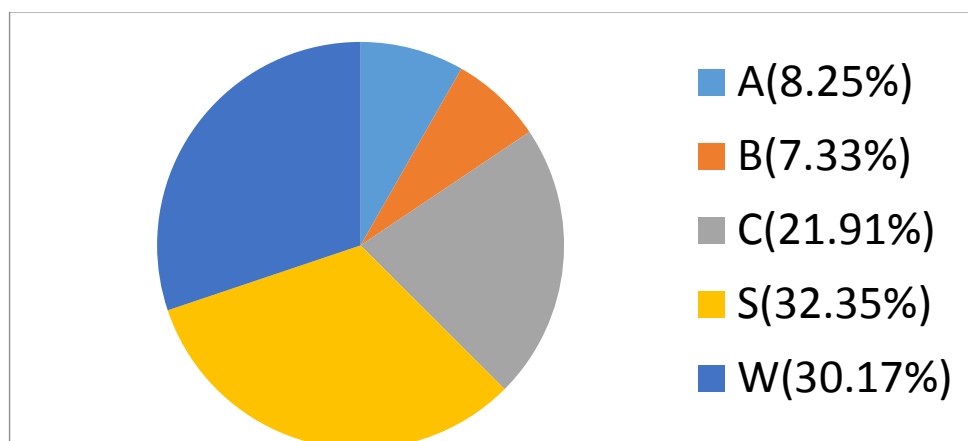


Figure 2: Science results of 2018 by grades [1].

Figure 2 depicts that the amount of the students who have scored higher grades at the ordinary level examination is low. Most of the students have scored average grades (c and s).

There are several reasons for the inability of most of the students to score higher grades in science.

- The concepts of science are complicated and hard to understand.
- Some students are not much interested in studying science.
- Lack of proper practical experience as some schools are not having proper lab facilities.

The proposed augmented reality based mobile app will solve all of these issues.

1.3.1 Problems Specific to the Component

As the result of survey we conducted among O/L students we were able to find out that most of the students prefer to have an interesting way to learn about Digestive system and Urinary System in Human Biology Section in the Biology. According to the Figure 3 depicts that 40% students have problem in conceptualizing of Urinary system and 25% students have problems in conceptualizing of Digestive systems.

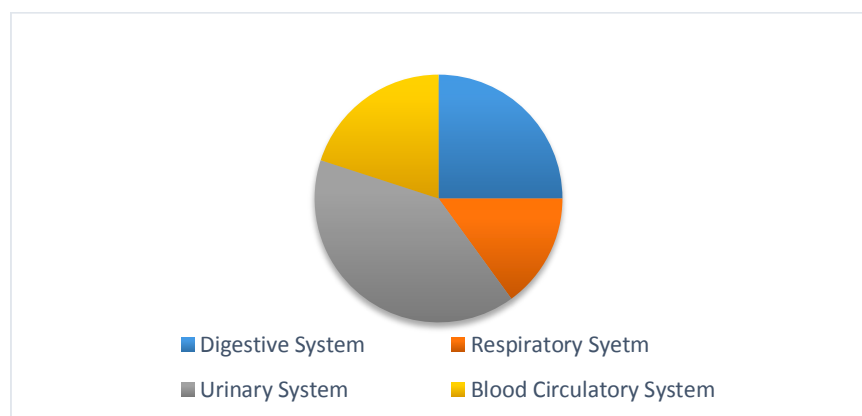


Figure 3: Human Body anatomies hard to study

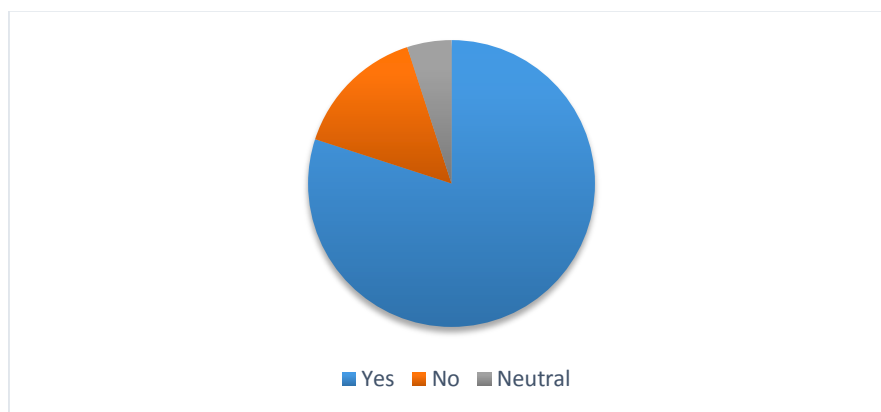


Figure 4: Preference to have a 3D Mobile Application

They have to memorize the contents which are provided using text based manner and two dimensional images. The Functions, diseases and disorders regarding to Urinary System and Digestive systems study within text based manner is very hard. And they would like to have an interactive and effective way to study these subject manners. According to the figure 4 depicts that 80% students likes to have 3D mobile application to get help for their studies.

1.4 OBJECTIVES

1.4.1 Main Objective

Main Objective of this research is to improve G.C.E ordinary level science results by introducing an augmented reality based self-learning mobile application.

The use of this modern learning tool in education assists students to their study, quality of learning and improve educational experience of the students. This system which appear to be interesting, enhancing and beneficial in the context of Human Biology.

1.4.2 Specific Objectives

- This research is to provide alternative methods of human body anatomy learning while reading the textbooks.

Students can use the mobile application and focus camera the 2D image on the text book and they can see all of the text based descriptions with real world objects with 3D interaction in real time while reading the textbook. This application developed using 3d model displaying, audios videos. Because visuals and audio visualizations are the best ways influence student's attention in studying science. This methods maximize the time spending on studying.

- Learn animal cell overviews and human body systems through generating 3D models within audio explanations digestive system and urinary system

Students will find it easier to understand the shape of the human body anatomy with best explanations. This is a way to gain more knowledge and understanding and ultimately increase their interesting in the subject.

- Functions regarding to systems within video demonstrations
Digestion process and urine formations are demonstrated using videos with best graphics.
- Generate important notes regarding to animal cell, digestive and urinary systems
- Online tutorial access to recommended videos about diseases
- Ability on study in both Sinhala and English languages

2 METHODOLOGY

2.1 Methodology

“Human Anatomy Learning – Science Zone” mobile application covers selected topics after investigating the result of the survey which conducted through a questionnaire among Grade 11 students. According to the survey we did we were able to find out they have lots of problems in Human Biology on conceptualizing digestive system and urinary system. As well we realized that students prefer to have a 3D application which can make an interesting on learning.

Augmented reality is the main technology used to implement this mobile application. Augmented reality has an ability to convert two dimensional objects into three dimensional versions of them. Visualizing as a virtual object makes better understanding of the real object because these virtual objects demonstrate even small details of the objects than which complicated to understand by referring real object.

Augmented Reality making immersive virtual learning environments. Augmented reality in order to this system implemented using Unity Integrated development environment (IDE) and Vuforia engine.

- Unity Integrated Development Environment (IDE) :
Unity is a powerful cross platform gaming engine allowing building two dimensional (2D), three dimensional (3D), Virtual Reality Augmented Reality scenes which supports to iOS, android, windows MacOS desktop platforms.
- Vuforia engine:
Vuforia is an augmented reality Software Development Kit (SDK). It recognizes the images and 3D objects real time. Vuforia has License manager

and Target Manager. First of all we have to create a database in Target manager, and store images as targets in the created database.

This system uses marker based approach in augmented reality. When students targets their device camera on to the images on the text book, it will generates 3D models with audio visualizations and videos. This Human anatomy mobile application is an android mobile application. This mobile application cover the topics as below

- Animal cell,
- Digestive system
- Urinary system

Aforementioned topics presented in following ways.

- Visualization of body system structures and cell overviews using 3D models displaying
- Further explanations about body system using Audio explanations
- Functions regarding to selected body systems using Video explanations
- Generate Text based descriptions and give online tutorial access to study about diseases and disorders.

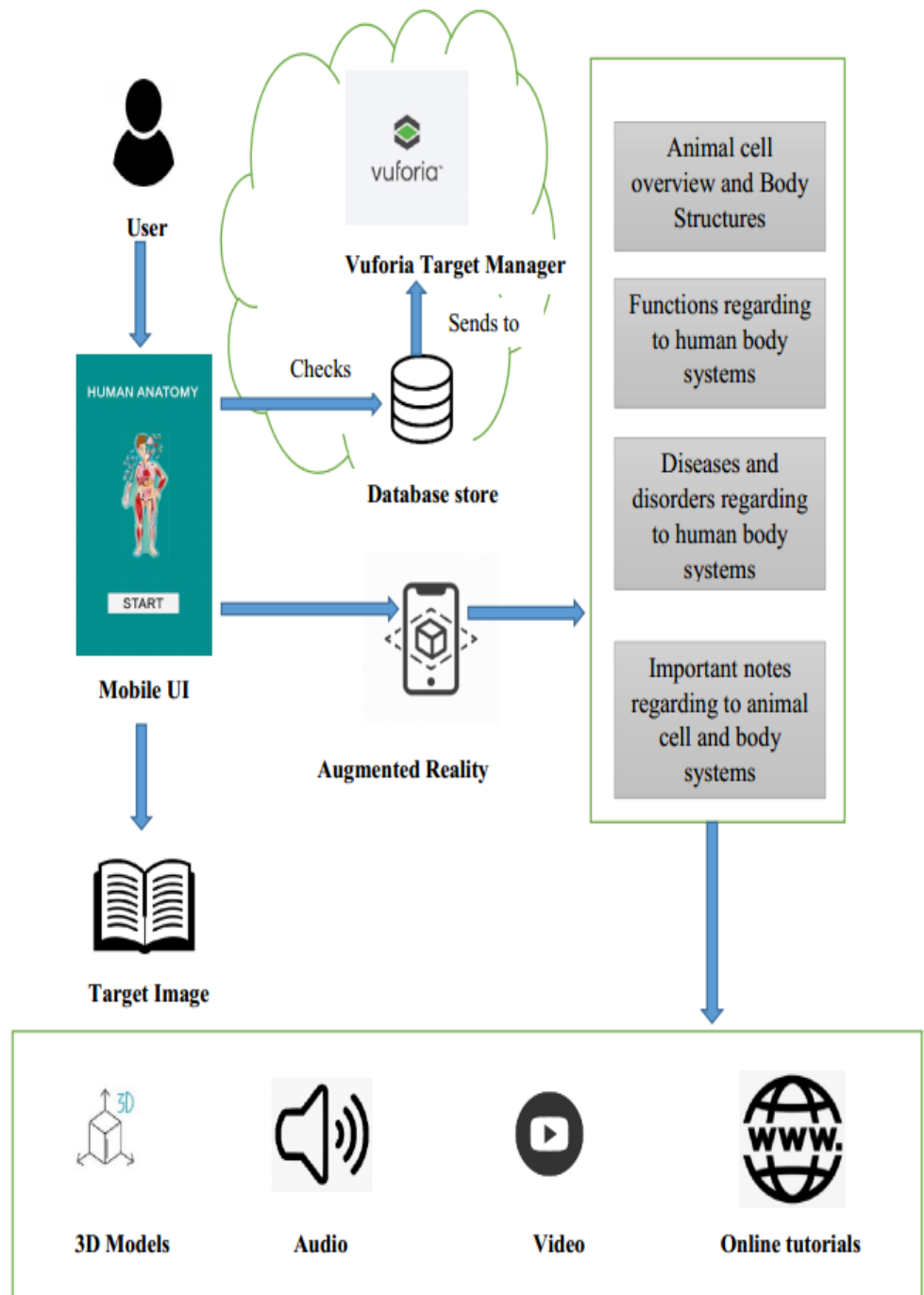


Figure 5: High-level diagram

Figure. 5 shows the system diagram of implemented human biology mobile application. When user targets to the target image, it will compares with vuforia database and send them to target manager to recognition process. If target manager recognized, it will generate computer graphics relevant to each image.

This mobile application describes about three sections, there are animal cell, digestive system and urinary systems. There are existing researches which developed based augmented reality only uses language as English. But in Sri Lankan G.C.E Ordinary Level curriculums provides within both English and Sinhala languages. Once user run the mobile application, they can choose Sinhala and English languages through buttons displayed in the system. They need to point their device camera onto the target images shown below on the text book to see the functionality of the application.

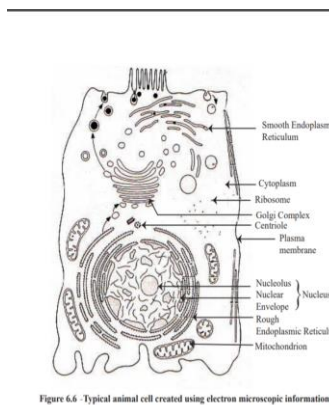


Figure 6: Animal cell image on text book

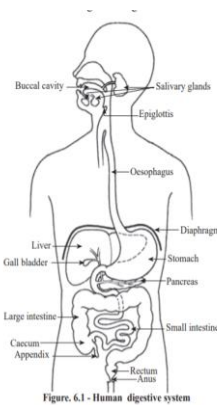


Figure 7: Digestive system image on text book

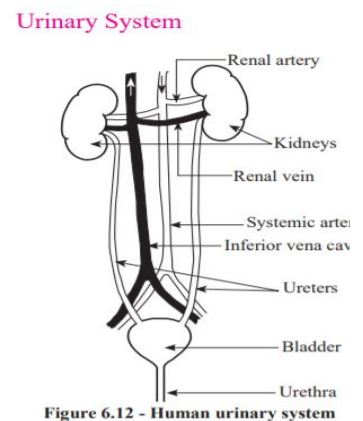


Figure 8: Urinary system image on text book

When run the application there is a start button in the human anatomy home page will display as figure 9. After user can select the preferred language. There are three options, animal cell, digestive system and urinary systems like figure 10. Those sections again divided into sub topics as below.

- Animal Cell - Cell overview and Important Notes
- Digestive System – System overview / Digestion process / important notes / Diseases
- Urinary system - System overview / Urine formation process / important notes / Diseases

Above mentioned categories describes using 3D models displaying, video and audio explanations, text based descriptions and further clarified descriptions and application enable students to study Sinhala and English medium content. These features helps to increase student's motivation in learning and it maximize the time spend within the learning and it enhance the self- studying experience of students.

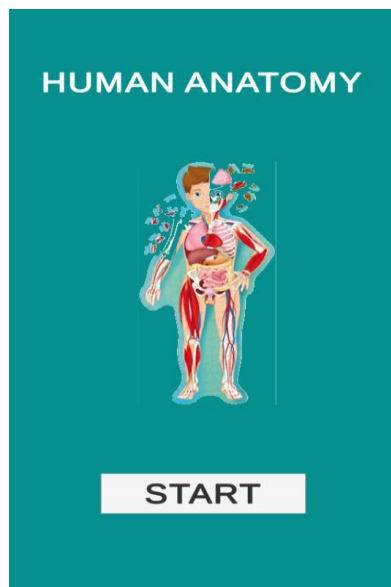


Figure 9: Human Anatomy Home Page

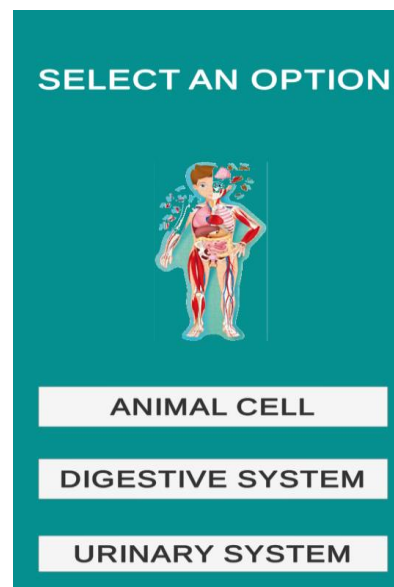


Figure 10: Select an option page

2.1.1 AR support on learn Animal Cell

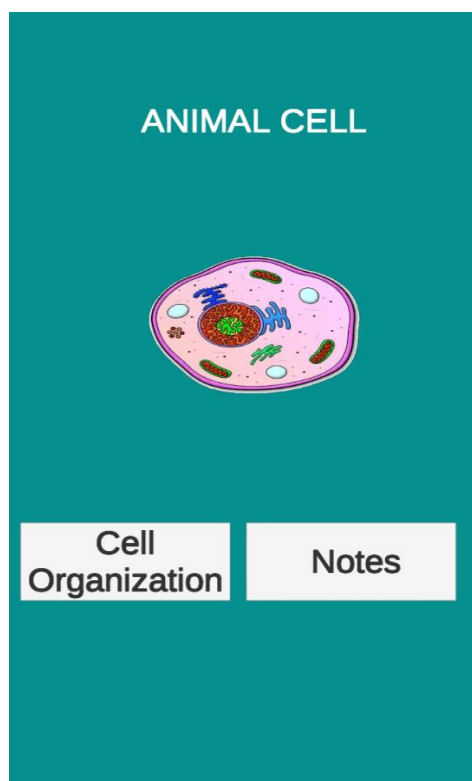


Figure 11: Animal Cell Home Page
- English



Figure 12: Animal Cell Home Page
- Sinhala

Once user navigates to the home page of animal cell, there are two options provided. There are cell overview and notes.

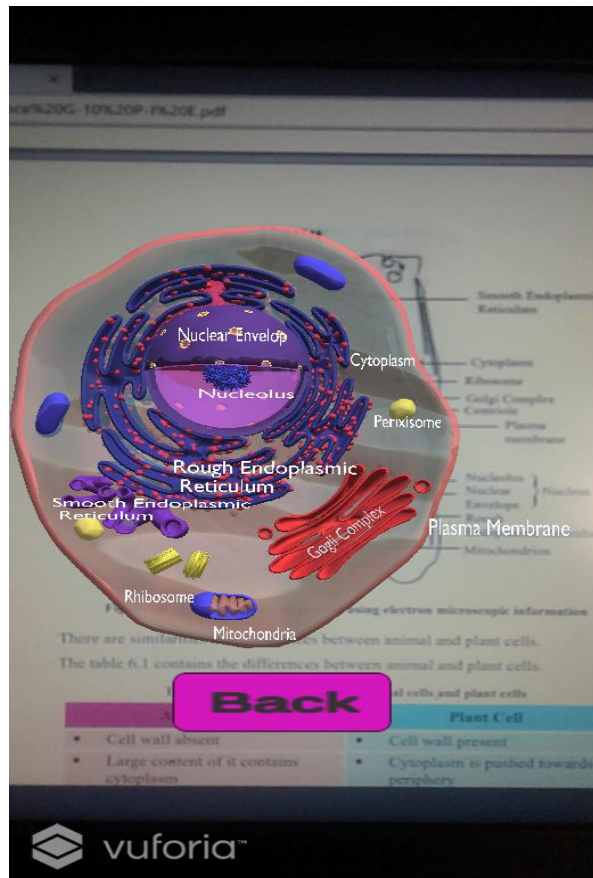


Figure 13: 3D model of animal Cell.

When student clicks any option, augmented reality camera opens which powered by vuforia, student needs to point the device camera on to the targets images. Then system displays 3d models with audio explanations. Under cell overview it describes about cell organization, organelles in the cell. There are plasma membrane, cytoplasm, Golgi complex, nucleus, smooth and rough endoplasmic Reticulum and mitochondrion.

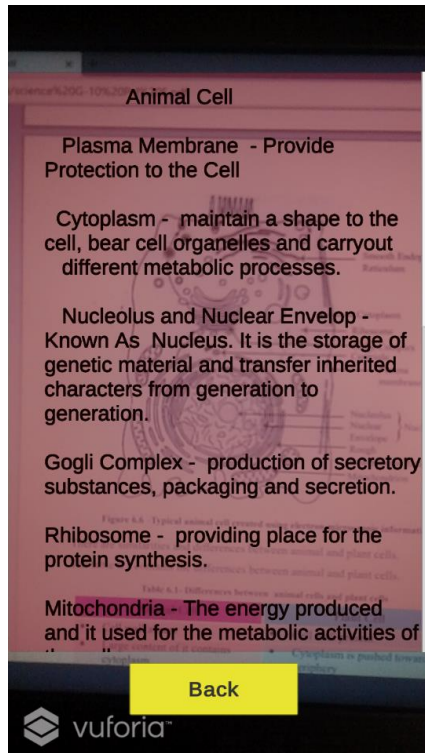


Figure 14: Notes regarding to Animal Cell - English

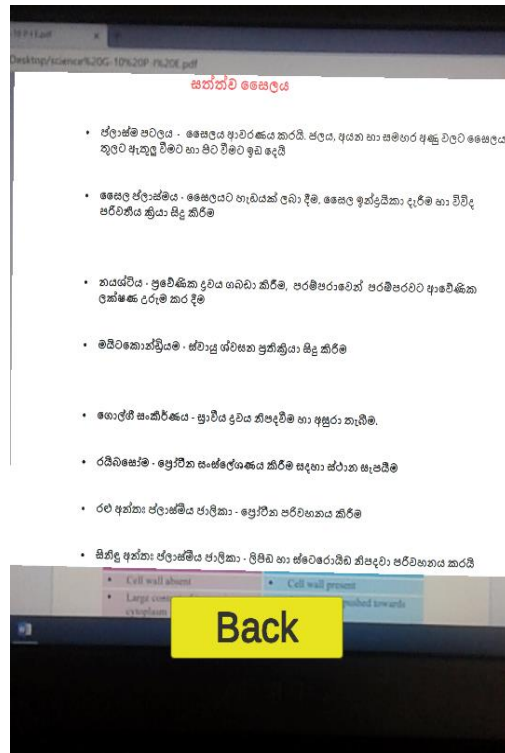


Figure 15: Notes regarding to Animal Cell - Sinhala

Under important notes text based descriptions will generated and it describes the functionalities of each organelle as above in both Sinhala and English languages.

2.1.2 AR support on learn Digestive System

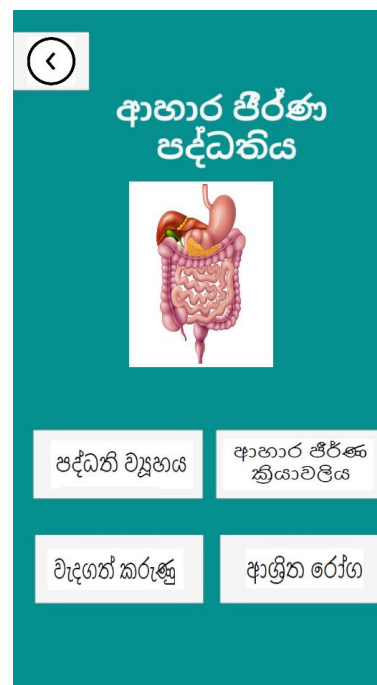
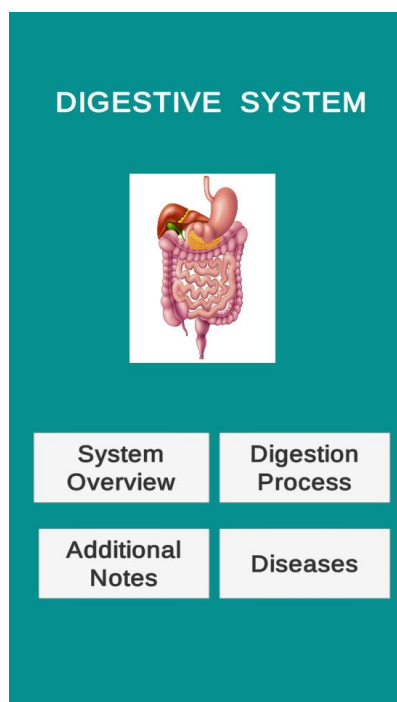


Figure 16: Home Page Digestive System - English

Figure 17: Home Page Digestive System - Sinhala

In the main user interface of digestive system has sub categories, there are system overview, digestion process, additional notes and Diseases. To see the functionalities of each sub section user needs to points the camera onto the figure 7.

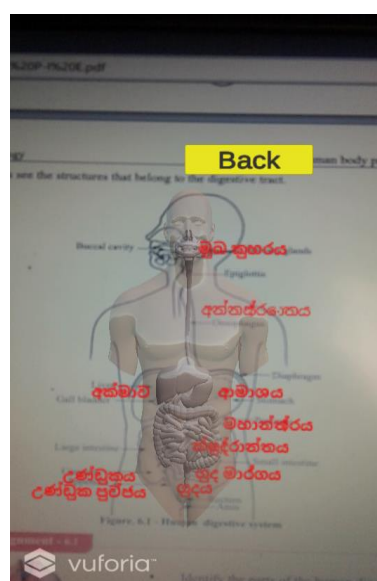
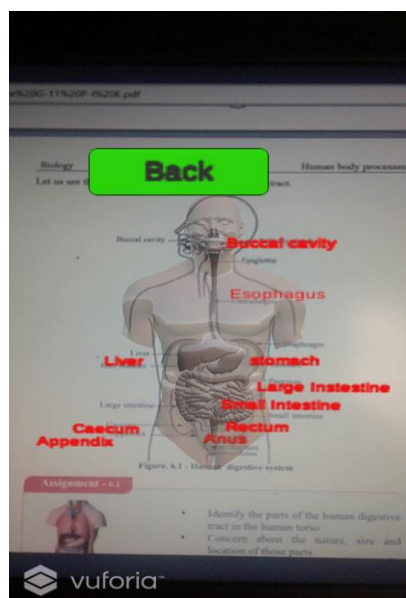


Figure 18: 3d model digestive system – English

Figure 19: 3d model digestive system – Sinhala

Under system overview describes about human body system structure using 3d model of digestive system and audio explanations. 3d model of digestive system clearly displays the buccal cavity, esophagus, liver, stomach, large intestine, small intestine, caecum, appendix and Rectum and anus. User can rotate the 3d model. Through 3d model user can capture structure of the system, positions of the organs and relationships between organs.

Digestion process is the main functionality performed by digestive system. It demonstrate using video. That video clearly demonstrate how each organ in digestive system involves to the digestion.

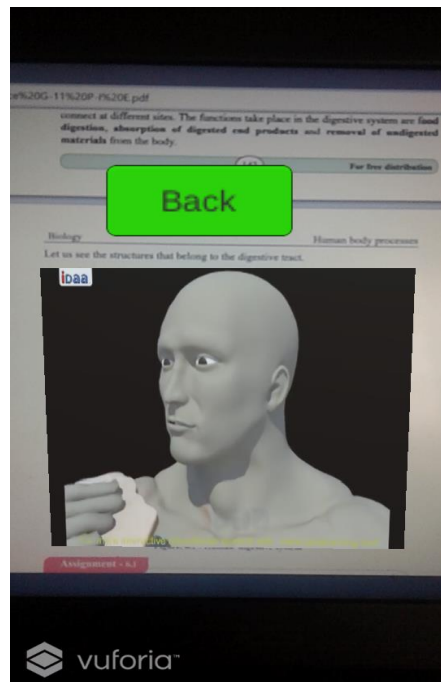


Figure 20: Video explanation of Digestion Process

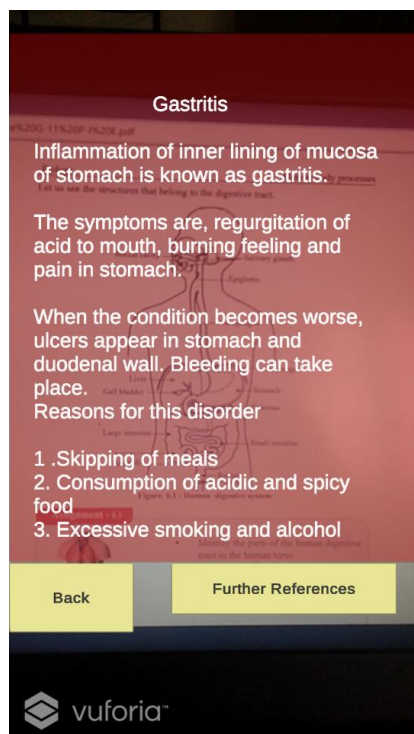


Figure 21: Text-based description of gastritis - English

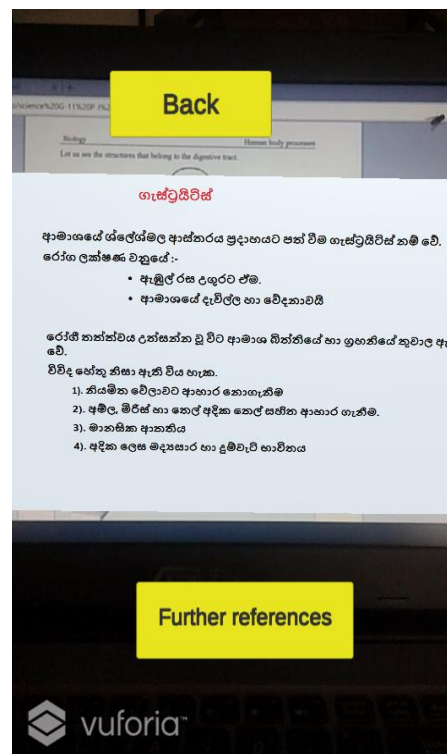


Figure 22: Text-based description of gastritis - Sinhala

Text based descriptions generated in additional notes and diseases. Gastritis is the main topic discussed in this section. And there are is a future references button which embedded into Uniform resource Locator (URL) within access to online tutorials.

2.1.3 AR support on learn Urinary System

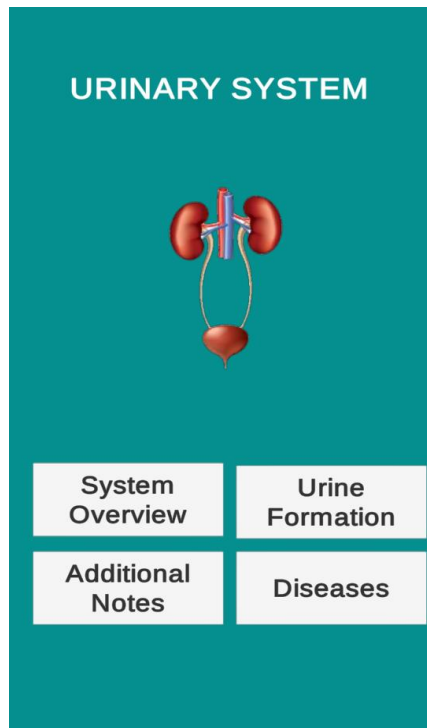


Figure 23: Home page of Urinary System - English



Figure 24: Home page of Urinary System - Sinhala

In the main user interface of urinary system has sub categories as above, there are system overview, urine formation process, additional notes and Diseases. To see the functionalities of each sub section user needs to points the camera onto the figure 8.

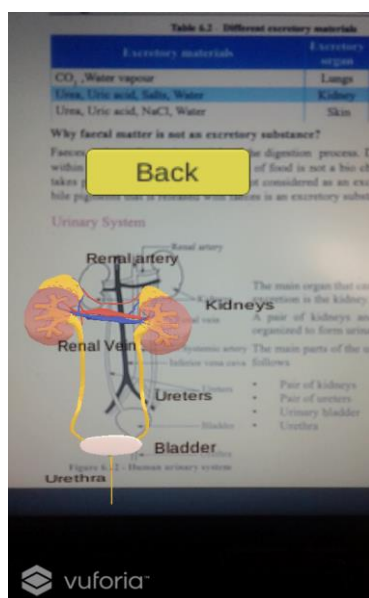


Figure 25: 3d model urinary system - English

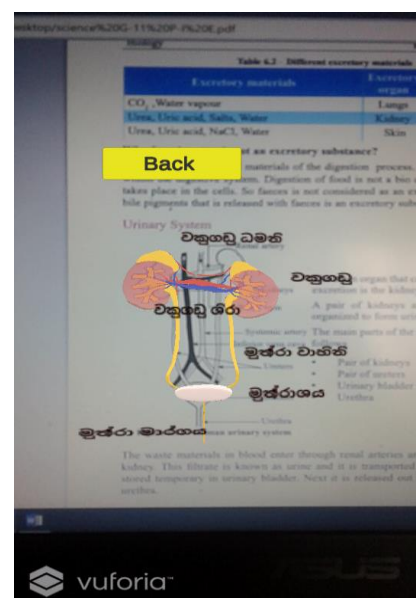


Figure 26: 3d model urinary system - Sinhala

Under system overview describes about human body system structure using 3d model of urinary system and audio explanations. 3d model of urinary system clearly displays renal artery, kidneys, renal vein, systemic artery, inferior vena cava, ureters, bladder, and urethra. User can rotate the 3d model. Through user can capture structure of the system, positions of the organs and relationships between organs.

Urine formation process is the main functionality performed by digestive system. It demonstrate using videos. That video clearly demonstrate how each organ in urinary system involves to the urine formation.

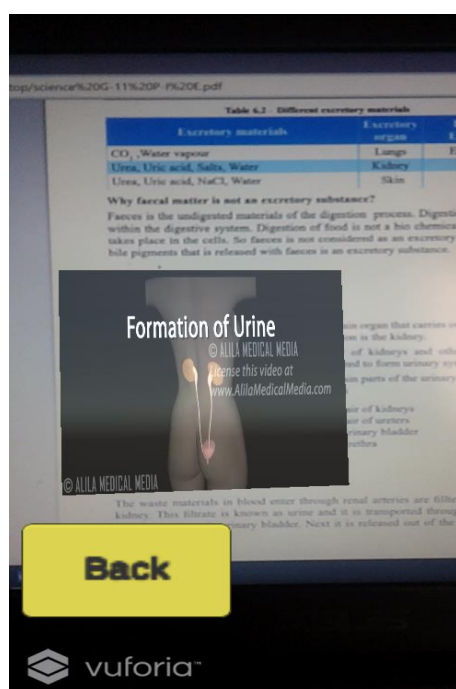


Figure 27: Video explanation of Urine formation

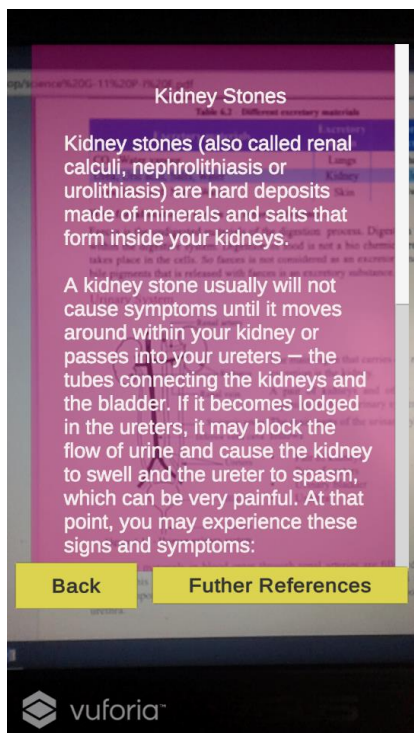


Figure 28: Text based description about Kidney stones - English

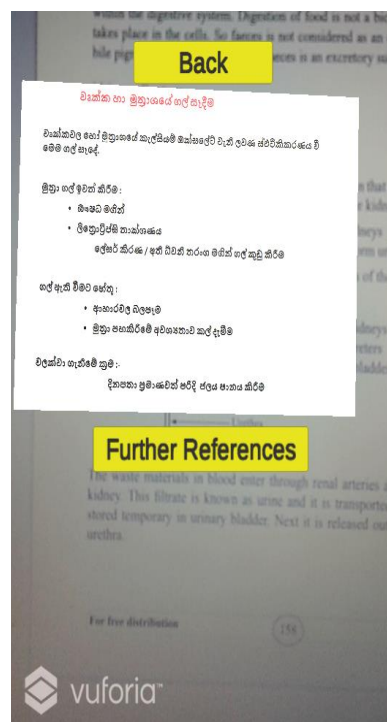


Figure 29: Text based description about Kidney stones - Sinhala

Text based descriptions generated in additional notes and diseases. Kidney stones is the main topic discussed in this section. And there are is a future references button which embedded into Uniform resource Locator (URL) within access to online tutorials.

2.2 Commercialization aspects of the product

This system is a 3D mobile application based on augmented reality which supports on Human anatomy section in G.C.E ordinary Level science syllabus. Main stakeholders of this system is School, Teachers and Grade 10 and 11 students. From this application students can learn animal cell overview, digestive and urinary body system structures, functions and diseases through 3d models, audio visualize contents, audio instructions, and text based descriptions and accessibility to online tutorials. Visuals and audio visualization are the most effective ways to learning. In recent years with the advancement of the technology, education sector gets beneficial from the technological advancement through combine the theoretical and practical learning

methods within the modern technologies, and it enhance the motivation of learners in learning and it helps to improve their performance. Augmented reality has its own characteristic of converting two dimensional version into their three dimensional version and it makes attractive and interactive virtual learning environments and it's enhance the motivation students in learning, improve students' performance on the other hand it enhance self – learning experience of student.

Local G.C.E Ordinary Level examination held with two main languages there are Sinhala and English. Therefore this application facilitates students to study in both Sinhala and English languages. Therefore its make a significant gap between existing researches done by different countries and this human anatomy augmented reality 3D mobile application, because they used the language as English. This application would direct the students through self-learning during a pandemic situation as present to cover up the contents in the syllabus. While Science is a practical topic this application was suggested for schools in rural areas to address the limitations that arise during the practical sessions.

2.3 Testing and Implementation

At the beginning of the project agile methodology was used to carry out the project tasks. The development process was done into two sprints and 50% progress evaluated in each sprint. Git Lab was used to version controlling to maintain the implementation process. We created a proper plan including each step must follow to achieve project tasks. Microsoft Planner was used to create the project plan.

Testing is an important step in the in the software development process. Testing performed in order to verify and validate functionalities of mobile application. Test cases are written to cover both functional and non – functional requirements. This application performed different types of tests to verify and validate functionality of “Human anatomy” component.

Table 2: functional testing types

Unit Testing	Unit testing is done to ensure that all functions related to human anatomy (audio explanation while 3d model displaying, display videos, text based descriptions and online tutorial access) are working accurately. Unit testing done to all four major components in “science zone” application.
Integration Testing	Combine all four major components of “Science Zone” application and tested as group to ensure that all functionalities working correctly.
System Testing	All four major components of “Science Zone” application are integrated as a system and tested.
Regression Testing	Regression testing done to ensure that system works fine with new functionalities, bug fixes or any change in the existing feature.

Table 3: non-functional testing types

Usability Testing	Usability testing was done to evaluate how easy to use the mobile application, and to ensure quality and user-friendliness of the product.
Performance Testing	Done to ensure speed and responsiveness of the mobile application

Table 4: Checks the language support

Test Case ID	01
Description	Language support on both Sinhala and English languages
Pre - condition	User should navigate to the Human Anatomy Home page and clicks “START” button
Steps	<ol style="list-style-type: none"> 1. User chooses a language 2. User selects a preferred option from “Select an option” page 3. User chooses preferred sub option provided in selected option
Expected Output	Audio explanations, video explanations and text based descriptions should given from the language which was selected by the use.
Actual Output	Audio explanations, video explanations and text based descriptions demonstrated from the language which was selected by the use

Table 5: Accessibility of mobile device’s camera

Test Case ID	02
Description	Accessibility to device’s camera
Pre - condition	User should navigate to the Human Anatomy Home page and clicks “START” button
Steps	<ol style="list-style-type: none"> 1. User chooses a language

	<ol style="list-style-type: none"> 2. User selects to preferred option from “Select an option” page 3. User chooses proffered sub option provided in selected option 4. Opens the device camera 5. Capture the image target
Expected Output	The mobile device’s camera should open successfully.
Actual Output	The mobile device’s camera opened successfully.

Table 6: 3D models generated while audio explanation

Test Case ID	03
Description	3D model display while audio explanation
Pre - condition	User should navigate to the Human Anatomy Home page and clicks “START” button
Steps	<ol style="list-style-type: none"> 1. User chooses a language 2. User selects preferred option from “Select an option” page 3. User chooses “Cell overview” or “System Overview” in according to the selected sub option provided in selected option 4. Opens the device camera 5. Capture the image target
Expected Output	3D model of animal cell, digestive system or urinary system and audio explanation should generate.
Actual Output	3D model of animal cell, digestive system or urinary system and audio explanation generated.

Table 7: Video displaying on process related to digestive and urinary systems

Test Case ID	04
Description	Process regarding to digestive and urinary system explained using video
Pre - Condition	User should navigate to the Human Anatomy Home page and clicks “START” button and choose language
Steps	<ol style="list-style-type: none"> 1. User selects an option either digestive system or urinary System 2. User selects “Digestion Process” or “Urine Formation” option in relevant pages 3. Opens the device camera 4. Capture the image target
Expected Output	Video should displayed using augmented reality.
Actual Output	Video displayed using augmented reality.

Table 8: Notes displaying related to animal cell, digestive and urinary systems

Test Case ID	05
Description	Notes display regarding to each section.
Pre - Condition	User should navigate to the Human Anatomy Home page and clicks “START” button and choose language
Steps	<ol style="list-style-type: none"> 1. User selects an option either animal cell, digestive system or urinary System 2. User selects “Notes” or “Additional Notes” option in relevant pages 3. Opens the device camera

	4. Capture the image target
Expected Output	Notes should generated using augmented reality.
Actual Output	Notes generated using augmented reality.

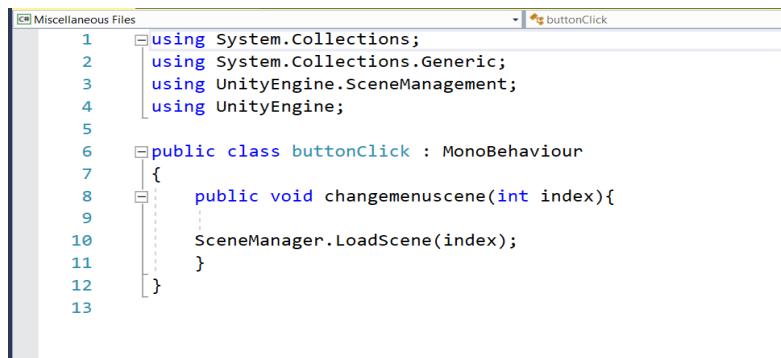
Table 9: Note generation of Diseases

Test Case ID	06
Description	Diseases display as notes regarding to digestive system or urinary system.
Pre - Condition	User should navigate to the Human Anatomy Home page and clicks “START” button and choose language
Steps	<ol style="list-style-type: none"> 1. User selects an option either digestive system or urinary System 2. User selects “Gastritis” or “Kidney Stones” option in relevant pages 3. Opens the device camera 4. Capture the image target
Expected Output	Notes regarding to gastritis or kidney stones should generated using augmented reality.
Actual Output	Notes regarding to gastritis or kidney stones generated using augmented reality.

Table 10: Accessing online video tutorials

Test Case ID	07
Description	Online video tutorial access to learn about diseases display regarding to digestive system or urinary system.
Pre - Condition	<ol style="list-style-type: none"> 1) User should enable Internet on the device 2) User should navigate to the Human Anatomy Home page and clicks “START” button and choose language
Steps	<ol style="list-style-type: none"> 1. User selects an option either digestive system or urinary System 2. User selects “Gastritis” or “Kidney Stones” option in relevant pages 3. Opens the device camera 4. Capture the image target 5. User select further references button
Expected Output	Online video tutorial regarding to gastritis or kidney stones should generated using augmented reality.
Actual Output	Online video tutorial regarding to gastritis or kidney stones generated using augmented reality.

To build up this augmented reality mobile application we used Unity IDE and got support of Vuforia engine. First of all we need to create a database using vuforia to store target images. Then we need to create project in unity. To create an augmented reality mobile application we need to enable vuforia augmented reality support under build setting. And this is an android mobile application, so we need to get support on android platform. Then we need to include licence key of the database as app key and import the database. C# is the programming language used to implement this project.



```

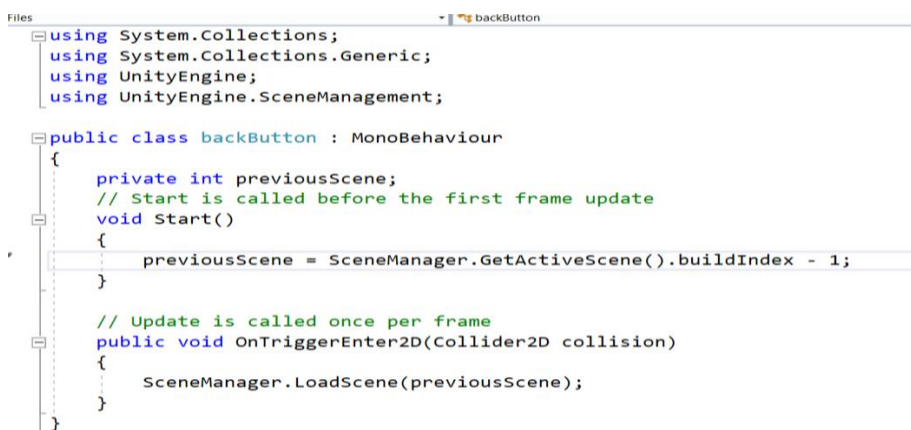
1 using System.Collections;
2 using System.Collections.Generic;
3 using UnityEngine.SceneManagement;
4 using UnityEngine;
5
6 public class buttonClick : MonoBehaviour
7 {
8     public void changemenuscene(int index){
9         SceneManager.LoadScene(index);
10    }
11 }
12
13

```

Figure 30: Button click code

User can easily navigate to the any of aforementioned topics through button clicks. Scenes has an ability on move to previous scene from current scene.

These scenes which enable with we needs to set image target and AR camera. Image targets can selected from the database that imported to the project. Animal cell organization and structure of the digestive system and urinary systems explained using 3d models and audio explanations. We used blender and unity softwares to create and edit 3d models. Each 3d model has an ability on rotation.



```

Files
backButton

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class backButton : MonoBehaviour
{
    private int previousScene;
    // Start is called before the first frame update
    void Start()
    {
        previousScene = SceneManager.GetActiveScene().buildIndex - 1;
    }

    // Update is called once per frame
    public void OnTriggerEnter2D(Collider2D collision)
    {
        SceneManager.LoadScene(previousScene);
    }
}

```

Figure 31: Back button press code

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class NewBehaviourScript : MonoBehaviour
{
    private Touch touch;
    private Vector2 touchPosition;
    private Quaternion rotationY;
    private float rotateSpeedModifier = 0.1f;

    // Update is called once per frame
    void Update()
    {
        if (Input.touchCount > 0)
        {
            touch = Input.GetTouch(0);

            if (touch.phase == TouchPhase.Moved)
            {
                rotationY = Quaternion.Euler(
                    0f,
                    - touch.deltaPosition.x * rotateSpeedModifier,
                    0f);
                transform.rotation = rotationY * transform.rotation;
            }
        }
    }
}

```

Figure 32: Rotation Code

Cell organization and structure of the body systems were explained using audio while displaying the 3d models. Digestion process and Urine Formation were explained. And there are online tutorial access to refer the about diseases regarding to digestive and urinary systems. Diseases page there is a further references button embedded with Uniform Resources Locator (URL).

```

1 using System.Collections;
2 using System.Collections.Generic;
3 using UnityEngine;
4
5 public class UrlOpen : MonoBehaviour
6 {
7     public string Url;
8
9     public void Open()
10    {
11
12        Application.OpenURL(Url);
13    }
14 }

```

Figure 33: url accessibility code

3. RESULT AND DISCUSSION

3.1 Results

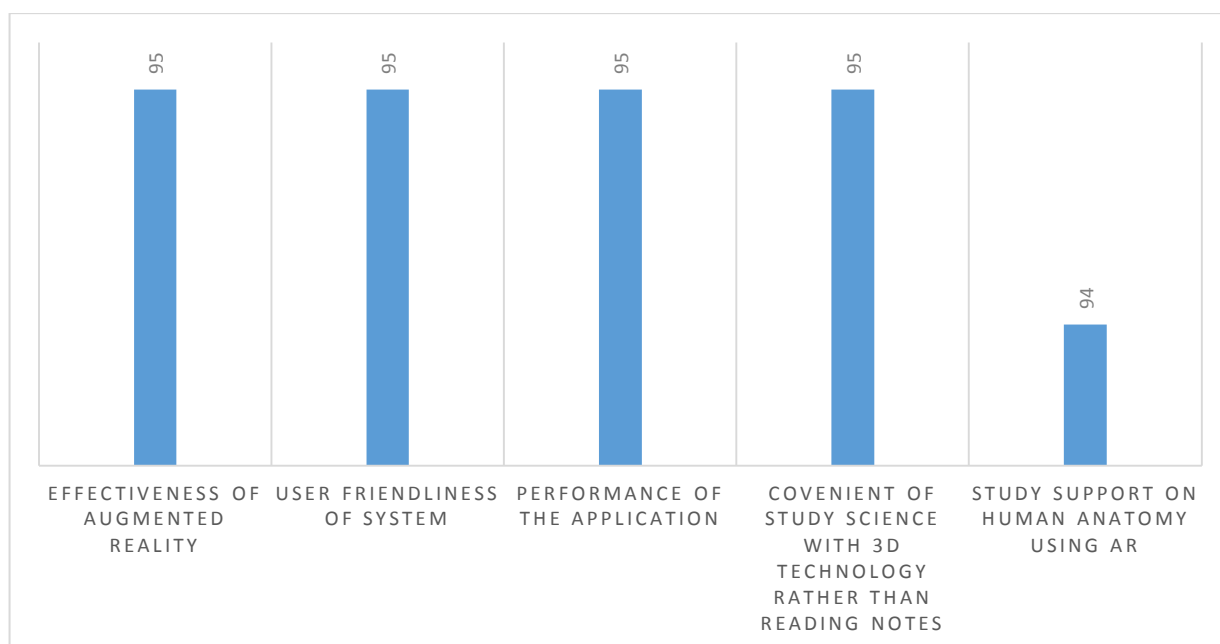


Figure 34: Summarization of responses of students

We tested our Human anatomy augmented reality mobile application among selected grade 11 students from different schools and science teachers to check whether effectiveness of the application and is it support to achieve main goal of this research. From analysing the feedbacks received we identified the areas must improve in this component.

This Human anatomy component was given to Grade 11 students. After they tested the mobile application, around 95% they were interested in 3D model displaying, audio explanations, video explanations and online tutorials. They stated augmented reality was effective and it makes convenient of studying science with 3D technology rather than reading notes. Around 95% of them highly appreciates the speed and responsiveness of mobile application and user friendliness of the mobile application and around 94% of students stated that it gives tremendous supports for student to study human anatomy.

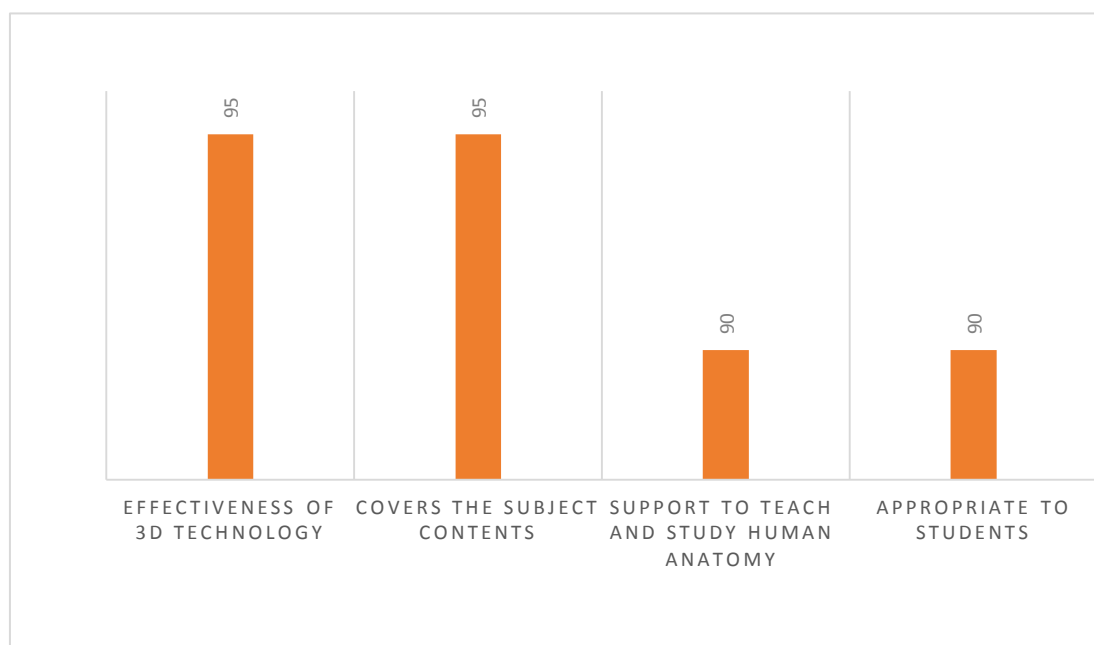


Figure 35: Summarization of responses of teachers

After evaluation done by science teachers they stated that Human anatomy component they highly appreciate on covering the subject contents properly related to selected areas in human anatomy and it support to teach human anatomy and it makes more attractive than the traditional classroom methodologies. Around 90% teachers stated that the human anatomy component is appropriate to students to study science and 3D model displaying, audio explanations, video explanations and online tutorials will effective and enhance self – learning skills of students and it is a new opportunity to gain the technological knowledge of students who keen on learning new technologies.

3.2 Research Findings

Table 11: summarized results of survey findings

Asked Question	Responses in Percentages
Interesting on studying science	55%
Familiar with Mobile phones	92%
Aware of 3D technology	64%
Difficulties in studying science	63%
Preference on studying science using 3D technology	72%

Table 12: Difficulty in studying human body systems

Human Body System	Percentage
Digestive system	35%
Respiratory System	12%
Urinary system	25%
Blood Circulatory System	13%
Reproductive System	15%

After investigating the responses given in the survey we realized that 63% of students want to get a good grade for the subject but they are facing difficulties in studying science. But 55% of the students interesting on studying science but it makes hard to score good grades because science syllabus come up with deep concepts of science

and it hard to understand only reading notes. Therefore it results students to low results in science subject.

So 64% of students stated that there is more effectiveness in 3D technology in supporting to study science and it makes most effectiveness on studying. Therefore we tend to use augmented reality as our main technology which is a modern and growing technology. We found out that 92% of evaluated students are very familiar with mobile phones and they stated that mobile application with 3D Technology will be more convenient for them in their studies.

Digestive system and urinary systems selected as main human body systems covered under human anatomy because 35% and 25% of students stated that it is hard to study digestive and urinary systems respectively.

3.3 Discussion

This product developed as a solution to improve results of G.C.E O/L science subject using an attractive approaches in modern technologies.

This research started at the end of the 2019. Initially we selected e – learning and education research area. After referred the statistics issued by national examination department, we realized that the problem mentioned above. Then gathered the requirements regarding to human anatomy. Requirement gathering was done by conducting a survey through a questionnaire. After investigating the results of the survey we realized that students hard to study digestive and urinary systems. Therefore we selected those systems under human anatomy. And they would like to refer the 3d technological supported mobile application as a study material rather than the reading notes.

Use of newest technologies would be a great impact on learning process of students. Therefore we come up with a solution based on augmented reality. Augmented reality has the ability on making virtual learning environments while converting two dimensional objects into their three dimensional versions. Therefore animal cell overview, human body systems, diseases and processes regarding to system

implemented using 3d models displaying, audio visualizations, videos and online tutorial access.

When compared this human anatomy component with existing researches done by different countries makes significant gap within the ability on support study using both English and Sinhala languages. Because existing researches used their main language as English. And those applications only described human body systems and internal organs. Within this application students can learn diseases and processes regarding to digestive and urinary systems within the support of 3d technology.

4. SUMMARY OF INDIVIDUAL CONTRIBUTION

Table 13: Description of individual Contribution

Member	Component	Task
IT17157988 Liyanage P.M	Human Anatomy	<ul style="list-style-type: none"> • Demonstration of the animal cell using 3D model of animal cell and audio explanations • Demonstrate urinary system overview using 3D model of urinary system and audio explanations • .Demonstrate Digestive System Overview using 3D model of animal cell and audio explanations • Demonstrate Process of Digestion using video explanations • Demonstrate Process of Urine formation using video explanations • Generate text based descriptions about animal cell, digestive system and urinary system • Demonstrate about Diseases and Disorders in each systems using text based descriptions and online tutorial access.

5. CONCLUSION

Main objective is to improve results of G.C.E. O/L science subject using interactive solutions. According to the test results and the feedbacks received from both teachers and students, they stated that it supports to study human anatomy this component provides alternative methods using augmented reality to learn animal cell overview, human body structures, processes and diseases. And it would be a great impact on improving science results.

As well they stated that this application has an ability on motivate students on learning human anatomy while it enhance the time spending on studying and it is a good supporting learning material for teaching process within properly align subject contents.

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AUGMENTED REALITY SCIENCE APP FOR O/L STUDENTS

We are a final year project group at Sri Lanka Institute of Information Technology (IT17107624 – De Silva K.V.P.W, IT17106252 – U.S Hettihewa, IT17157988 – Liyanage P.M, IT17098588 – N.M.W.K.P.C Naranpanawa). The purpose of this questionnaire is to gather requirements for our final year research project. Please spare few minutes from your busy schedules and be kind enough to respond to this survey. Further, we will assure that all correspondence, including completed survey forms will be kept confidential and secure.

1. What is your expected grade for science at the O/L examination?
 - i. A
 - ii. B
 - iii. C
 - iv. S
 - v. F
2. Are you facing any difficulties in studying science?
 - i. Yes
 - ii. No
3. How familiar are you in using mobile phones?
 - i. Very familiar
 - ii. Somewhat familiar
 - iii. Not familiar
4. Do you think that a mobile app with 3D technology will support you to study science more effectively?
 - i. Yes
 - ii. No
 - iii. Neutral
5. Which way will be more convenient for you to study science?
 - i. Reading notes
 - ii. Using a mobile app with 3D technology
6. Number the following according to the order you think that 3D technology will be benefited most study (1- most benefited, 4 – least benefited)?
 - i. Acids

- ii. Bases
- iii. Salts
- iv. Hydrocarbons

7. Number the following according to the order which is hard for you to study (1-most , 4 - least)?

- i. Digestive System
- ii. Respiratory system
- iii. Urinary System
- iv. Blood Circulatory System
- v. Reproductive System

8. Which of the below topics on plant processes, you feel difficult in your studies?
Number according to your preference. (1-most difficult, 3-least difficult)

- i. Photosynthesis
- ii. Plant respiration
- iii. Reproduction

9. Number the following according to the order which is hard for you to study (1-most , 4 - least)?

- i. Plant cell structure
- ii. Plant tissue organization

10. Which of the following experiments do you feel difficult from your science syllabus?
(1-most, 5-least)

- i. Starch production during photosynthesis
- ii. Need of light energy for photosynthesis
- iii. Need of CO₂ for photosynthesis
- iv. Need of chlorophyll for photosynthesis
- v. O₂ production during photosynthesis

11. Number the following cycles according to the order which is complicated for you to understand? (1 – most, 4- least)

- i. Water Cycle
- ii. Hydrogen cycle
- iii. Nitrogen cycle
- iv. Carbon cycle

12. According to you, what kind of benefits you can gain by using a mobile app with 3D technologies to study your O/L science syllabus?

Thank You!