AUGMENTED REALITY BASED LAB ASSISTANT SYSTEM

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August 2013

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Dissertation submitted in partial fulfillment of the requirements for the degree of Science

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DECLARATION

I declare that this is my own work and this dissertation 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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ABSTRACT

Nowadays Scientific and engineering equipment is required in undergraduate education since the students have to deal with lots of laboratory practical. Normally lab instructors explain about the operations of the particular machines but since some machines have lots of operations normally students find it hard to remember each and every operation.Therefore as a solution students refer devices' user manuals / online resources.But when the device is not physically available at the moment,it is difficult to learn by referring user manuals and internet resources.Also teaching each and every student separately takes lot of time and most of them are asking same kind of questions. Another problem is these equipments are very expensive and there are only few equipments available per university.These are current problems in universities but there are no any solution to overcome these. ARLAB system was planned to develop as a solution for these problems.Its goal is to identify controllers of machines using an android phone which can be used by students as a self learning tool. It consist with two main options, online mode(with the device) which will identify controllers and provide a description of them in real time and the offline mode(without the device) which provide facilities to search tutorials and video playback. In the backend there is a web site where any user can create a user manual for any device by adding pictures and descriptions. Support Vector Machine(SVM) has been used here as the machine learning algorithm. The front end is an android mobile application. There are several options available in the mobile application.One option can be used when the device is not available physically at the moment.By using it user can search for tutorials which demonstrate some tasks. This functionality enables students to search videos that are available in the internet. The other option can be used when the device is available physically at the moment. In that case when a student focuses his phone's camera towards a specific controller and after capturing an image, the description of it will be shown on the phone display.So this ARLAB system will help to overcome problems addressed before.

ACKNOWLEDGMENT

Even though final year Information Technology Research Project is just another subject, it is the last opportunity for IT undergraduates to face the real industry in the field of Information Technology. This is totally a fresh situation for us, thus we need guidance and help from our lecturers. We gratefully acknowledge those who contributed to our project. First and foremost we would like to thank the Sri Lanka Institute of Information Technology for providing us with the knowledge and the tools to complete the project. They also initialized the requirement of the fourth year project which is vital for completing the course.

We would also like to thank the driving force behind the project, our supervisor Mr. Bathiya Lakmal Priyadarshana and our co-supervisor Mr. Sheron Dinushka, providing us support in numerous ways. We would gratefully acknowledge our Lecture-in-charge, Head of the Research Groups Mr.Jayantha Amararachchi for his guidance through the course.They guided us at our difficult times, motivating and pointing out our mistakes to make the project a success. We couldn't have been able to complete the project without the excessive support and guidance them.

Last but not the least we would like to thank out team members, for tolerating, for sharing, for giving and mostly for all the compromising. Our collective thinking and effort is what making our system in success. The team spirit and commitment we developed towards the latter part of the project and the lasting bond of friendship was undoubtedly a positive side effect. We thank everyone who helped us to complete the project in numerous ways and who guided us in many ways.

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LIST OF ABBREVIATIONS

ARLAB	Augmented Reality Based Lab Assistant
ARLAB Mobile Application	Application developed to run in Android environment with aid of Smart phone.
ARLAB Web Application	Web site where Users or Lectures can get register with the system.
Database	Collection of all the information monitored by this system.
Software Requirements Specification	A document that completely describes all of the functions of a proposed application and the constraints under which it must operate. For example, this document.
User	Any person uses both ARLAB Mobile Application and Web Application.
Online mode	When the user is near the device the system is using the device to identify components (With the device).
Offline mode	When the user is not near the device use searching facility to get the information of the device (Without the device).
WCMS	Web Content Management System

Chapter 1

INTRODUCTION

1.1 Research Background

Augmented reality (AR) is a live, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. It is related to a more general concept called mediated reality, in which a view of reality is modified (possibly even diminished rather than augmented) by a computer [1].

The first augmented reality (and also the first virtual reality) system was created by Ivan Sutherland in 1968.It uses an optical see-through head mounted display that is tracked by two different 6DOF trackers. There were a mechanical tracker and an ultrasonic tracker. Because very limited computing power of computers at that time, this system only displayed simple wireframe drawings in real time [2].

Streaming video is content sent in compressed form and displayed by the viewer in real time. With streaming video or streaming media, a user does not have to wait to

download a file to play it. Instead, the media is sent in a continuous stream of data and is played as it arrives. The user needs a player, which is a special program that uncompresses and sends video data to the display and audio data to speakers.Mobile video streaming is possible because of recent enhancements in mobile phone displays and fast broadband connections over cellular service. 3G networks are capable of streaming video at about 14 Mbits per second. 4G is expected to reach speeds of up to 100 Mbits per second,that's faster than most home broadband connections. Some phones use Adobe Flash and Microsoft's Silverlight softwares for video streaming. Others are depending on new browser technology that can display high-definition video straight through your phone's mobile browser without having to install any additional software. The most exciting prospect regarding full-featured browsers on mobile phone is that any video user can play on his desktop will be able to stream to his phone -too.

Machine learning systems automatically learn programs from data. This is often a very attractive alternative to manually constructing them, and in the last decade the use of machine learning has spread rapidly throughout computer science and beyond. Machine learning is used in Web search, spam lters, recommender systems, ad placement, credit scoring, fraud detection, stock trading, drug design, and many other applications. [3].

While developing ARLAB system those addressed technologies - AR,mobile video streaming and machine learning were used to come up with an accurate,efficient and fruitful system.

1.2 Research Problem

The ARLAB system is based on a back end web service a web site and a front end mobile application. This system would provide an easy and accurate way to learn different devices for undergraduates.By using this they can learn devices not only when the device is physically available with them but also when the device is not physically available with them.

The idea for this project came as a result of problems encountered by undergraduates specially CSN,civil engineering students while they are learning new devices.When someone finds a new device for the first time it is very hard and complicate to handle the device by himself. In that case students always need someone to instruct them, who knows about the device very well. Therefore it might be really an embarrassment for the students who are using numerous devices for their education such as engineering students. The ARLAB system would help them in such situations

To develop this system as a working system there were some areas needed to be considered.They were Augmented Reality,Image processing and machine learning.

Augmented Reality is a type of virtual reality that aims to duplicate the world's environment in a computer. An augmented reality system generates a composite view for the user that is the combination of the real scene viewed by the user and a virtual scene generated by the computer that augments the scene with additional information. The virtual scene generated by the computer is designed to enhance the user's sensory perception of the virtual world they are seeing or interacting with. The goal of Augmented Reality is to create a system in which the user cannot tell the difference between the real world and the virtual augmentation of it. Today Augmented Reality is used in entertainment, military training, engineering design, robotics, manufacturing

and other industries.

Digital image processing is a set of computational techniques for analyzing, enhancing, compressing, and reconstructing images.Image processing has extensive applications in many areas, including astronomy, medicine, industrial robotics, and remote sensing by satellites. pattern recognition[4].

Machine learning algorithms can gure out how to perform important tasks by generalizing from examples. This is often feasible and cost-eective where manual programming is not. As more data becomes available, more ambitious problems can be tackled. As a result, machine learning is widely used in computer science and other elds.

Within our project the purpose of using machine learning is to identify the components of a device or a machine according to the given samples. But the problem is when we take different versions of same machine they may represent controllers in different ways. As the time goes different versions of same machine will be created. In those different versions the color, shape of the controllers will be changed and also new features, functions will be introduced. In that case the application wont be able to identify the components according to the samples that have been fed to the system previously.Another problem is difficulty in identifying faded and chafed controllers.

Even though there are such problems this project will be implemented in such a way to overcome those problems as much as possible.

1.3 Research Questions

Mobile Application

1. Get the live images continuously from the camera.

2. Send the images to the backend server using a web service.
3. Retrieve the relevant information about the images which you sent to the web-server.
4. Point out the controllers and display the information using augmentation reality technique.
5. After user select a particular controller display the information and small video about the controller if available.

Problems of mobile application

1. Show the description and mark the controllers using augmentation reality technique.
2. Mobile app video streaming.

Back end (Web service)

1. Get the image from the mobile.
2. Identify the controller separately from the background using image segmentation and detect the edges.
3. Match the current image using some of other image processing techniques with our Database
4. Using machine learning techniques tell computer how to identify the controllers under any circumstances.

Problems of back end

1. What is the most suitable image segmentation technique that we should use?

2. How to detect the edges and perform feature matching.

3. Predict whether the controller is a controller of the relevant machine or not, identify chafed controllers using machine learning techniques.

Chapter 2

METHODOLOGY AND RESEARCH FINDINGS

A methodology is a set of guidelines or principles that can be tailored and applied to a specific situation. In project duration, members must follow these guidelines. A methodology could also be a specific approach, templates, forms, and testing used over the project life cycle. A formal project methodology should lead the work of all team members throughout the life cycle of a project.

2.1 Addressing the Literature

Mobile learning, or ”m-learning”, offers modern ways to support learning process through mobile devices, such as handheld and tablet computers, MP3 players, smartphones and mobile phones [5]. In other words it means any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile tech-

nologies. Therefore by using mobile learning, learners can learn anywhere and at any time.

Today's learners expect information to be available at all times, not just in the classroom. Companies such as Apple recognize this phenomenon and provide ways for teachers to distribute multimedia course content to their students in non-traditional [6]. Now, learning can take place anywhere, from the bus to the home.

The concept of the undergraduate student as an experimenter is fundamental to engineering education and to the role of a practicing engineer. The undergraduate student should become an experimenter in the laboratory, which should provide him with the basic tools for experimentation, just as the engineering sciences provide him with the basic tools for analysis.

The primary goal of The Augmented Reality Based Lab Assistant system is to identify controllers of some specified set of machines using an android phone which can be used by students as a self-learning tool. It consists with two main options, online mode(with the device) which will identify controllers and provide a description of them in real time and, the offline mode(without the device) which provide facilities to search tutorials and video playback.

After commencing the research a survey was carried out to identify that there are any other research have done in this area. Internet, books, university lecturers were the foremost resources of this survey. In accordance this survey done by using Internet there were no similar applications found but there were applications similar in some of the functionalities.

- Contextual Mobile Learning System for Saudi Arabian Universities

With the help of this system, the students can learn just in time in their daily lives

whenever they need to learn; using mobile computing devices like Tablet PCs and Smart Phones. The main principles and the essential components such as functional modules and context databases are presented [7].

- Augmenting Memory for Student Learning : Designing a Context-Aware Capture System for Biology Education

This is a context-aware capture system for undergraduate biology students. This system will enable students to automatically capture virtually all of their personal educational information such as lecture notes, slides, videos, lesson plans, and assigned readings, as well as paper drafts, assignments, brainstorming on whiteboards, or images and artifacts from field trips. It describes an alternative approach that can both reduce complexity and improve retrieval of captured digital educational information [8].

The Augmented Reality Based Lab Assistant system provides an effective, accurate, reliable and real-time mobile application as a self-learning tool which can be used to identify the operations of a machine. The System is designed especially for the students who deal with the advanced machineries which has lots of operations.

2.2 Methodology

Nowadays Scientific and engineering equipment is required in undergraduate education since the students have to deal with lots of laboratory practical. Normally lab instructors explain about the operations of the particular machines but since some machines have lots of operations normally students find it hard to remember each and every operation.Therefore as a solution students refer devices' user manuals / online

resources.But when the device is not physically available at the moment,it is difficult to learn by referring user manuals and internet resources.Also teaching each and every student separately takes lot of time and most of them are asking same kind of questions. Another problem is these equipments are very expensive and there are only few equipments available per university. These are current problems in universities but there are no any solution to overcome these. ARLAB system was planned to develop as a solution for these problems.Its goal is to identify controllers of machines using an android phone which can be used by students as a self learning tool. It consist with two main options, online mode(with the device) which will identify controllers and provide a description of them in real time and the offline mode(without the device) which provide facilities to search tutorials and video playback.

In the backend there is a web site where any user can create a user manual for any device by adding pictures and descriptions. Support Vector Machine(SVM) has been used here as the machine learning algorithm. The front end is an android mobile application. There are several options available in the mobile application.One option can be used when the device is not available physically at the moment.By using it user can search for tutorials which demonstrate some tasks. This functionality enables students to search videos that are available in the internet. The other option can be used when the device is available physically at the moment. In that case when a student focuses his phone's camera towards a specific controller and after capturing an image, the description of it will be shown on the phone display.So this ARLAB system will help to overcome problems addressed before.

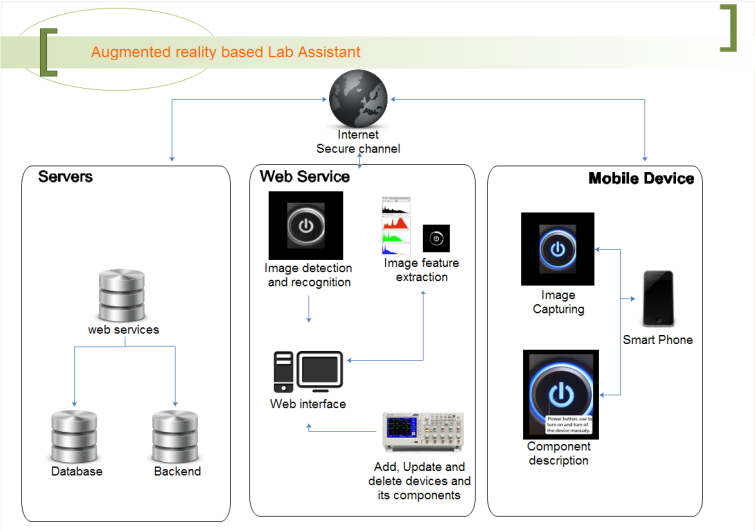

Figure 2.1: system diagram of the Augmented Reality Based Lab Assistant system

2.3 Process behind the activities

The Augmented Reality Based Lab Assistant System has a front end mobile application and a backend implementation. The functionalities of the overall system can be classified as follows,

- Web site to 'Add, Update and Delete devices'
- Image capturing
- Handling the communication between Mobile Application and the Remote Server
- Feature extraction
- Analyze data and recognize patterns, used for classification and regression analysis (Machine learning)
- Offline mode for tutorial searching
- Video streaming

2.3.1 Web site to 'Add, Update and Delete devices'

By using this website any user can create a user manual for any selected device. In order to do that first of all he should provide the name of the device, an image of the device and a description and You Tube URL's for the device. After that he can provide the details of the components(controllers).In that case for each controller he must provide a set of negative and positive images. Here negative images mean images which are not images of that particular controller, positive images mean images of that particular controller taken under different light conditions, different angles etc.

Using this images the system will extract certain features such as colour histogram and edge extraction and convert it to a metric and feed it to the system as samples to that particular device component. which will help in image identifying process. Once a device and its component added to the system user can update and delete its information any time user want.

2.3.2 Image capturing

In order to use this application in online mode the student should capture the image of the controllers. Then the image will be passed to the backend web service and the controller will be identified using LibSVM. After that the description related to that particular controller will be passed to the front end mobile application and mobile application will show it on its display.

2.3.3 Handling the communication between Mobile Application and the Remote Server

This application uses KSOAP as the communication protocol. KSOAP was specially designed or developed to deal with small embedded device like mobile devices .And also KSOAP is a lightweight and efficient SOAP library for the Android platform. KSOAP toolkit provides not only small size and great functionality, but also relative simplicity and ease of use for the developer. Using KSOAP, a developer can develop complex SOAP Web services clients in a remarkably short time. By Consider those advantages of the KSOAP was chosen as the communication protocol for this application.

After capturing the image, the captured image will be converted into Base64 string and then the application will pass it to the backend web service. After receiving the Base64 String the web service will convert it back to a real image. Then the required processing will be done to the image and then the final result will be passed to the mobile application as an xml file.

2.3.4 Feature extraction

In pattern recognition and in image processing, feature extraction is a special form of dimensionality reduction.

When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (e.g. the same measurement in both feet and meters) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called

feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input [9].

Colour histogram and edge extraction are the main key features that is use by the ARLab to train and identifying device component. When it comes to the training process it's totally done in the WCMS, which is extracted when the sample images uploading to the system to train the system. Apart from that colour histogram, edge extraction has to be extracted again for the identifying process. This also extracted inside the WCMS. Because still mobiles have less processing power so it will make the application slower. There for the image that has been captured from the device will be transferred as Base64 string. After producing the actual image from the Base64 string the web application will consider each pixel's intensity value of that image and extract a color histogram and edge based on that. After that the application will compare it with the color histograms and edges of the images which were added while adding the device to the system.

2.3.4.1 Color Histogram extraction

The histogram provides a compact summarization of the distribution of data in an image. The color histogram of an image is relatively invariant with translation and rotation about the viewing axis, and varies only slowly with the angle of view [10]. By comparing histograms signatures of two images and matching the color content of one image with the other, the color histogram is particularly well suited for the problem of recognizing an object of unknown position and rotation within a scene. Importantly, translation of an RGB image into the illumination invariant rg-chromaticity space allows the histogram to operate well in varying light levels.

2.3.4.2 Edge Extraction

The purpose of edge detection in general is to significantly reduce the amount of data in an image, while preserving the structural properties to be used for further image processing. Several algorithms exists, and this worksheet focuses on a particular one developed by John F. Canny (JFC) in 1986 [11]. Even though it is quite old, it has become one of the standard edge detection methods and it is still used in research [12].

The AForge.NET framework has been use for the edge detecting process.AForge.NET framework provides number of edge detection filters, which may suite different tasks providing different performance.ARLab uses the canny edge detector to detect the edges. What AForge.Net filter dose is searches for objects' edges by applying Canny edge detector. Figure 2.2 illustrate the Canny edge detection.

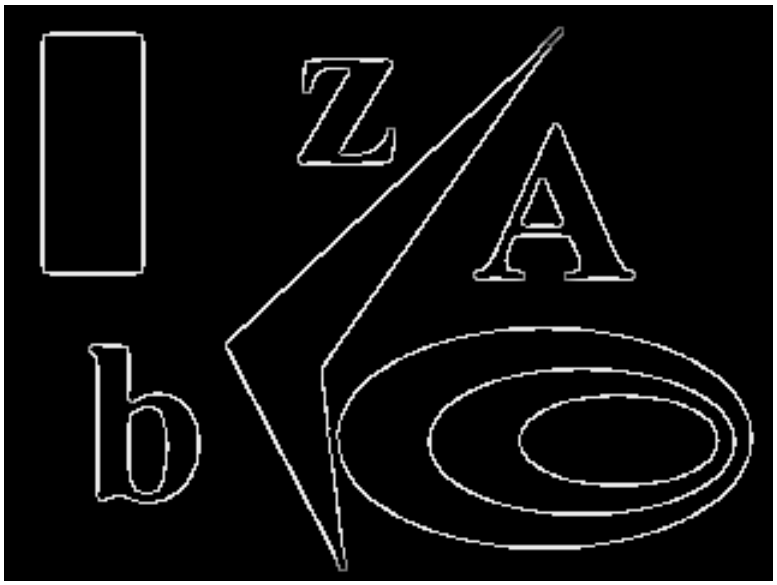

Figure 2.2: Canny edge detection

2.3.5 Analyze data and recognize patterns, used for classification and regression analysis (Machine learning)

Machine learning is the science of getting computers to act without being explicitly programmed. It focuses on prediction, based on known properties learned from the training data. Training the system by giving number of samples is done in machine learning. According to purpose of this research, application should be able to identify images of the controllers under different lighting conditions and it should be able to identify chafed controllers as well.

For this application Support Vector Machine(SVM) has been used as machine learning algorithm. Support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. The basic SVM takes a set of input data and predicts, for each given input, which of two possible classes forms the output, making it a non-probabilistic binary linear classifier. Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on.

Since the machine learning part is run in WCMS LibSVM library has been use to do machine learning. ARLab uses an clean .NET conversion of libsvm 2.89, specifically from the Java version. Full functionality and efficiency is maintained, but the object structure has been modified to be more appropriate for the .NET platform (including

C# and VB.NET). Sample code of LibSVM works illustrate in Figure 2.3.

```
//First, read in the training data.

Problem train = Problem.Read("a1a.train");
Problem test = Problem.Read("a1a.test");


//For this example (and indeed, many scenarios), the default
//parameters will suffice.
Parameter parameters = new Parameter();
double C;
double Gamma;


//This will do a grid optimization to find the best parameters
//and store them in C and Gamma, outputting the entire
//search to params.txt.

ParameterSelection.Grid(train, parameters, "params.txt", out C, out Gamma);
parameters.C = C;
parameters.Gamma = Gamma;


//Train the model using the optimal parameters.

Model model = Training.Train(train, parameters);


//Perform classification on the test data, putting the
//results in results.txt.

Prediction.Predict(test, "results.txt", model, false);
```

Figure 2.3: Sample code of LibSVM works

Train files for the machine learning is illustrate by figure 2.4

```
[label] [index]:[value] [index]:[value] ...
...
```

Figure 2.4: Train files for the machine learning

2.3.6 Offline mode for tutorial searching

This functionality can be used when the device is not physically available at the moment. In that case the application will show available devices and the user has to select

the device he wants to learn. Then the application will show an image and a description of the device. Furthermore if the user wants to learn the controllers of the device, the application provides him the functionality to search the tutorials related to that device.

2.3.7 Video streaming

Augmented Reality Based Lab Assistant consists with video streaming facility which gives the user to use the smart phone to search and watch for available video tutorials regarding the machine that they need to study. Streaming video is content sent in compressed form over the Internet and displayed by the viewer in real time. Video streaming has a big advantage since with the streaming video or streaming media a user does not have to wait to download a file to play it. Instead, the media is sent in a continuous stream of data and is played as it arrives. As we mentioned early in this document this research application targets the laboratory students who have to deal with machines with lots of operations. Therefore it is very useful for them to learn about the machine by watching video tutorials using their smart phone. This application provide that facility, when the user use this application in order to identify the operations a particular machine and at the same time the user can search for online video tutorials regarding that machine. Figure 2.5 illustrates the video streaming life cycle.

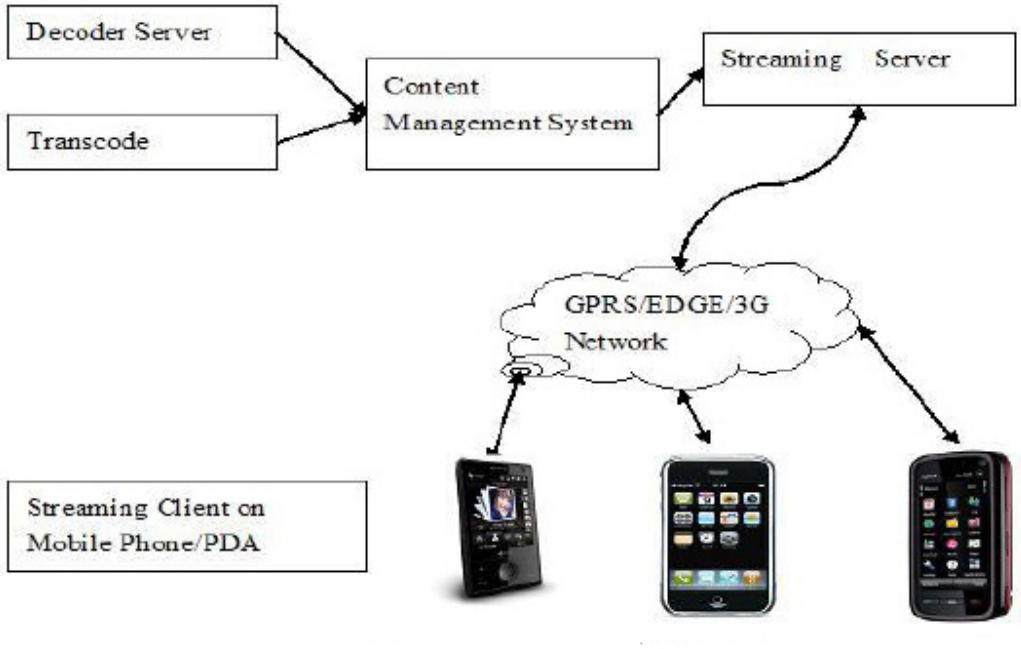

Figure 2.5: video streaming life cycle

2.3.8 Research Findings

This document propose an innovative mobile device learning system specially designed for undergraduate students who are using number of devices for their studies. Many irrelevant topics have to be examined and filtered before the real research reading could be done. But all this relevant content had to be read over and over again for it to be made clear and to be used in the design stage of the development.

In this project, we investigated various algorithms to implement the system. We used histogram based color extraction, edge extraction and Support Vector Machine for controller identification. The test results show that the system works well for most cases; however, some improvements are still necessary in working towards a reliable system.

Controller identification in uncontrolled environment was a very difficult task due to

the large number of variable conditions affecting to the quality of the image. Lighting conditions, angle of the image taken were some of them. To control the effect of lighting conditions, the system was trained using number of images of the same controller under different lighting conditions.

When detecting the controllers, sometimes those controllers are chafed .So it introduces a great deal of dissimilarity between the test image (image of the chafed controller) and the sample images already in the system. Using machine learning algorithms the system is able to deal with those types of situations for a certain degree.

Limited computational power of the mobile phones was also a major problem because Augmented Reality Based Lab Assistant application needs high performance RAM and processor to implement the Image processing algorithm. Therefore RAM and the processor of the mobile phones are going to be a limiting factor. Because of this problem the Image Processing part was shifted to the backend.

Finally group members successfully developed and tested the application which is based on SVM, edge detection and color detection algorithms. As part of the future work, we would like to develop the complete solution to be run inside the mobile phone. Accuracy of the result gives from Color detection module depends on the quality of the image and the lighting conditions. So we hope to develop the color detection module to work with all the images even with very low quality images. We would also like to explore better algorithms for controller identification to improve this as a very efficient and accurate application.

Chapter 3

RESULT AND DISCUSSION

The main result that can be mentioned after the research into this project is the development of a self-learning application that can help SLIIT students and teachers about the Lab devices. This application is mainly focusing on following key aspects.

- Implement an Effective Lab assistant System to SLIIT.
- By motivating the students to self-learning, reduce the workload of the lectures.
- Save the precious time of the Instructors as well as students of SLIIT.
- Introduce the concept of Augmented Reality to the students of SLIIT.
- Provide detail information about the devices which are in the labs very efficiently.

A great amount of effort on C#, Lib SVM, Android and relevant algorithms have created the way into successfully understanding the research parts of the project. It helped the team to develop a successful Augmented Reality based lab assistant system.

Evidence plays an important role in any software product. Because from that end user and other external parties related to the project development can get an idea of final outputs and the quality of the final products. This verifies the final output verification and the validation. Evidence helps to prove main concept of the whole project. Discussions support the user to get an idea about the project. Evidence can be collected from different ways throughout the development life cycle. According to the evidence, discussions can be performed to better outputs. In any software these can be many bugs before release or after release of the product. There is no software which has no bugs or defects. That is why the evidence and discussions are needed, to minimize the bugs of the product before releasing it.

End user satisfaction is one of the goals on any software product and the product should be well suited for the user as well. To accomplish the above target, evidence and discussions are very helpful. Discussions or the test cases can be set at different phases in the software life cycle.

3.1 Results

The main purpose of ARLab is motivating the students of the SLIIT to self-learn in an interactive way. It is designed to be a personal assistant to a user to serve his or her need for not only learning basic things about the devices that are in the lab but also it gives the additional knowledge about the devices him or her working with. By labeling the device components around him/her, it will assist the users how to operate the devise correctly by merging the real world with the digital content on the mobile display creating an Augmented Reality (AR).

Apart from that AR lab assistant will have a web application. It will mainly act as a

Web Content Management System (WCMS), which provides an excellent way of organizing distributing data among the core components of ARLab. Users can register themselves with ARLab WCMS and get facility to access its core services once registration is done. Figure 3.1 illustrates the ARLab WCMS overview.

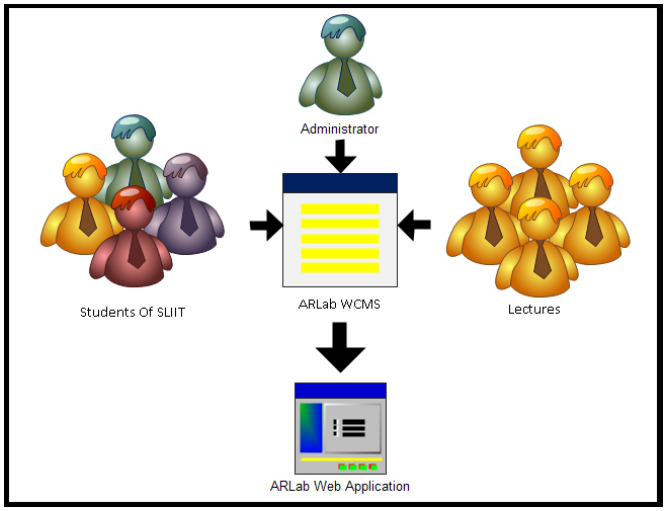

Figure 3.1: ARLab WCMS Overview

3.1.1 Mobile Application

This module mainly acts as a client application, which will connect with the web application. This module is responsible of providing the information regard to the devices added on the WCMS. Once the image is taken it provides the information correspond to that device by communicating with WCMS.

3.1.2 Web Assistant

This module mainly acts as a Web Content Management System, which provides an excellent way of organizing & distributing data among the core components of ARLab. Users can register themselves with ARLab WCMS and get facility to access its core services, once registration is done. Users could also add certain devices to the system by him self.

3.2 Evidence

A software testing needed to be handled to discover the accuracy of the newly created application. Even though it can be time consuming it would be useful to avoid or lower the possibility for unnecessary retesting or debugging.

Software testing is a method of assessing the functionality of a software program. There are many different types of software testing but the two main categories are dynamic testing and static testing [13].

Dynamic testing is an assessment that is conducted while the program is executed; static testing, on the other hand, is an examination of the program's code and associated documentation. Dynamic and static methods are often used together [14].

To review the capabilities or features on a certain function, a set of test cases would be created. This would be a set of conditions or steps and inputs to achieve a particular goal. To determine the exact requirement or objective of a functionality of the application more than one test case would be required.

Here is a sample of the test cases that has been applied to test the ARLab. The format

of the test case is as follows;

- Test ID number - Rationale.
- Steps to follow.
- Expected outcome.

3.2.1 Test cases for Mobile Application

Test ID 1: Welcome Screen - Start up.

Steps to follow:

1. Tap the ARLAB icon.

Expected Outcome:

1. Display the ARLAB Welcome Screen.

Test ID 2: Main Interface Select Lab Assistant view.

Steps to follow:

1. Repeat Test ID 1.
2. Tap on the ”Lab Assistant” icon available in the main interface.

Expected Outcome:

1. If the mobile device connected to the internet display the Lab Assistant screen successfully.
2. If the mobile is not connected to the internet display ”No internet connection” Message and open the ”Mobile network setting” window.

Test ID 3: Main Interface select Available machines.

Steps to follow:

1. Repeat Test ID 1.
2. Tap on the ”Machines” icon available in the main interface.

Expected Outcome:

1. If the mobile device connected to the internet display the Available Machines screen successfully.
2. If the mobile is not connected to the internet display ”No internet connection” Message and open the ”Mobile network setting” window.

Test ID 4: Main Interface selects Tutorial.

Steps to follow:

1. Repeat Test ID 1.
2. Tap on the ”Tutorial” icon available in the main interface.

Expected Outcome:

1. If the mobile device connected to the internet display the Tutorial screen successfully.
2. If the mobile is not connected to the internet display ”No internet connection” Message and open the ”Mobile network setting” window.

Test ID 5: Main Interface selects Quick Search.

Steps to follow:

1. Repeat Test ID 1.
2. Tap on the ”Quick Search” icon available in the main interface.

Expected Outcome:

1. If the mobile device connected to the internet display the Quick Search screen successfully.
2. If the mobile is not connected to the internet display ”No internet connection” Message and open the ”Mobile network setting” window.

Test ID 6: Main Interface selects Instructions.

Steps to follow:

1. Repeat Test ID 1.
2. Tap on the Menu icon of the Mobile phone inside the main interface.
3. Tap on the ”Instructions” button available in the Menu.

Expected Outcome:

1. Display the Instructions screen successfully.

Test ID 7: Main Interface selects About us.

Steps to follow:

1. Repeat Test ID 1.
2. Tap on the Menu icon of the Mobile phone inside the main interface.
3. Tap on the ”About us” button available in the Menu.

Expected Outcome:

1. Display the About us screen successfully.

Test ID 8: Main Interface selects Exit.

Steps to follow:

1. Repeat Test ID 1.
2. Tap on the Menu icon of the Mobile phone inside the main interface.
3. Tap on the ”Exit” button available in the Menu.

Expected Outcome:

1. Exit from the application.

Test ID 9: Lab Assistant Interface selects AR view.

Steps to follow:

1. Repeat Test ID 2.
2. Set the Screen size by Tapping on the combo box available in the interface.
3. Tap on the ”Still Mode” icon & point out the mobile Camera to the particular controller.
4. Tap on the ”Tap Here” icon.

Expected Outcome:

1. Display a detailed description of the particular controller of the machine according to the AR View.

Test ID 10: Lab Assistant Interface selects Camera Information.

Steps to follow:

1. Repeat Test ID 2.
2. Tap on the Menu button of the mobile phone.
3. Tap on the ”Camera information” button on the menu.

Expected Outcome:

1. Display the camera information.

Test ID 11: Machines Interface selects Machine.

Steps to follow:

1. Repeat Test ID 3.
2. Tap on the List (Available machines will be display in the list).

Expected Outcome:

1. Display a detailed description of the machine with an image.

Test ID 11: Machines Interface selects Machine.

Steps to follow:

1. Repeat Test ID 3.
2. Tap on the List (Available machines will be display in the list).

Expected Outcome:

1. Display a detailed description of the machine with an image.

Test ID 12: Machines Interface search Machine.

Steps to follow:

1. Repeat Test ID 3.
2. Enter the machine name in search field and Tap on the front button to the search field.

Expected Outcome:

1. If the machine is available within the system database it will display detailed description of the machine with an image.
2. If the machine is not available within the system database, ”Sorry! The machine is not available” message will be shown and gives the web search opportunity.

Test ID 13: Machine Interface Clear search field.

Steps to follow:

1. Repeat Test ID 3.
2. Tap on Menu button of the mobile phone
3. Tap on ”Clear” button of the Menu.

Expected Outcome:

1. Search field cleared.

Test ID 14: Tutorial Interface selects Machine.

Steps to follow:

1. Repeat Test ID 4.
2. Tap on the List (Available machines will be display in the list).

Expected Outcome:

1. Display the Video list Screen.

Test ID 15: Tutorial Interface search Tutorial.

Steps to follow:

1. Repeat Test ID 4.
2. Enter the machine name in search field and Tap on the front button to the search field.

Expected Outcome:

1. If the machine is available within the system database it will display detailed description of the machine with an image.
2. If the machine is not available within the system database, ”Sorry! Tutorial for this machine is not available” message will be shown and gives the YouTube Search opportunity.

Test ID 16: Tutorial Interface Clear search field.

Steps to follow:

1. Repeat Test ID 3.
2. Tap on Menu button of the mobile phone.
3. Tap on ”Clear” button of the Menu.

Expected Outcome:

1. Search field cleared.

Test ID 17: Video List Interface Select Video Tutorial.

Steps to follow:

1. Repeat Test ID 14.
2. Tap on the List (available video Tutorials for selected machine will be shown in the list).

Expected Outcome:

1. Play the selected video.

Test ID 18: Quick Search Interface select Quick search.

Steps to follow:

1. Tap on the ”Quick Search” icon and speak the machine name.

Expected Outcome:

1. Display the web search result according to the voice search.

3.2.2 Test cases for Web Application

Test ID 1: Home page (Welcome Screen) - Start up.

Steps to follow:

1. Launch any available web browser.
2. Add security exception.

Expected Outcome:

1. If security exception were not added to browser before, a warning message will be displayed due to un-trusted SSL certificate.

2. Else Home page will be loaded in to web browser.

Test ID 2: Home page (Welcome Screen) Log in.

Steps to follow:

1. Repeat Test ID 1.
2. Click on ”logIn” button which appear in right upper corner navigation web page.
3. Type User name & Password in relevant text boxes.
4. Click on ”LOGIN” button.

Expected Outcome:

1. If user gets authenticated successfully, User will be redirected to Home page.
2. Name of the user will be displayed in right upper corner of web page.
3. If user gets failed to authenticated, the ”Login not successful. Please check the username and password” message will be displayed.

Test ID 3: Home page (Welcome Screen) Crate New ARLab Account.

Steps to follow:

1. Repeat Test ID 1.
2. Click on ”logIn” button which appear in right upper corner of web page.
3. Click on ”Register” link button which appear in left upper corner below the navigation bar of web page.
4. Type User Name, e-mail address, password & confirm password & answer in relevant text boxes.
5. Click on ”SUBMIT” button.

Expected Outcome:

1. If user account created successfully, User will be redirected to Home page.
2. Name of the user will be displayed in right upper corner of web page.
3. If user enters invalid e-mail address, ”Invalid e-mail address” message will be displayed.

Test ID 4: Add New device to the system.

Steps to follow:

1. Repeat Test ID 1& 2.
2. Click on ”Device” button which appear in navigation panel of web page.
3. Add device name, description
4. Add device tutorial URL and click on ”Add” button
5. Click on ”Select File” button and file chooser will appear. Select device images related to the device and click on ”Open” button.
6. Click on ”Next” button.
7. Add component name, component description.
8. Choose one radio button between two choices. Positive or Negative.
9. Click on ”Select File” button and file chooser will appear. Select device componet images related to the device positive or negative and click on ”Open” button.
10. Click on ”Add Device Component” button to add component to the particular device.

11. If user want to add another component click on ”Add New Componet” button.

Expected Outcome:

1. If user enter a invalid url ”Invalid URL” message will be displayed.
2. Add device component interface will appear.

Test ID 5: Update device information.

Steps to follow:

1. Repeat Test ID 1& 2.
2. Click on ”Device” button which appear in navigation panel of web page.
3. Click on ”Update Device” button located at left navigation bar.
4. Select the device name from the Dropdown box.
5. Information related to the particular device will shown inside corresponding text boxes.
6. Update description
7. If user want to add new URL’s Add device tutorial URL and click on ”Add” button
8. If user want he or she can delete current URL’s correspond to that particular device.
9. Click on ”Select File” button and file chooser will appear. Select device images related to the device and click on ”Open” button.
10. Click on ”Next” button. Then Update device component interface will appear.
11. Select the component name from the Dropdown box.

12. Update component description.
13. Choose one radio button between two choices. Positive or Negative.
14. Click on ”Select File” button and file chooser will appear. Select device componet images related to the device positive or negative and click on ”Open” button.
15. Click on ”Update Component” button to add component to the particular device.
16. If user want to add another component click on ”Add Componet” button.
17. If user want to delete particular component that is currently added in the system click on ”Delete Componet” button.

Expected Outcome:

1. If user enter a invalid url ”Invalid URL” message will be displayed.
2. Add device component interface will appear.

Test ID 6: Delete a device from the system.

Steps to follow:

1. Repeat Test ID 1& 2.
2. Click on ”Device” button which appear in navigation panel of web page.
3. Click on ”Delete Device” button located at left navigation bar.
4. Select the device name from the Dropdown box.
5. Click on ”Delete Device” button to delete a particular device.

Expected Outcome:

1. User will be redirected to ”Add Device” page.

3.3 Discussion

The discussion part is mainly focused on discuss about problems faced during the project design and implementation and how those issued are solved. This section also describes how the successful achievements are gained. Most of the software products consist of different kind of bugs. It is our responsibility to minimize the number of bugs before releasing the product to the end user.

3.3.1 How the system achieved excising problems.

The project was started on 6th January 2013. On that day group members were formed. This is the final year project in the degree program and it is indispensable to have a research part in the project. We analyzed the problem through several weeks. After collecting requirements and adding the research parts we came up with a solution. Since we are Information Technology students we had to do our analysis part and designing part in a tremendous manner. Therefore we allocated more time to analyze the problem.

To find out the reason for this situation we went through many web sites, blogs, journals and articles that are mentioned in references. According to that literature survey we identified that there were no similar products available but there were some products which had same functionality but they were not designed for the purpose we were looking for.

In order to provide a solution we categorized overall content of the solution into four functionalities. According to that we designed out the architectural diagram and discussed what were the technological aspects needed to be considered. After that we

identified what are the suitable algorithms for developing the each of the functionality. Then we started designing content of each. We decided to start on basic design diagrams in order model the system and its architecture. Documentation was carried out throughout the duration of the project along with the problem analyzing, system designing.

The testing phase was mainly done for the UI interfaces. This was done in two ways. Namely they are Black box testing and white box testing. The development code was reviewed by peers and followed industrial standards. The functionality was checked by system designers with developers who were in the team. The final outcome of the entire project will be the combination of the work done by each member. Each members' work will finally be plugged to form the final system.

Apart from that we used some newly introduced technologies like Image processing and web services in order to success our target. When considering about the parts the image processing content is combination of two major parts. They are color extraction and edge detection. Also there is a web services which is used for handling the communication between the mobile phone and the remote server.

3.3.2 Special requirements for the system

The following are the minimal requirements we recommend for the smooth operation of the system.

- Dual Core CPU 1GHz processor or higher.
- 3.5 Or bigger display with 240dpi.
- 5MP camera or better.

- The application requires minimum of 30MB free space from the SD card in order to run the application successfully.
- 512mb of RAM during the processing time of the application.
- Wi-Fi / 3G / 4G / HSPDA or any kind of internet connectivity.

Chapter 4

CONCLUSION

The Augmented Reality Based Lab Assistant was developed mainly as an android application but it facilitates the communication between the remote server and the mobile application using web services. In the mobile application, after capturing a particular image it will send the image information to the backend web service. Also the android application use augmented reality technology to show the respond which come from the backend after comparing the information sent from the android app with the images already in the database. In the offline mode the mobile app will provide functionalities like searching tutorials and video playback as well. Apart from comparing images, the backend is provided for creating/modifying user manuals.

The system will basically give all the necessary instruction to the user in order to achieve productive experience with this application. So the user must have to follow all the instructions.

Main benefits of the system

- **User friendliness.**

  The ARLab is design in a simple way that any student can learn the system very easily. And also the web application may consist with simple interfaces that the backend users can easily perform its tasks.

- **Accuracy.**

  The system may identify controllers with 95% accuracy.

- **Self-learning facility.**

  It is much easier to use this device and learn about the devise by the student himself, rather than browsing internet to find out how to use device or asking someone to instruct.

- **Time saving.**

  ARLab helps to save precious time of the Instructors as well as students when conducting lab sessions.

- **Motivate students to self-learning.**

- **More attractive than typical lab sessions.**

- **Less complexity.**

Assumptions and Limitation

- User must have a mobile phone running on Android OS version 2.3.3 or higher with 5.0 MP camera or better.
- Any Internet connection technology (Wi-Fi / 3G / 4G / HSDPA) should be available with the smart phone in order to get connected to the mobile web.
- User should select the best window size in order to capture the controller.
- User must follow the instructions before use this application.

Future Directions

- Future versions of this application shall work on many devices.
- Future versions of this application shall operate on Smart phones running on iOS.
- Future versions of this application will facilitate to add a new device through the mobile phone.
- Future versions of this application will allow organizations which are willing to promote their products to the public and would like to build up awareness about their businesses on general public.

REFERENCES

[1] Mashable developers,"Augmented Reality",[HTML].Available: http://mashable.com/category/augmented-reality/ [Accessed: 24th March 2013].

[2] I. Sutherland, "A Head Mounted Three Dimensional Display", Proceedings of Fall Joint Computer Conference, 1968, pp.757 764. [Download: 26th January 2013].

[3] Pedro Domingos,"A Few Useful Things to Know about Machine Learning", [HTML] Available: http://homes.cs.washington.edu/ pedrod/papers/cacm12.pdf [Accessed: 21st August 2013].

[4] answers.com developers,"Image processing", [HTML].Available :http://www.answers.com/topic/image-processing [Accessed: 21st August 2013].

[5] United Nations Educational(UNESCO),"ICT in Education - Mobile Learning", [HTML].Available : http://www.unesco.org/new/en/unesco/themes/icts/m4ed/ [Accessed: 21st August 2013].

[6] eHow Developers,"Mobile-Based Learning", [HTML].Available: http://www.ehow.com/about_5475157_mobilebased-learning.html [Accessed:

24th March 2013].

[7] T. Altameem, 4, May 2011,"Contextual Mobile Learning System for Saudi Arabian Universities", [HTML].Available: http://www.ijcaonline.org/volume21/number4/pxc3873377.pdf [Accessed: 21st August 2013].

[8] Deborah Barreau, Abe Crystal, Jane Greenberg,*janeg@ils.unc.edu, and Anuj Sharma, School of Information and Library Science, University of North Carolina at Chapel Hill Michael Conway, John Oberlin, Michael Shoffner, Information Technology Services, UNC-CH Stephen Seiberling, Biology Department, UNC-CH, "Augmenting Memory for Student Learning: Designing a Context-Aware Capture System for Biology Education", [HTML].Available: http://www.ils.unc.edu/mrc/pdf/barreau06augmenting.pdf [Accessed: 21st August 2013].

[9] Wikipedia, the free encyclopedia, 23 July 2013,"Feature extraction", [HTML].Available: http://en.wikipedia.org/wiki/Feature_extraction [Accessed: 21st August 2013].

[10] Shapiro, Linda G. and Stockman, George C,"Computer Vision" Prentice Hall, 2003, ISBN 0-13-030796-3.

[11] John Canny. A computational approach to edge detection. Pattern Analysis and Machine Intelligence, IEEE Transactions on, PAMI-8(6):679698, Nov. 1986.

[12] F. Mai, Y. Hung, H. Zhong, and W. Sze. A hierarchical approach for fast and robust ellipse extraction. Pattern Recognition, 41(8):25122524, August 2008.

[13] Sergei Azernikov. Sweeping solids on manifolds. In Symposium on Solid and

Physical Modeling,pages 249255, 2008.

[14] ”Software Testing”, Margaret Rouse, December 2012, [HTML].Available: http://whatis.techtarget.com/definition/software-testing [Accessed: 21st August 2013].

Appendix A

Activity Diagrams

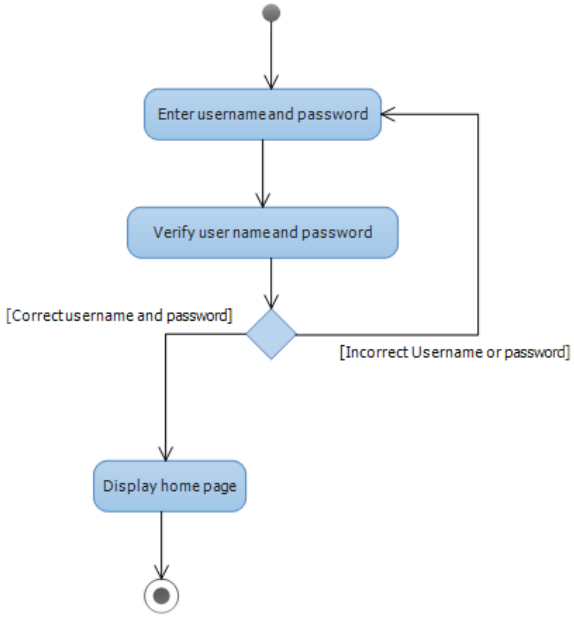

Figure A.1: Login

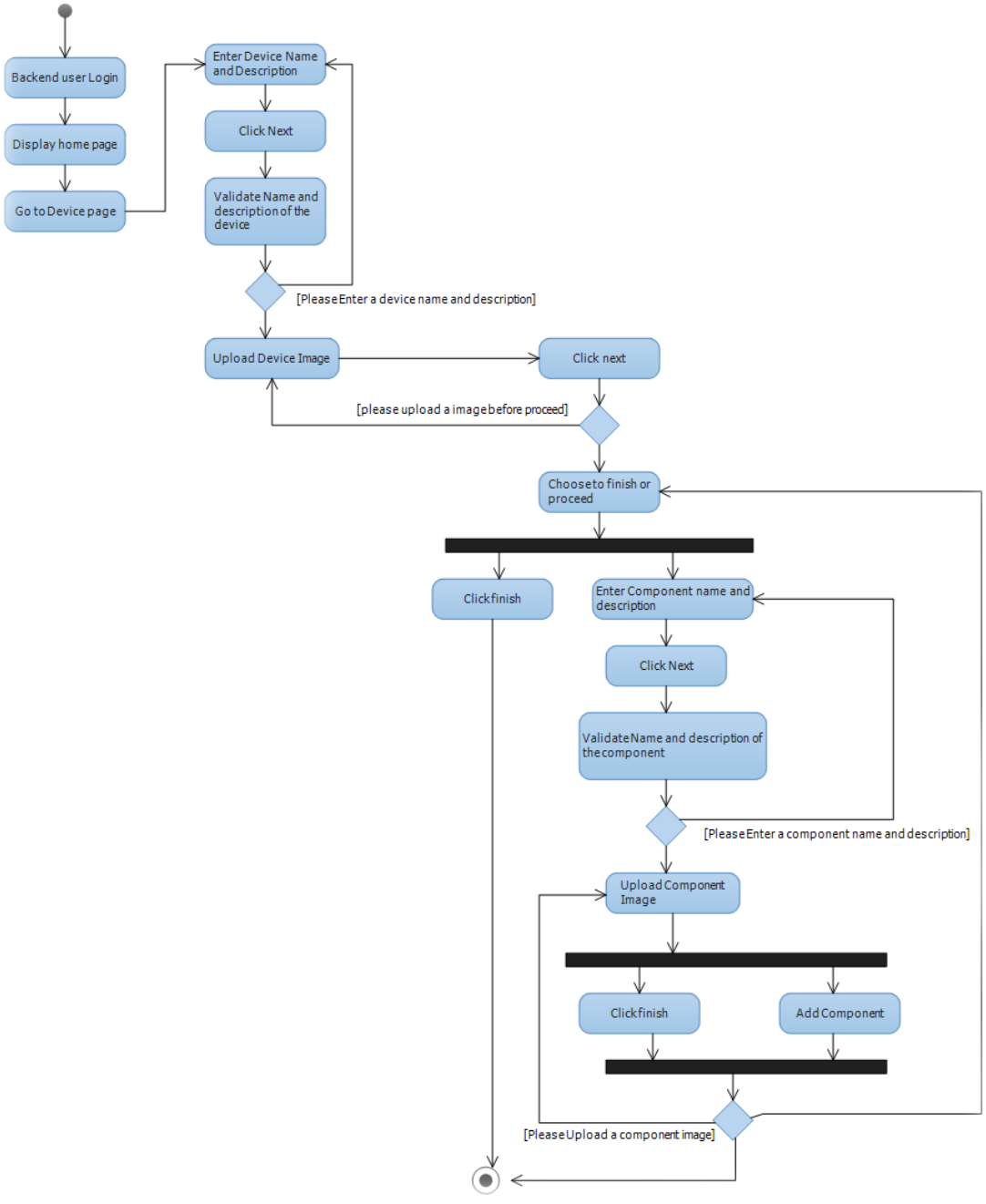

Figure A.2: Add Devices

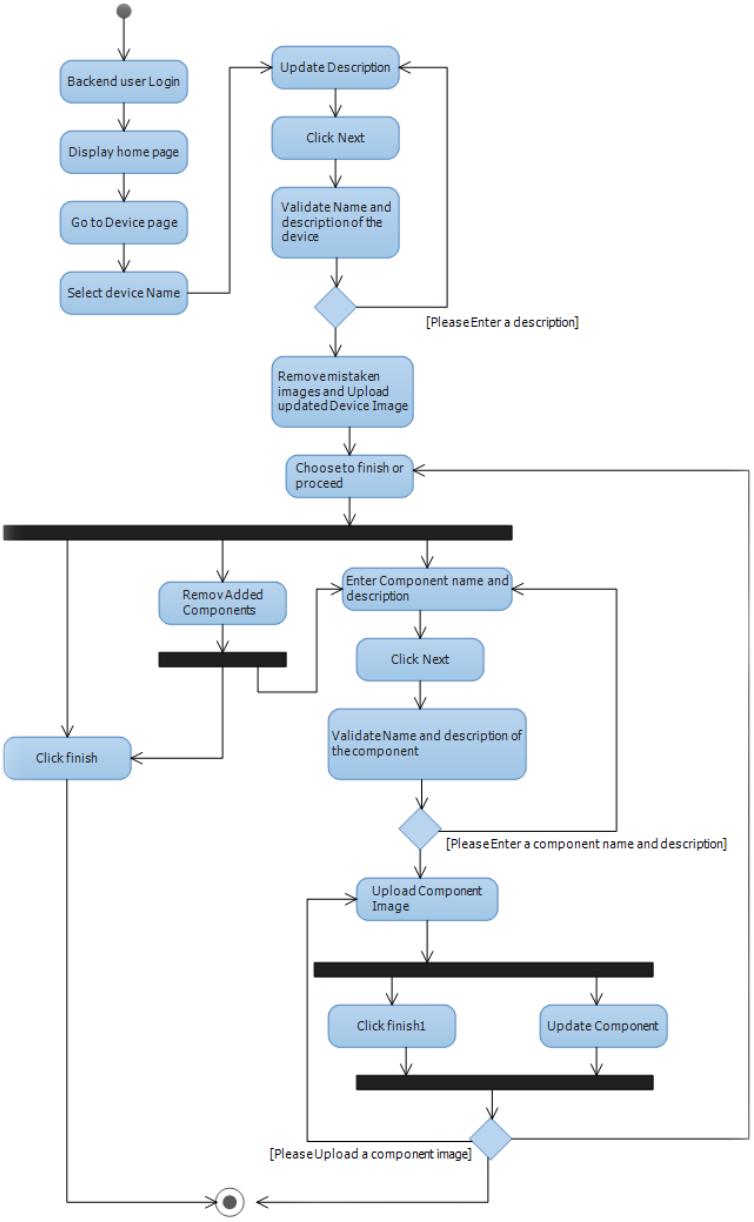

Figure A.3: Update Device

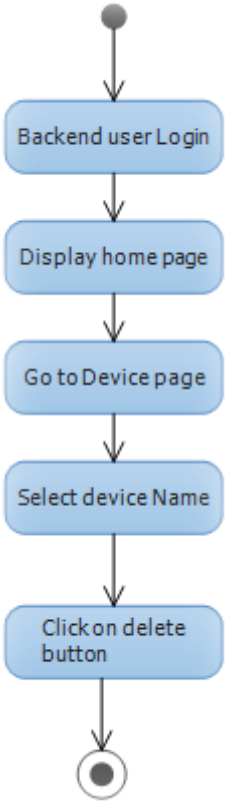

Figure A.4: Delete Device

Appendix B

Sequence Diagrams

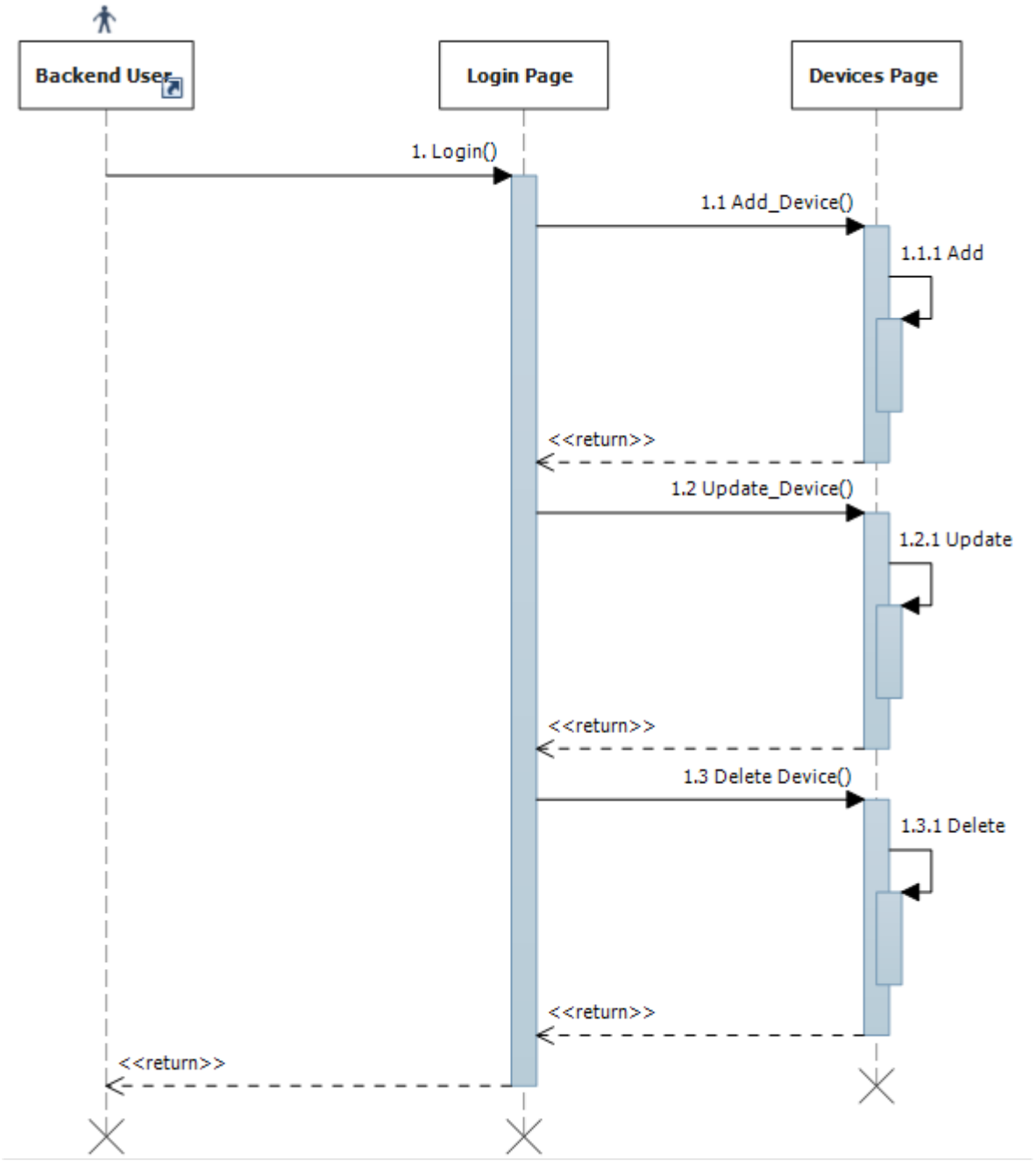

Figure B.1: Add, Update And Delete Device

Appendix C

Use case diagram

Figure C.1 illustrates the use case diagram for overall mobile application and Web application activities.

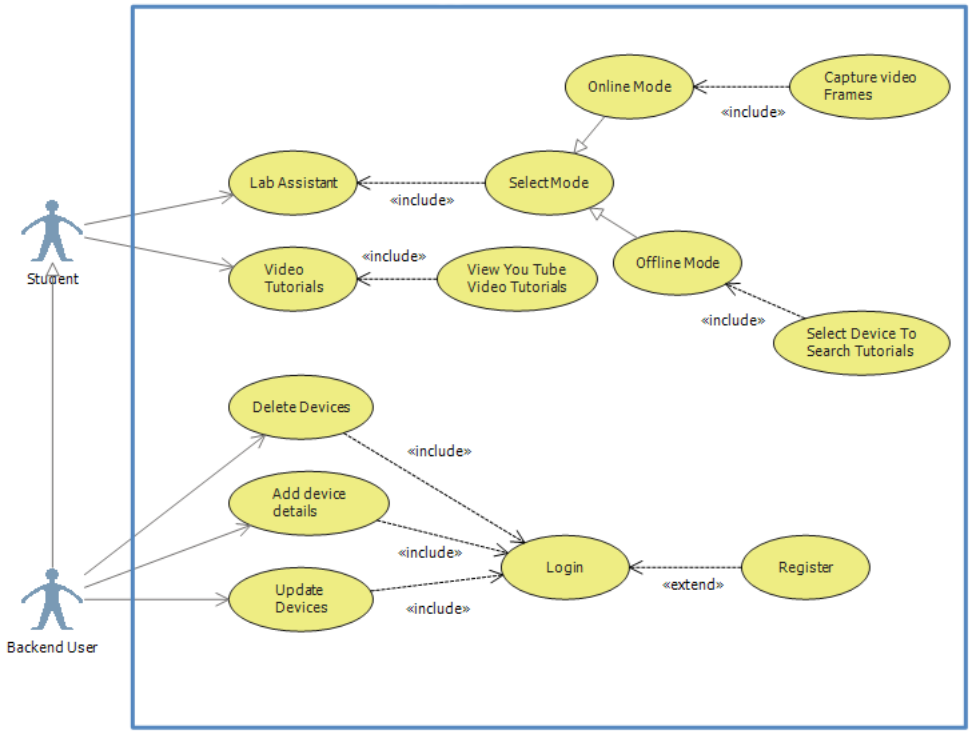

Figure C.1: Use case Diagram

C.1 Use case scenarios

C.1.1 Use case scenarios for overall web application activities

Use case 1	**Register user**
Goal	Allows users to register with the system.
Scope and Level	General
Preconditions	Database should be created and it should be connected with the backend web service.
Primary actors	Primary user
Main success scenario steps	1. Use case starts when a user clicks 'Register' option. 2. User fills the necessary details. 3. User clicks 'Submit' button. 4. Use case ends after Redirecting the user to the login page.
Extensions	4a. If the user leaves some necessary fields empty or if he has given some incorrect information an error message will be shown telling what he has done wrong.

Table C.1: Register User

Use case 2	**Login to the system**
Goal	Allows registered users to login to the system
Scope and Level	General
Preconditions	User should have registered with the system.
Primary actors	Registered user
Main success scenario steps	1. Use case starts when a user clicks 'Login' option. 2. User fills the user name, password fields. 3. User clicks 'Login' button. 4. Use case ends after redirecting to the home page.
Extensions	4a. If the user enters the user name or password incorrectly/if the user isn't a registered user an error message will be displayed and the system will prompt user to re-enter the user name and password.

Table C.2: Login To The System

Use case 3	**Add new device to the system**
Goal	Allows registered users to add new device details to the system.
Scope and Level	General
Preconditions	1. Database should be created and it should be connected with the backend web service. 2. User should have registered with the system.
Primary actors	Registered user
Main success scenario steps	1. Use case starts when the user clicks 'Add device' tab. 2. User adds new device name and it's details. 3. User click 'Next' button. 4. Then user has to upload the necessary images of the device. 5. User click 'Next' button. 6. User add component name and description of the device. 7. User click 'Finish' button. 8. Use case ends after showing a message saying "Device added successfully".
Extensions	1a.If the user isn't a registered user will be redirected to the login page. 7a. If the new device details weren't inserted successfully, an error message will be shown.

Table C.3: Add New Device To The System

Use case 4	**Update device details in the system**
Goal	Allows registered users to modify device details in the system.
Scope and Level	General
Preconditions	1.Database should be created and it should be connected with the backend web service. 2.User should have registered with the system. 3.Device should be already in the system.
Primary actors	Registered user
Main success scenario steps	1. Use case starts when the user clicks ”Update device” tab. 2. User select the device name. 3. User modifies device details. 4. User click ’Next’ button. 5. If the images are incorrect remove the current images and upload new images. 6. User click ’Next’ button. 7. Add new components if there any. 8. Remove the component information that has mistaken. 9. User click ’Finish’ button. 10. Use case ends after showing a message saying ”Device updated successfully”.

Extensions	1. Use case starts when the user clicks 'Modify device' tab. 10a. If the device details weren't modified successfully an error message will be shown.

Table C.4: Update Device Details In The System

Use case 5	**Delete device from the system**
Goal	Allows registered users to delete device details from the system.
Scope and Level	General
Preconditions	1. Database should be created and it should be connected with the backend web service. 2. User should have registered with the system.
Primary actors	Registered user
Main success scenario steps	1. Use case starts when the user clicks 'Delete device' tab. 2. User select the device name 3. User click 'Delete Device' button. 4. Use case ends after showing a message saying "Device deleted successfully".
Extensions	1a.If the user isn't a registered user will be redirected to the login page. 4a. If the new device details weren't inserted successfully, an error message will be shown.

Table C.5: Delete Device From The System

C.1.2 Use case Scenarios for Overall Web Application Activities

Use case 6	**Load the application**
Goal	Allows user to handle the application.
Scope and Level	General
Preconditions	Application needs to be installed in the mobile phone.
Primary actors	Primary user
Main success scenario steps	1. Use case starts when the user clicks the AR based lab assistant application icon. 2. Use case ends after showing the welcome screen.
Extensions	No

Table C.6: Load The Application

Use case 7	**Capture image using mobile device**
Goal	Allows users to capture image of a controller.
Scope and Level	General
Preconditions	1. Database should be created and it should be connected with the backend web service. 2. Device should be already in the system.
Primary actors	Registered user
Main success scenario steps	1. Use case starts when the user selects online mode. 2. User focuses his mobile camera towards a controller. 3. Use case ends when the mobile display shows the description of the controller using AR technique.
Extensions	3a. If the device is not included in the system an error message will be shown.

Table C.7: Capture Image Using Mobile Device

Use case 8	**Search tutorials**
Goal	Allows users to search tutorials of a controller.
Scope and Level	General
Preconditions	1. Mobile phone should be able to connect to the internet.
Primary actors	Primary user
Main success scenario steps	1. Use case starts when the user selects offline mode. 2. User selects a device. 3. User search for tutorials. 4. Use case ends when the mobile devise displays available information regarding particular device.
Extensions	3a. If the mobile device is unable to connect to the internet an error message will be shown.

Table C.8: Search Tutorials

Use case 9	**Video Tutorials**
Goal	Allows users to search tutorials of a controller.
Scope and Level	General
Preconditions	1. Mobile phone should be able to connect to the internet.
Primary actors	Primary user
Main success scenario steps	1. Use case starts when the user selects video tutorial. 2. User selects a device. 3. User search for vedio tutorials. 4. Use case ends when the mobile devise displays available video tutorial information regarding particular device.
Extensions	3a. If the mobile device is unable to connect to the internet an error message will be shown.

Table C.9: Video Tutorials

Appendix D

Classes diagram

This section describes the classes that are used for design phase of the ARLab application.

D.1 Mobile application

Figure D.1 illustrates the class diagram of mobile application

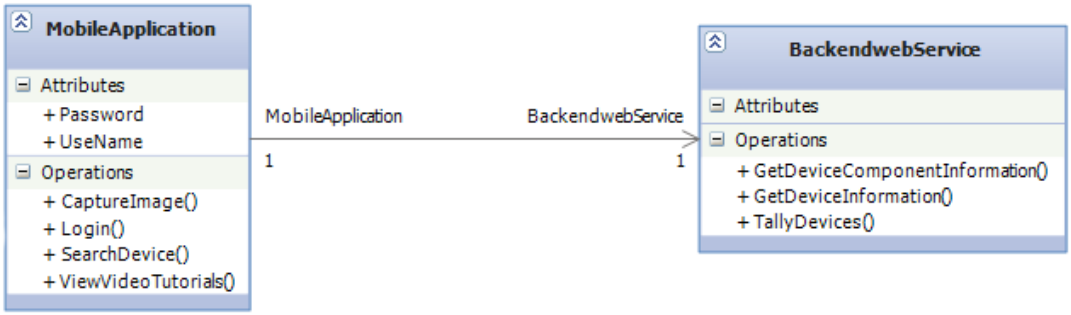

Figure D.1: Class Diagram Of Mobile Application

D.2 Web application

Figure D.2 illustrates the class diagram of web application

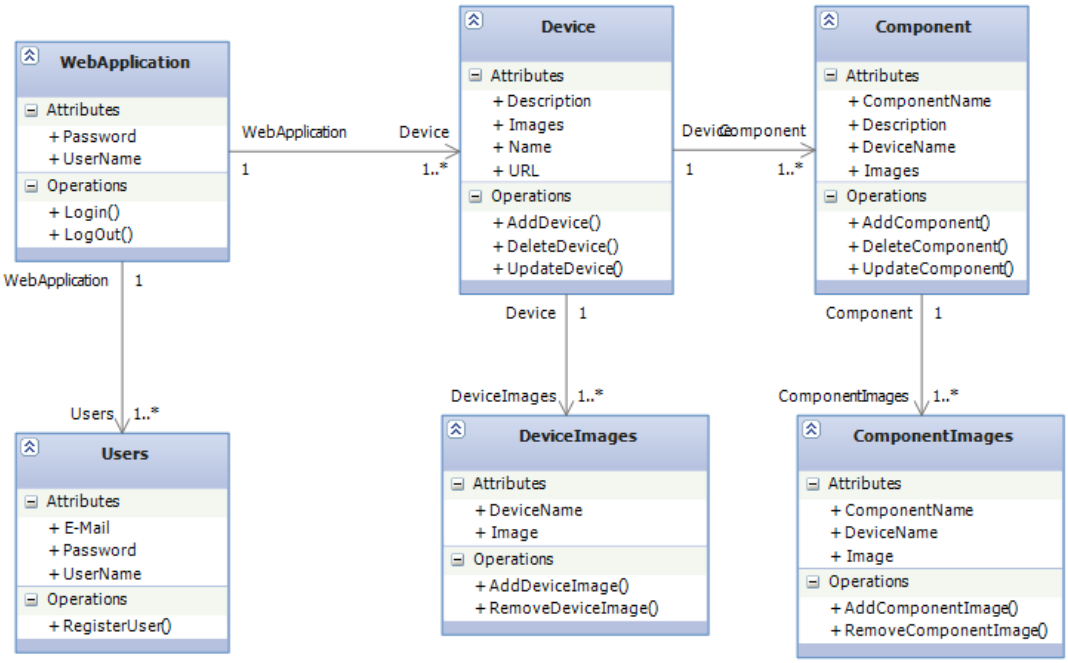

Figure D.2: Class Diagram Of Web Application