

**Mobile Based  
Livestreaming Television Channel and  
3D Architectural Visualization for a  
Higher Education Institute**

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2018**



# **Mobile Based Livestreaming Television Channel and 3D Architectural Visualization for a Higher Education Institute**

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

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University of Colombo School of Computing  
2018**



**Declaration**

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

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

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

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## **Abstract**

Learning Buddhism, meditation and Ayurveda has become a latest trend in the education sector creating a greater demand globally. Ven. Bodhagama Chandima Thero recognized this requirement and developed the Nagananda International Buddhist University in Manelwaththa, Sri Lanka, with the intention to offer the most sought-after academic programs in the fields of: Buddhism, Meditation and Ayurveda. According to the University, currently, there is a requirement to teach Buddhist practices globally. Secondly, as the south Asia's largest institute to teach Buddhism and Ayurveda there is a necessity to make the University and its programs popular both locally and internationally. As a solution for these requirements, a mobile application over a website was analyzed and developed having: an online livestreaming TV channel to spread the Buddhist teaching, Meditation and Ayurveda and, provide information on facilities and academic programs available at the University. Accordingly, at the successful completion of this project two main components were analyzed, developed and implemented namely: livestream TV channel and an interactive 3D architectural visualization application in one mobile application. As a result, the developer firstly, analyzed, developed and implemented a multimedia audio visual studio using latest technology to livestream TV programs to the Youtube after a comprehensive similar system analysis. Secondly, an Android mobile application with Youtube Application Programming Interface was developed to broadcast the above said TV programs along with an interactive 3D architectural visualization application which gives virtual tour around the university and information regarding facilities and academic programs available at the institute. Further, during this project Agile System Development methodology was used. During the System analysis and design stages tools and techniques such as: Object Oriented Analysis and Design, Unified Modeling Language were utilized. Furthermore, 3D model was developed using Autodesk Maya and this was exported to Unity game engine in order to add interactive mobile controls and subsequently, it was exported to Android and integrated to the mobile TV application. Then, both Alpha and Beta testing were performed to test the application. Finally, this report also highlights the problems faced and the suggested future developments.



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## **List of Abbreviations**

TV:	Television
VFX:	Visual Effects
HD:	High Definition
HDTV:	High Definition Television
ICT:	Information Communication Technology
NIBU:	Nagananda International Buddhist University
FTA:	Free-To-Air
ISDB-T:	Integrated Service Digital Broadcasting-Terrestrial
SLRC:	Sri Lanka Rupavahini Corporation
ITN:	Independent Television Network
UCSC:	University of Colombo School of Computing
JSON:	JavaScript Object Notation
APK:	Application Package Kit
NDK:	Native Development Kit
App:	Application



# 1 Introduction

The Nāgānanda International Buddhist University has organized to lead a prominent role in providing an excellent contribution for the mental, social and spiritual development of the society. It is established in the premises of the Manelwatta temple and it is the 10th International Buddhist University in the world and the first of its kind after 800 years of Buddhist educational history. Nāgānanda International Institute for Buddhist Studies has been established in August, 2013. The Institute gained the acceptance of the Ministry of Higher Education, Sri Lanka in December 2015.

The Nāgānanda International Buddhist University has five faculties and an Ayurveda Hospital. It is conducting undergraduate and postgraduate studies in the fields of Buddhism, Meditation and Ayurveda medicine. Construction of the University is near completion and academic programs are already started.

With the establishment of Nāgānanda International Buddhist University as part of its vision of “providing leadership necessary for creating an enlightened world full of peace and unity by disseminating the philosophical and ethical teachings as well as the noble exemplary characters of Buddhism” there was a requirement to build its own Audio/Visual studio and start an online TV channel to broadcast educational and health programs live through a mobile application. As the University is new and very few people know about this new establishment, there was a requirement to create an interactive 3D architectural simulation of the university premises and include it in to the same mobile application with live TV channel. To fulfill these requirements, in this project a medium size professional Audio/Visual studio will be established with all the necessary equipment and other infrastructure required for a live streaming TV channel. Television programs will be produced and live streamed to a native mobile application that runs on the Android Operating System.

The Audio/Visual studio will consist with a multi-camera set up of three cameras, professional lighting set up, audio recording set up and a main control unit including Audio/Visual mixtures and other necessary equipment. Programs will be recorded live using 3 point multi camera set up. Live edited programs will be streamed through video switcher to the viewers through the Mobile application.

Interactive 3D architectural visualization application will be also created using a game engine and a fully 3D modeled University premises and necessary information regarding different

places and buildings will be also included in the application. Users can navigate through the landscape of university premises and once they double tap on a building or a special place of the University premises, information of that place will pop up in a new window. Through this interactive 3D visualization application both local and international students will have the opportunity to have a look around the University without actually visiting the real place.

Mobile app users can also watch previously recorded programs in large variety of categories in the fields of Buddhist education, Meditation and Ayurveda medicine through the app. Viewers can share their favorite programs through social media platforms and they can vote for them as well.

Hardware will be analyzed and selected to get the optimum quality within a reasonable budget to establish the multimedia studio. Payable and free online video streaming methods will be analyzed to choose the best and economical option for video live streaming. Different mobile phones in different conditions with Android Operating system will be tested for the mobile streaming application. 3D modeling and texturing software will be used to develop the 3D model of the University premises. 2D design software will be used to create textures and other graphic elements for the Mobile application including interactive 3D architectural visualization environment.

There are not any dedicated live streaming TV channels for a University or Higher Education Institute in Sri Lanka. So this would be the first time such a system will be developed. There are few online entertainment mobile systems such as Gluuoo by Derana Media, Rupa mobile application and MobiTV mobile application provide the facility of live TV and recorded program facility.

## **1.1 Aim and Objectives**

This section provides the aim and objectives of this project.

### **1.1.1 Aim**

To efficiently identify issues, analyze, design, develop, test and implement a mobile application including: an online livestreaming TV channel to spread Buddhist teachings, Meditation and Ayurveda and an interactive 3D architectural visualization application to educate facilities and academic programs available at the Nagananda International University globally using most appropriate methodologies, technologies and tools within agreed time, cost and scope.

### **1.1.2 Objectives**

In order to achieve the above aim the following objectives were formulated:

- Conduct requirements analysis to determine the specific requirements;
- Evaluate the existing systems and the identified requirements;
- Choose the most suitable technologies to develop the system;
- Choose the most suitable methodologies to design system;
- Identification of functional and non-functional requirements;
- Produce system design;
- Design the user interface including 3D models;
- Create a test plan and execute the test plan on the prototype;
- Implementing the prototype;
- Evaluate the prototype and system design against the requirements and identify the problems faced and further developments.

## **1.2 Scope of the Project**

One mobile application will be developed with two main parts including a live streaming TV Channel and University information section consist with a University premises 3D interactive simulation. An audio/visual studio will be setup with all the necessary equipment with minimum cost to create professional multi-camera, High Definition (HD) TV programs and live stream them to an online audience.

Interactive 3D visualization application will be created for a University virtual tour using a game engine for the interactivity and other information related to the University will be also included. To implement the 3D visualization system, a 3D model of The Nāgānanda International Buddhist University will be created including all the necessary textures using a professional 3D modeling and Texturing software. Completed, textured 3D model of the University will be exported in to a game engine to add the interactivity. Inside the game engine touch inputs will be added to navigate around the 3D model and explore different areas in the University premises.

Native mobile application using Android mobile development platform will be created and both the TV channel and University information section with University interactive 3D architectural simulation will be added to it.

### **1.3 Structure of the Dissertation**

The report of this project will initially provide the declarations, abstract and the acknowledgements. Then it will list the table of tables, tables of figures, table of tables and abbreviations.

Next, an introduction will be provided under the first Chapter. This chapter will mainly consist of the aim, objectives, scope of this project.

Under the Chapter 2, this dissertation will discuss the Hardware system development for Audio/Visual studio, Software system for Audio/Visual live streaming, Mobile application interface for live streaming programs, Web application development vs Mobile application development and multimedia project workflow.

Next will be the Chapter 3 which will concentrate on the system analysis and Design sub sections. Under system analysis sub section, requirements will be gathered and analysed. Further, both functional and non-functional requirements and system requirements will be identified and listed. Further, more under the system design sub section use case diagrams, use case descriptions, activity flow diagrams will be presented and mobile App navigation system will be discussed.

Under the Chapter 4 of this project, the development stage of this mobile app will be discussed. Accordingly, Main UI design strategy and Requirement gathering to design NIBU Premises and screenshots as evidences will be provided.

Then under the Chapter 5, implementation stage will be explained. Accordingly, Software Development Methodology for the Mobile application, Interactive 3D Architectural Visualization component of Mobile App, Live Streaming TV channel component of the Mobile App, Activity workflow of the finished Mobile Application for NIBU will be discussed and Error messages and user support information will be provided.

The next Chapter, Chapter 6 will provide the testing and system evaluation related information. Here, test cases will be provided along with evidence of system testing, alpha

and beta testing. Furthermore, conclusions came through test results, livestreaming issues and lessons learned will also be discussed.

Then under the Chapter 7 conclusions and further developments will be provided and discussed. Finally, references and appendix will be provided at the latter part of this dissertation.

## **2 Background**

As the first step, it was decided to search currently available technologies to establish an Audio/Visual studio that can be used to produce professional quality TV programs for an affordable cost. The main requirement was to produce high quality digital videos that can be streamed online so the video production set up should also be capable of fulfilling that requirement.

As the second step to address the requirement of interactive 3D architectural simulation of the Nagananda International Buddhist University premises currently available technologies in that area will be analyzed and implemented.

As the third step current mobile application development technologies and mobile operating systems will be analyzed to recognize the most suitable platform to develop the mobile application.

### **2.1 Hardware system development for Audio/Visual studio**

Different hardware systems of Audio/Visual studios are analyzed to select the most appropriate and cost effective way to produce TV programs and live stream them to an online audience. Free-to-air (FTA) Analog TV channels are most popular in Sri Lanka as most of the television viewers receive analog TV channels free of charge and there are Satellite broadcast service providers who provide digital TV channels with a cost. Sri Lanka is planning to move in to digital TV transmission system in the near future by adopting Japan's Integrated Service Digital Broadcasting-Terrestrial (ISDB-T). Sri Lankan TV channels like Derana TV, Hiru TV and state owned SLRC and ITN have already purchased equipment to do digital transmission which is cost effective to both TV Channel service provider and the consumer. SLRC is still using an Analog system to broadcast TV programs. (Appendix 1) Both Video and Audio quality in the digital transmission is also high. [1] Private owned TV channels such as Derana TV using Blackmagic™ Audio and Video production system to create and broadcast high definition digital TV programs. University of Colombo School of Computing (UCSC) has established a new Audio/Visual production set up using a Blackmagic™ solution. So it is decided to create the Audio/Visual studio using a Blackmagic™ production system including Blackmagic™ cameras, Decks, Audio and Video Converters, Recorders, Switches connected each other using a highly reliable cabling system. A proper lighting system required to be



installed inside the studio to get professional video production output in different situations and audio recording was also a major requirement (Figure 2.1).

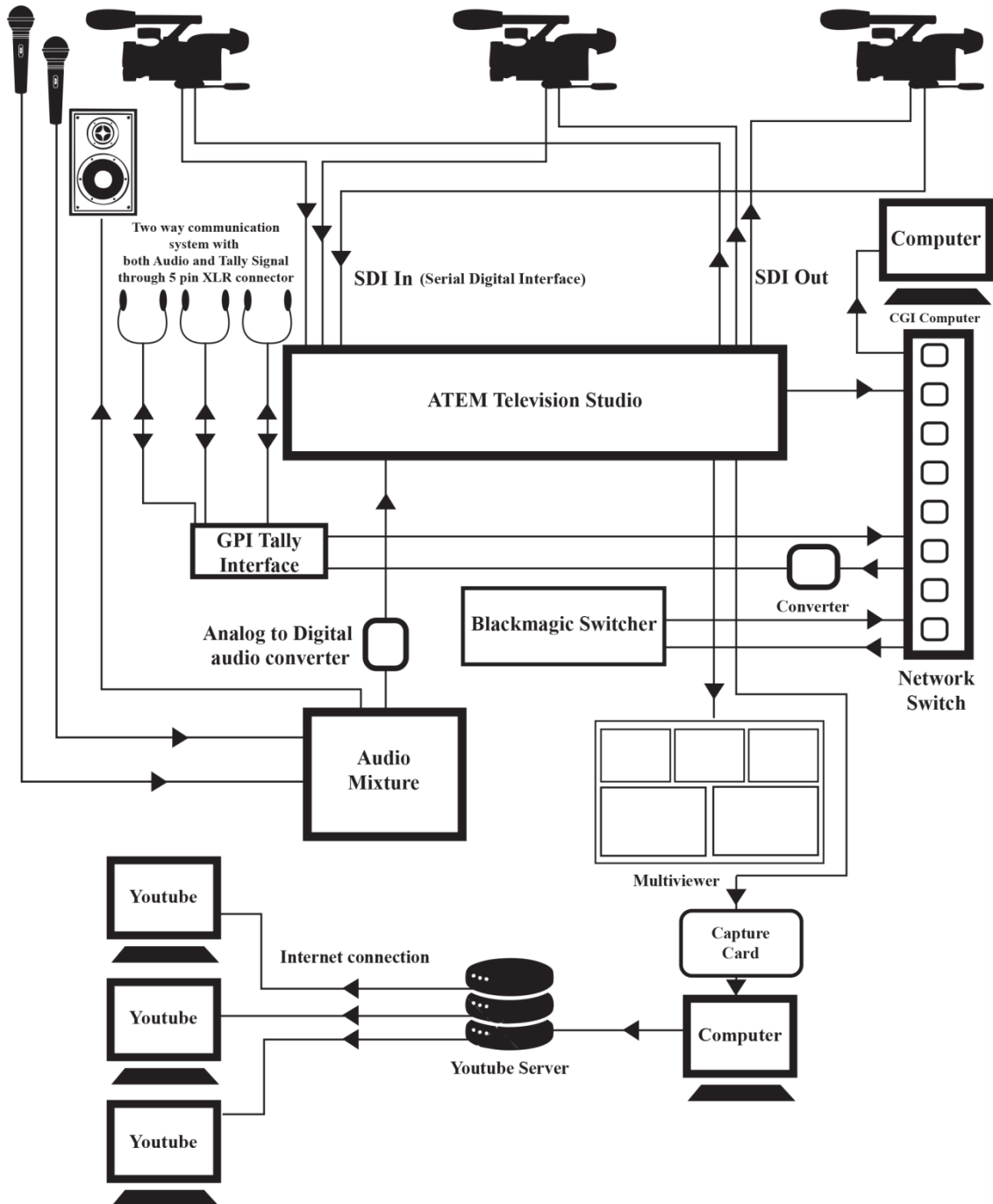


Figure 2.1 Established multimedia audio visual studio system for NIBU online TV channel

## 2.2 Software system for Audio/Visual live streaming

Almost all the TV channels in Sri Lanka providing online streaming facility and most of them are using Youtube Live Streaming instead of payable options. State owned TV channels such as Sri Lanka Rupavahini Corporation (SLRC) and Independent Television Network (ITN) are using paid live streaming software but almost all the private owned TV channels are using free Youtube Live Stream option for their online broadcast requirement.

	Youtube	Livestream Premium	Ustream Premium
Price	Free of charge. (only 100 or more subscribers required)	45\$ General 399\$ no embedding	NO viewers have limit. 99\$ per month. 499\$ live analytics
Video Quality	Good quality. 1080p stream capability. Different bit rates available.	Only 720p streaming capability. ( quality is not that good)	240p to 1080p video quality. Good internet connection is required to watch the high quality videos.
Statistics availability	Youtube has good statistics compared to others ( Google analytics can be received)	Not much. ( Google analytics can be received)	Ustream has better analytics compared to other two.

*Table 2.1 Comparison of three of the most popular live streaming vendors [2] [3]*

Considering above comparison Youtube live streaming is selected as the live stream vender.

## 2.3 Interactive 3D simulation for NIBU

It was decided to create a 3D model of the University premises using an off the shelf 3D modeling and animation software and Autodesk Maya was selected for that. To add the interactivity to the scene it was decided to use a game engine. An analysis was carried out to find the most suitable and economical game engine for this purpose.

The game engine to be utilized in this project should be able to import 3D assets from outside software, should be able to add and edit terrain, trees and water effects, should have enough

learning resources to learn and implement and last but not least ability to export to Android mobile platform is a must.

Game Guru game engine was export only supported for Windows so it was not suitable for this mobile application. CopperCube was good game engine even though it was not that famous. It provides terrain adding and editing facility, 3D assets importing from outside and ability to export VR games for the Oculus Rift. But there were not enough learning resources.

Unity and Unreal game engines were able to provide all the requirements for this interactive 3D architectural simulation development. From those two game engines Unity was selected as it is economical to use compared to Unreal and in the Masters Degree program under Virtual Reality and Simulation module there was an opportunity to learn Unity game engine thoroughly.

## **2.4 Mobile application interface for live streaming programs**

When starting a mobile app development there are few questions to be addressed. What differentiates mobile application development and traditional application development? What options are available? What are the important design principles for mobile application?

## **2.5 Web application development vs Mobile application development**

Before exploring different mobile operating systems, it would be worth considering mobile web application development versus native application development. Depending on the type of application, mobile web application could simplify the development in terms of time and cost but there are so many downsides as well.

It was argued in [6] that the performance of native applications will only be noticed for high image processing or 3D games. It was also pointed out that the native application languages are more complicated than Web application languages.

One of the disadvantages of Web mobile applications was that the standard APIs for Web application interfaces are lot weaker compared to native mobile applications. The scaling of Web interfaces on different platforms and devices was also raised as an issue in Web mobile app development [6].

Users may also have different expectation for a native application than for the web application. Web applications must be connected to the Internet the entire time the application is running but native applications can work offline as well as online.

When it comes to performance, the size of the payload and the interpreting of code effect how fast the web application can run. The conclusion reached in [6] was give priority to data over decoration in the web application. The advantage of a native application is that performance issues are not related to the size of payload and the code is already compiled.

## **Android vs iOS**

Android dominates when it comes to the market share of the smartphone operating systems. In the fourth quarter of 2016 80.7% smartphones using Android operating system and iOS owned only 17.7 market share. [8] Android is open source platform and learning material was highly available. Therefor Android was selected as the mobile application development platform and Android Studio is selected as development environment.

## **2.6 Multimedia**

Multimedia applications utilize more than one kind of media to deliver content and functionality. Multimedia items generally fall into five main categories namely, text, imagers, audio, video and animation.

Text is the basic multimedia element. It involves use of text types, sizes, colors and background colors. For an effective multimedia presentation, the position of the text on the screen, length of the message and legibility of the message should be considered. Images make the multimedia application attractive as well as universal symbolic meanings that anyone can understand without a language barrier. Analog and digital audio systems are used in multimedia applications to full fill the requirements of the use of speech, music and sound effects. Videos provide a powerful impact in a multimedia program. 2D or 3D animations have also become important elements of a multimedia projects and these elements should be edited to be used effectively. In some of these items, choice of color is important for a successful multimedia project. It should be in agreement with the color theory, which includes complementation, contrast, and vibrancy. Complementation is the way one sees colors in terms of their relationships with other colors. Colors should occupy opposite ends of the color spectrum, so that they lead people to consider a design visually appealing. Contrast refers to the effective selection of background and text color reducing eyestrain and focuses user attention by clearly dividing elements on a page. Vibrancy refers to the emotions of a design. Brighter colors help user to focus more on the subject whereas darker shades relax the user allowing mind to focus on other things.

### 2.6.1 Multimedia Project Workflow

Producer, Consumer and the Product are the three main components of a multimedia project (Figure 2.2). Producer is the creator of the project and responsible for managing the budget, resources, tools and schedule. Consumer is the sponsor for the project and the source defines the needs and skills of the end user, and the benefits of the product. Product includes contents such as audios, videos, images, and functions, how the product works and the technology.

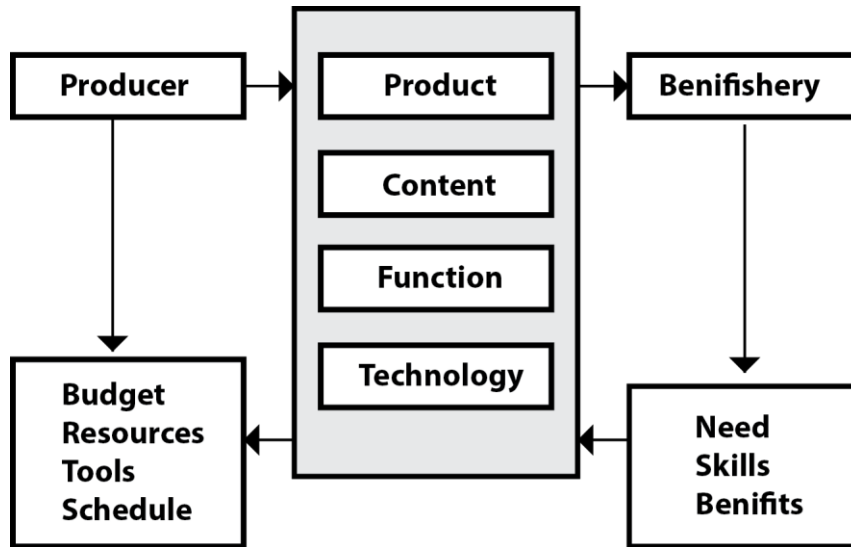


Figure 2.2 Cycle of a multimedia project development

### Structured multimedia project development life cycle

Every multimedia project follows steps of planning (analysis and design), implementation, construction and evaluation. Having a structured multimedia development methodology provides a necessary structure for the successful implementation of a multimedia project. It saves time allows accurate cost and recourse estimate and provides a plan for members of the team if multiple individuals are involved. [13]

### Requirement analysis

Requirements analysis is one of the most significant and tedious task of software development process. It includes the tasks required to determine the needs or conditions to meet new or altered product. During this process the developer consider the requirements of various stakeholders. Requirements are gathered by interviews, referring similar systems and making observations. [13]

## **Architecture design**

System architecture design is a structured solution that meets most of the technical and operational requirements of the software, while enhancing quality attributes such as performance, security, and manageability. [13]

## **Planning**

Planning includes, developing concepts, defining project goals and addressing questions such as; what do we need to do, who will be using the product, how the product will be used, what resources are available, how long it will take to complete the project, who will be involved in designing, planning and testing, what hardware and software to be used and what are the critical parameters that determines the success of the project? Performance, user interface, specific features of the hardware will be recognized and the architecture transforms these requirements into a design by identifying specific software and hardware. [13]

## **Storyboarding screen layout and logical flow**

Storyboard is used as an overview of a project, to provide a guide (road map) for the designer/programmer, to illustrate the links among screens and to illustrate the functionality of the objects. Storyboarding is useful in describing what the application is going to do, how it is going to do, and inspiring people/users to think about possibilities. Storyboarding is important to make changers before starting the project designing part by using as the first prototype. [13]

## **Content production**

In producing the contents, several issues need to be addressed; the level of quality of the content, how will the content be generated, how will the content be achieved and documented, and how to get copyright? Content production includes, identification of new resources to be created, obtaining copyrights, digitizing pictures, audio, video into compatible format, production of original materials and format data. [13]

## **Authoring**

Authoring is the process of bringing everything together or assembling the content into multimedia software development following the map provided in the storyboard. This would be the place to ask does it work the way it was initially planned. [13]

## **Prototype**

In some instances, prototypes of the real systems are requested. This is useful in selling the concept, test the design strategies and capabilities, and assess the content effectiveness. Prototype helps to visualize all the design ideas and solutions in action. [13]

## **Evaluation/Testing**

Testing is an important part of design and development. Multimedia product should be tested by the users and through this process developers can locate flaws ahead of time and repair them before releasing the finished product. During the test, developer may consider whether it is user friendly and interactive enough or not. There are two formal testing procedures; alpha testing and beta testing. Alpha testing usually conducted in house and restricted to the development team. Alpha testing is done relatively early in the development phase. Beta Testing on the other hand, is the final functional test before release. The idea is to get feedback from as wide as variety of potential users as possible, to have the test done on as many different computer configurations as possible and to fix any bugs. [13]

## **Deployment**

Deployment refers to the release of the product to the end user. Several tasks have to be completed in the deployment phase. Documentation of product in written including user and installation guide and troubleshooting instructions, mass production of CD\_ROM, packing of product, marketing the product, mass production of hardware, installation of the software and training of personal to use the software are included in the deployment phase of the multimedia system development. [13]

## **Maintenance**

Any product should evolve and grow with emerging technology or to meet user demands. Therefor maintenance is one of the most important and final phase of the multimedia project. [13]

## **3 Analysis and Design**

### **3.1 Analysis**

#### **3.1.1 Requirements gathering and analysis**

Primarily discussions were conducted with the Nagananda International Buddhist University administration and potential students to identify the wants and needs. As this is the first mobile application of this kind in a Sri Lankan Higher Education Institute so many innovative ideas had to be implemented from scratch. Outcome of the discussions and brainstorming sessions were used to recognize the needs, aspects to be addressed, options to be included and avenues to cater to the target groups.

#### **3.1.2 Functional requirements**

The requirements were grouped into functional and non-functional, i.e., what the application should do in functional requirements and how the system should perform as non-functional requirements.

Functional requirements are the operations, functions and activities that a system must be able to perform. It describes the set of inputs, the processing or manipulation of the inputs and the outputs with regards to the target users' expectations.

1. NIBU university information such as academic programs, vision, mission and etc. should be included in the mobile application and the user should be able to access these information easily
2. Online live streaming TV channel should be implemented and the user should be able to watch live and recorded TV programs easily through the mobile application
3. As this is a newly established International Buddhist university the app should provide a 360 degree 3D view of the University premises which is built in a beautiful landscape in Sri Lanka and the user should be able to explore different places with informative description.
4. App administrator should be able to constantly update video content of the application.



### **Additional functional requirements to be implemented later**

5. Online live streaming Radio channel should be also included later to go in line with the TV channel.
6. There is a monthly magazine issued by the NIBU. A soft version of the magazine with news item creation and management ability regularly should be included
7. There are popular meditation programs conducted by the NIBU. A series of meditation video lectures should be included In the mobile application to encourage locals and foreigners in meditation.
8. A chat option should be included in all relevant places so there would be larger interaction among the users and NIBU.
9. Mobile app content should be able to share through social media platforms so the content of app would widely open to a larger audience.
10. Notifications of new intakes and courses should be sent for the app users upon their prior approval.
11. Every morning an inspirational Buddhist quote should be sent with a picture as a notification to the app user to start the day with positive thoughts upon users prior approval.

#### **3.1.3 System Requirements**

Web application was discarded due to the nature of the constant requirement of online connection. Also, the native application platform offered better support libraries. Therefor the requirement was to build a native application, so Android and iOS were selected as main mobile platforms to build the software application on. Majority of smartphone users are using smartphones with Android operating platform [7], so there was an agreement to start the development process with the Android mobile platform first and once all the prototyping sessions are finished then move on to iOS mobile platform as well.

#### **3.1.4 Non-Functional Requirements**

Non-functional requirements specify the criteria that can be used to evaluate the operation of a system and they have direct impact on the quality of the proposed application final outcome. Non-functional requirements are often called quality attributes that help to improve user friendliness.

**Following main non-functional requirements were identified.**

1. The app should be user friendly to users in the age category of 10 to 70. Therefore the use of font size and easy access to content was important.
2. Easy navigation is was must. There should be more than one way to visit the main menu and the user should be able to go directly to the main menu from almost all the other activity layouts.
3. Content should be correct and should get the confirmation of relevant parties before making them available to the end user.

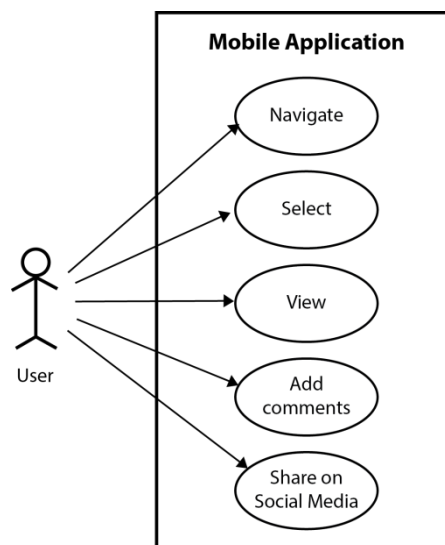
### **3.2 System Design**

#### **3.2.1 System overview**

In the preliminary stage of this mobile application system two main components were identified. One is an interactive 3D architectural visualization experience for the user to have a 360 degree look of the University premises with mobile screen touch controls and ability to explore further in to different places. Other component is an online live streaming TV channel for the University to broadcast Buddhist and Ayurveda programs. Both of these parts had to be included in a single mobile application.

#### **3.2.2 Use Case of the Mobile App**

After the analysis of the requirements, use case diagram was created to depict the core features of the mobile application.



*Figure 3.1 Use case diagram of the User*

## **Use Case Description for a User**

### **Use case 1: Navigate**

Primary actor: User.

Pre-condition: No prerequisites are required.

Main scenario:

Navigate through the system. Access different content

Alternate scenario: None.

### **Use case 2: Select**

Primary actor: User.

Pre-condition: No prerequisites are required.

Main scenario:

View selected content. User can use given controls to control the view.

Alternate scenario: None.

### **Use case 3: View**

Primary actor: User.

Pre-condition: No prerequisites are required.

Main scenario:

Navigate through the system. Access different content

Alternate scenario: None.

### **Use case 4: Add Comments**

Primary actor: User.

Pre-condition: User has to login first

Main scenario:

Add comments to the chat for videos and news items

Alternate scenario: None.

### **Use case 5: Share content on Social Media**

Primary actor: User.

Pre-condition: User has to login first

Main scenario:

User can share content on Social Media

Alternate scenario: None.

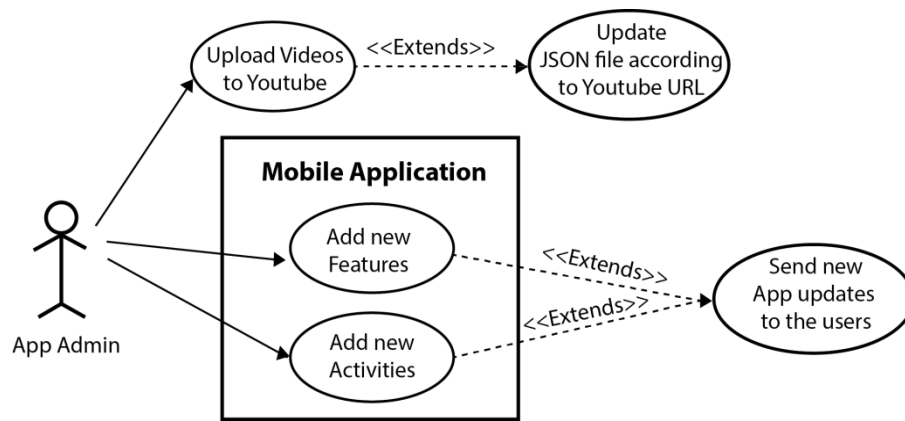


Figure 3.2: Use case diagram of the App Admin

## Use Case Description for the App Admin

### Use case 1: Upload Videos to Youtube Channel

Primary actor: Admin.

Pre-condition: Videos have to be created.

Main scenario:

Upload Videos to Youtube Channel

Alternate scenario: None.

Extended scenario: Update the JSON file according to the uploaded video URL

### Use case 2: Add new features

Primary actor: Admin.

Pre-condition: Feature should be identified.

Main scenario:

Add new features to the existing mobile application

Alternate scenario: None.

Extended scenario: Send new app update to the app user.

### Use case 3: Add new activities

Primary actor: Admin.

Pre-condition: Activities should be identified.

Main scenario:

Add new activities to the existing mobile application

Alternate scenario: None.

Extended scenario: Send new app update to the app user.

### 3.2.3 Activity flow diagrams

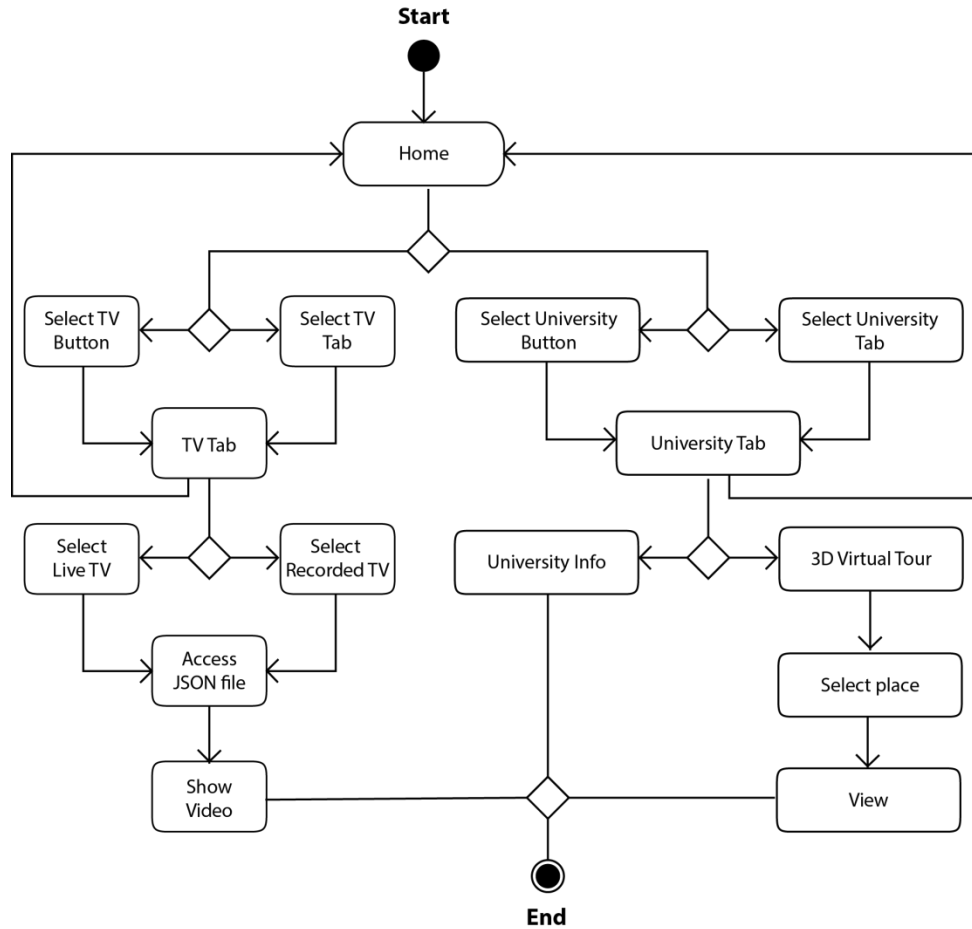


Figure 3.3: Activity diagram

### 3.2.4 Mobile Application navigation system

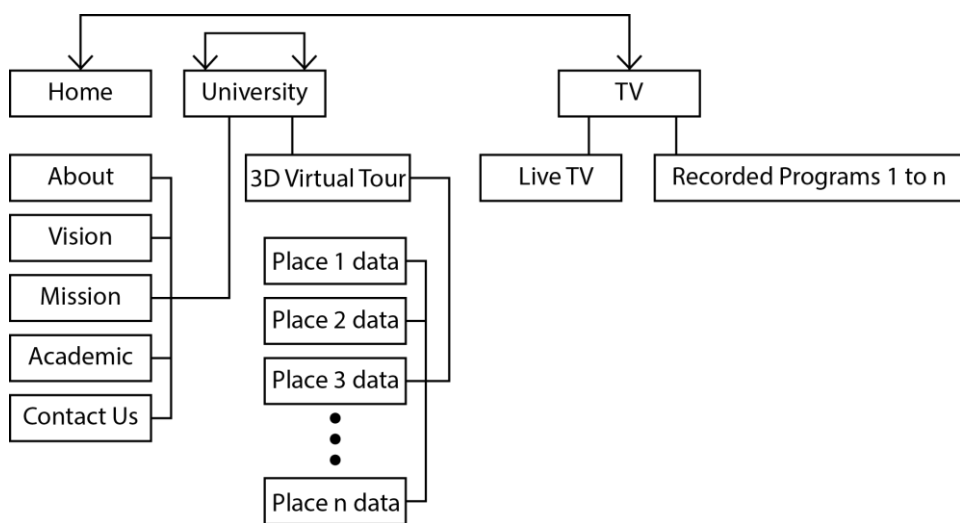
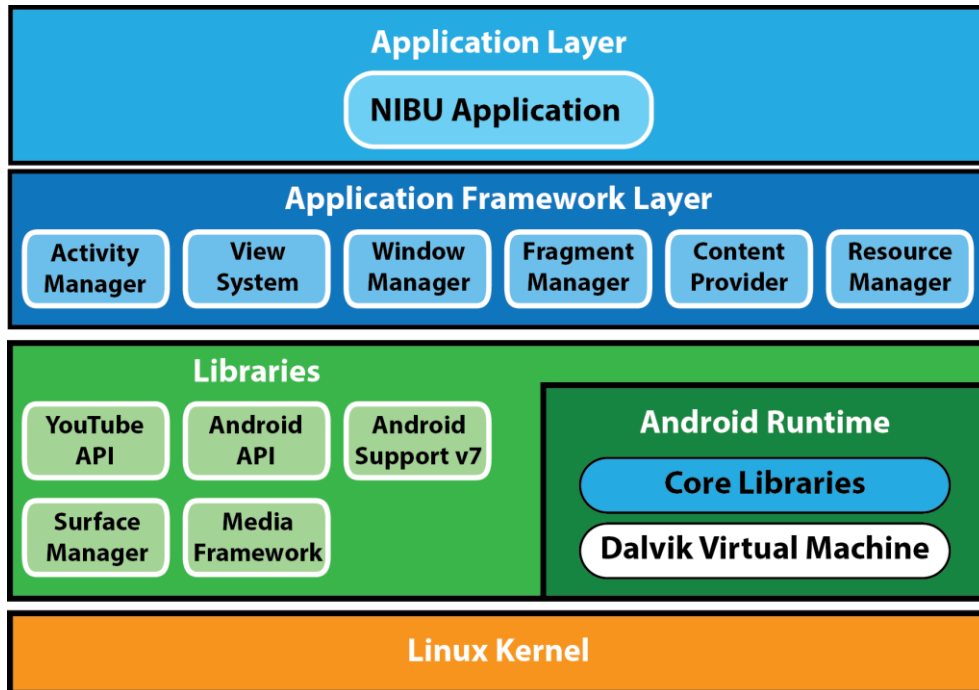


Figure 3.4 : Mobile Application navigation

### 3.2.5 System Architecture

NIBU application uses the android framework with the supporting libraries. At run time, Dalvik Virtual Machine pulls all the libraries with the compiled source code and executes the application.



*Figure 3.5: NIBU Mobile Application Framework*

Figure 3.2.5: Adapted from TutorialsPoint  
[http://www.tutorialspoint.com/android/android\\_architecture.htm](http://www.tutorialspoint.com/android/android_architecture.htm)  
[Accessed 24-03-2018]



## 4 Development Methodology

### 4.1 Main UI design strategy

Dominating colour of the NIBU logo is gold colour. So it is decided to use gold colour to be used as much as possible throughout the layout design of the mobile application. Design of the whole mobile application is mainly focused on easy navigation with minimal design elements. Least number of colours with highly readable font size and colour suitable for every user in the target age group of 10 to 70 years of age were used in the design process.

**Considering the requirement analysis, the following table of technologies, software, scripting languages and platforms were used to develop this application.**

Requirement	Technologies, Software, Scripting languages, Platforms
3D Modeling & Texturing	Autodesk Maya
Image processing	Adobe Photoshop and Adobe Illustrator
Video editing and composing	Adobe Premier
Visual effects and composing	Adobe After Effects and RealFlow
Mobile app development	Android platform using Android Studio, Java, XML scripting
Interactive 3D visualization component	Unity Game Engine, C# scripting
Mobile app server data and Youtube URL handling	JSON
Video uploading and Livestreaming	Youtube
Smartphone specifications	Linux based Android SDK 21 or above, Above 1GB RAM

*Table 4.1: Technologies, software, scripting languages and platforms used in the NIBU app [8], [9], [10], [11]*



## 4.2 Requirement gathering to design NIBU Premises

Even though some of the academic courses already started, University constructions are still underway. So the blueprints were used to create the 3D model of the NIBU University premises. By utilizing the collected blueprints of the NIBU premises and data collected through a site visit, a 3D model of the University and its surrounding was created using Autodesk Maya software. Texturing was also done using the same software.



*Figure 4.1 Top elevation of the Nagananda International Buddhist University premises*

*Image 1*

Figure 9: NIBU official website  
<https://www.niibs.lk/about/construction-progress>  
[Accessed 20-03-2018]

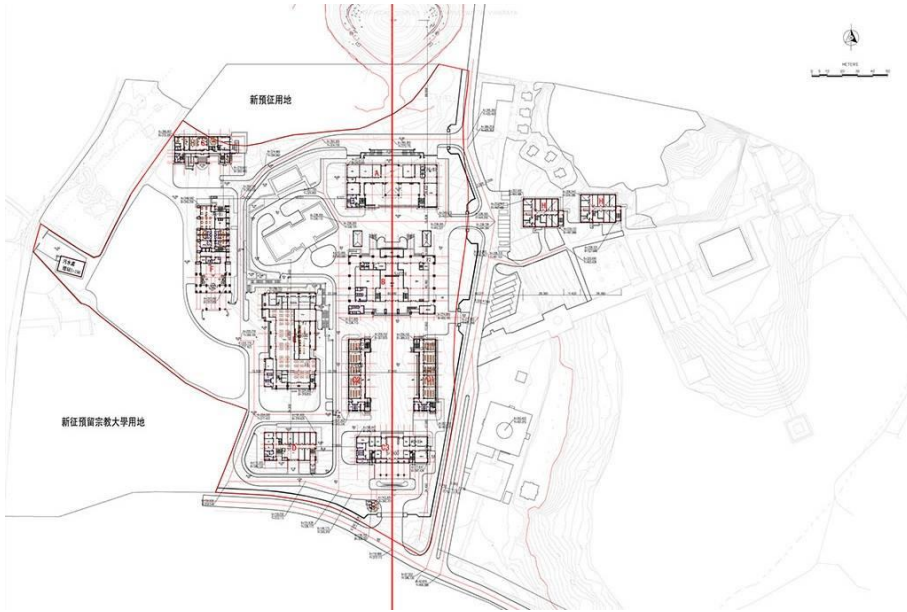


Figure 4.2 : Top elevation of the Nagananda International Buddhist University premises  
Image 2

Figure 10: NIBU official Facebook page  
<https://www.facebook.com/niibs/photos>  
 [Accessed 20-03-2018]

#### 4.2.1 Recreating the Nagananda International Buddhist University premises in Autodesk Maya

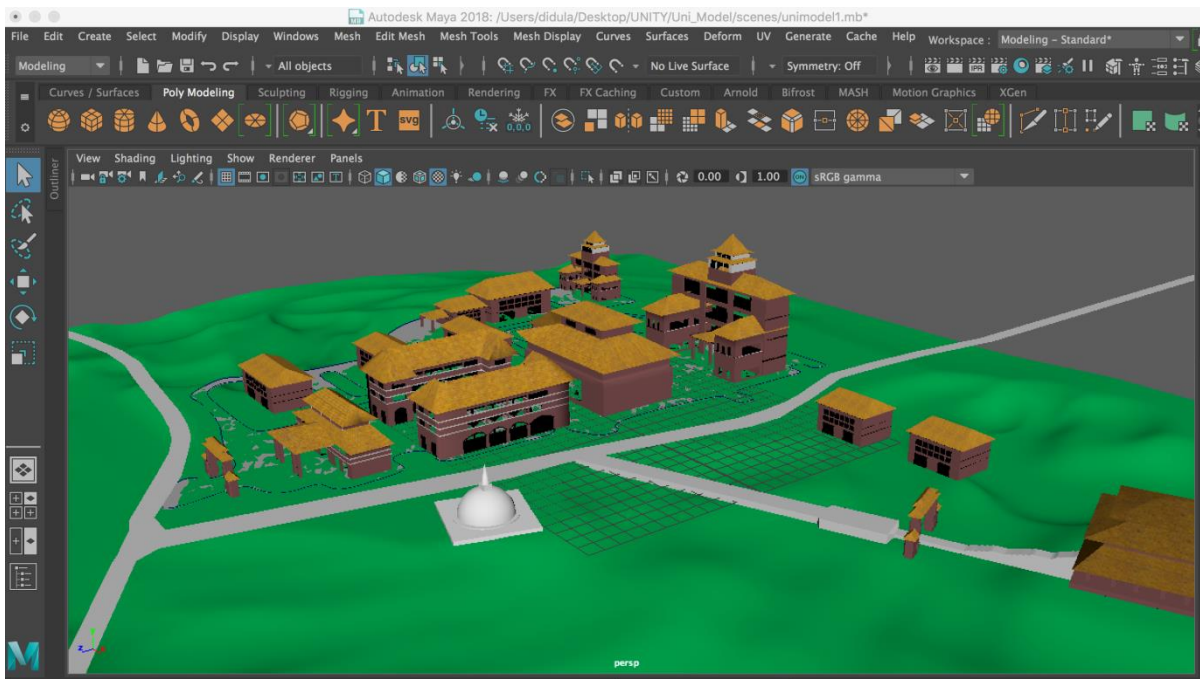
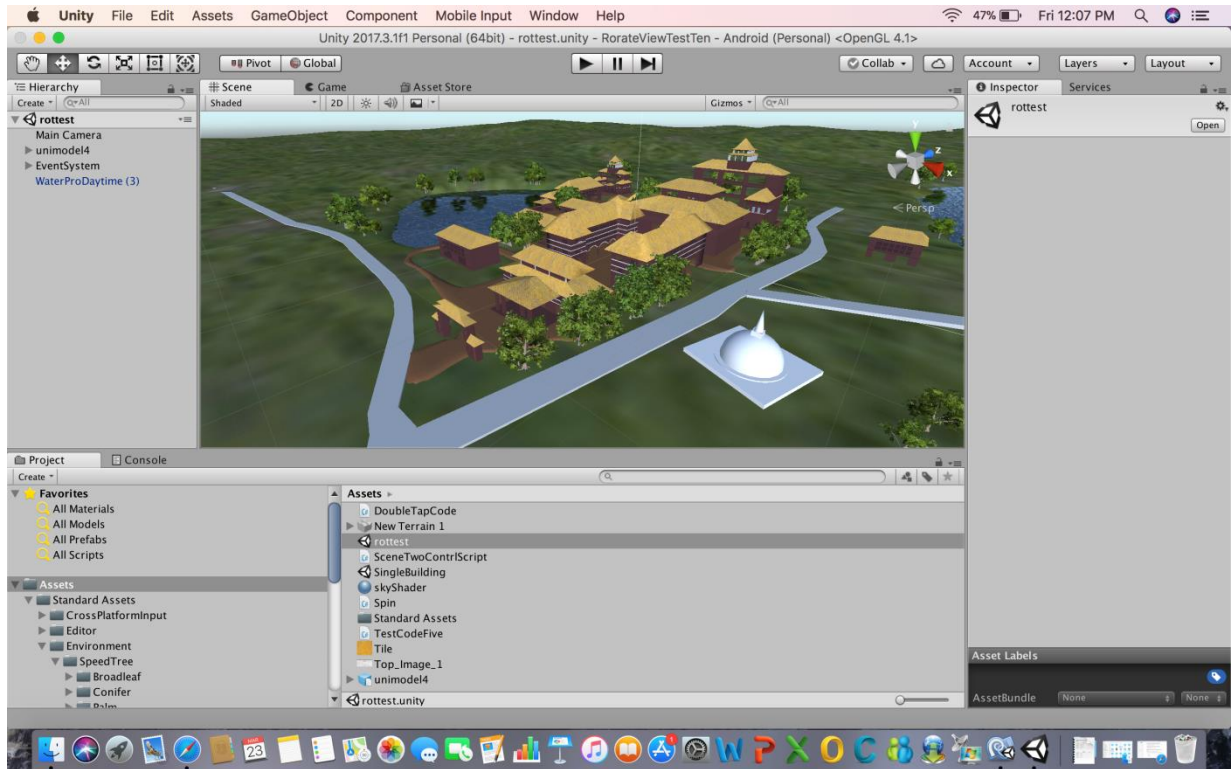


Figure 4.3 : Nagananda International Buddhist University Premises modeled and textured in Autodesk Maya 2017

Water effects, terrains and trees normally consume great amount of Video and Random Access Memory because of large number of polygons and complex mathematical calculations required for their realistic simulations. Therefore completed 3D model and textures of the NIBU Maya Binary file exported to Unity game engine and added a terrain, water effects and trees. Because it is a game engine Unity has special capabilities to manage memory economically when displaying and redrawing 3D objects compared to a dedicated 3D Modeling and Animation software like Autodesk Maya.



*Figure 4.4 : Water effects, terrain and trees added to the scene in Unity*

## 4.2.2 Splash Screen Logo

NIBU logo has a deep meaning in it. To show that meaning to the app user it is decided to use an animation as a splash screen when loading the mobile app.



Figure 4.5: NIBU logo and its meaning

Figure 13: NIBU website  
<https://www.niibs.lk/about/vision-mission>  
[Accessed 20-03-2018]

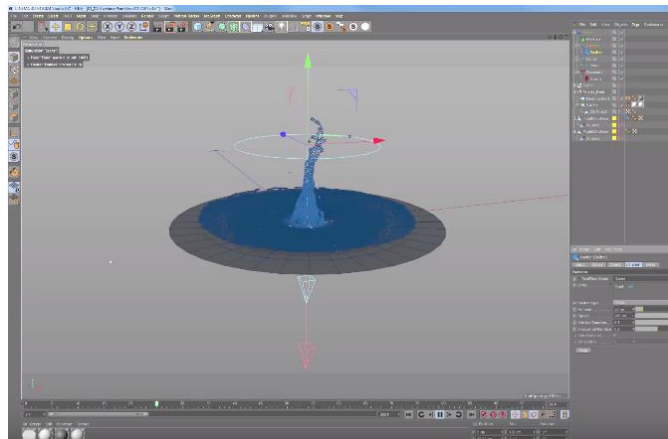


Figure 4.6 : Blue water section (Sila) was created using RealFlow software to get the realistic water effect.

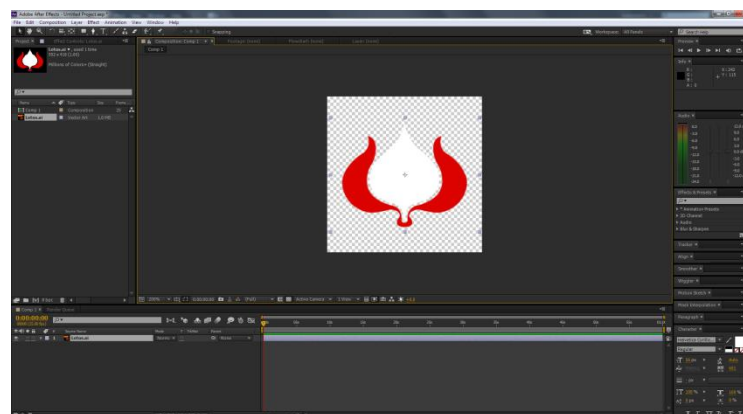


Figure 4.7 : Lotus blossoming animation was created using Adobe After Effects software and design objects like lotus pedals were created using Adobe Illustrator software.



### 4.2.3 App Launch Icon and other Images

NIBU logo, App Icons and Images were recreated in Vector format using Adobe Illustrator and saved in PNG format before exporting to Android Studio to use in the app design.

#### PNG file format

PNG stands for Portable Network Graphics. This format is used for lossless compression and for display of images on the web and mobile devices. Unlike GIF, PNG supports 24bit images and produces background transparency without jagged edges. PNG format supports RGB, Indexed Color, Grayscale, and Bitmap mode images without alpha channels. PNG preserves transparency in grayscale and RGB images. [9]



*Figure 4.8 : Six main app buttons to go to six tabs of the app from Home tab*

Android studio icons require five different sizes for different screen pixel densities of different devices.

MDPI - 48px

HDPI – 72px

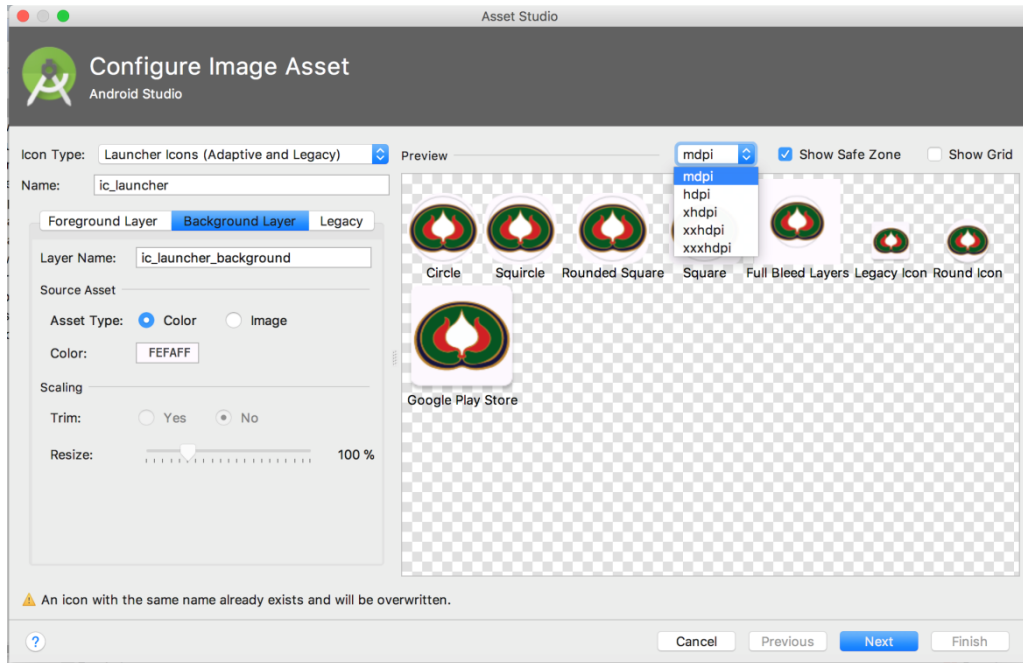
XHDPI – 96px

XXHDPI – 144dx

XXXHDPI – 192dx

Icons for lower resolution are created automatically from the baseline.

Configure Image asset of Android Studio automatically create all the required resolutions when one PNG image is uploaded as the baseline.



*Figure 4.9: Configure Image asset of Android Studio automatically create all the required resolutions when one PNG image is uploaded as the baseline*

## Mobile App screen layouts

Mobile app screen layouts were first sketched on a paper and then recreated in Adobe Illustrator. Image buttons and Icons are separated and exported in PNG format to Android Studio.

## XML layout coding

XML stands for eXtensible Markup Language. XML is a mark-up language more like HTML used to describe data. It was designed to store and transport data. It was designed as both humans and machine-readable scripting language. [10] In Android Studio XML is used to design the layouts because it's lightweight and easiness to use.

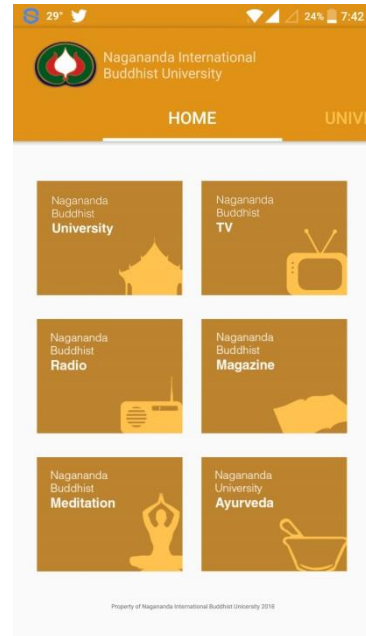
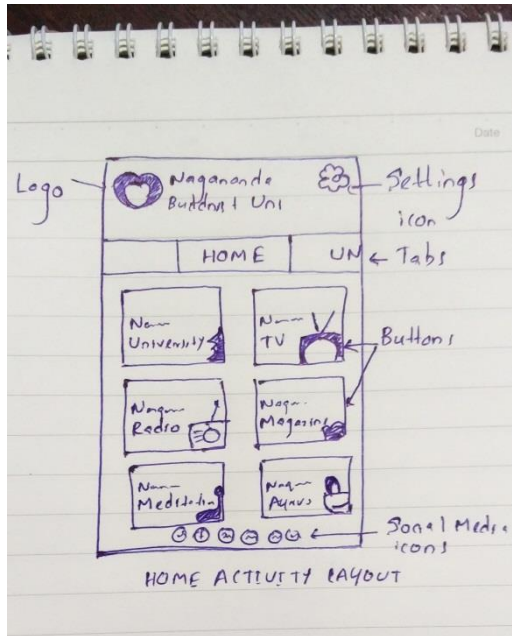


Figure 4.10 : Low Fidelity to Home tab layout sketch

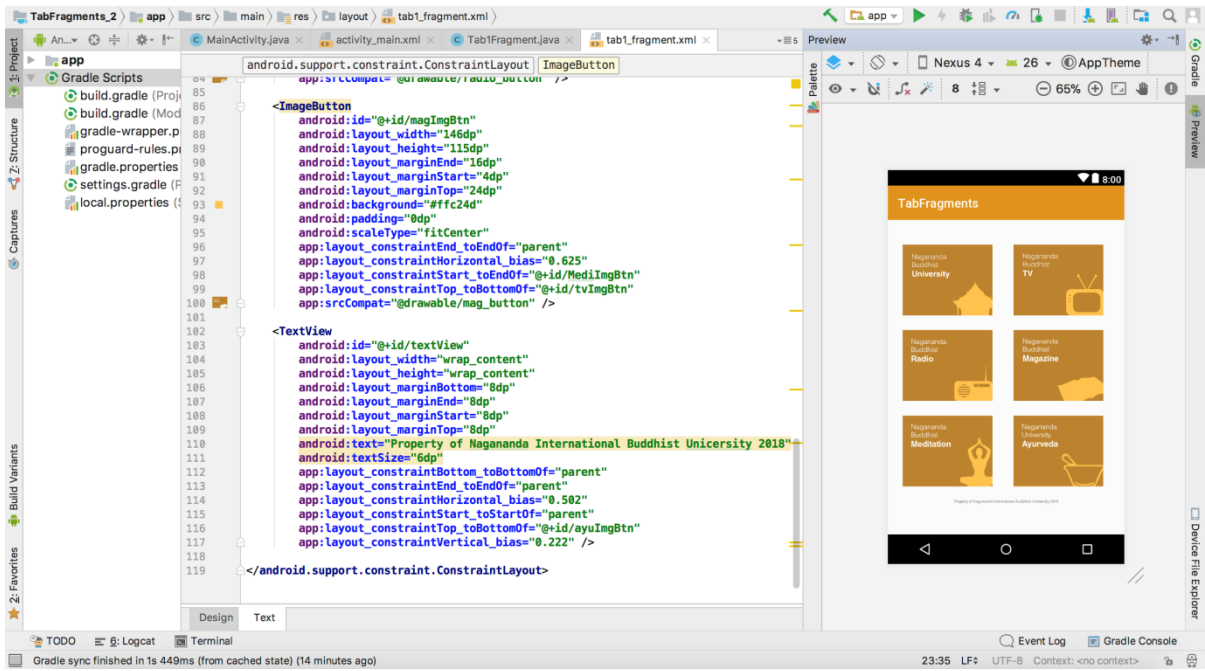


Figure 4.11 : XML layout design of the Home tab in Android Studio

## 5 Implementation

### 5.1 Software Development Methodology for the Mobile application

It was decided to select most appropriate software development methodology from Agile methodology and Waterfall methodology. Either of these technologies are a way of organizing work in the quest to build mobile applications. Waterfall methodology is the traditional approach to mobile app development taking methodical and systematic route while Agile methodology is a slightly tweaked, rapid application development type that takes a more “time-boxed”, team-based, sprint action style.

The tables below illustrate the advantages and disadvantages of both Agile and Waterfall methodology.

<b>Waterfall Software Development Methodology for Mobile Application Development</b>	
<b>Pros</b>	<b>Cons</b>
A methodical and sequential approach	Every step is final. Developers cannot go back to previous stages and make changes.
Stresses methodical record keeping and documentation	Project depends heavily on inputs and initial requirements. Any false instruction will destroy the project.
Client knows exactly what to expect in every stage of the development	Testing only happens in the end of the sequence.
Thanks to a strong documentation, employee training or turnover is not much of a hassle	If clients have evolving needs it is difficult to include them in the system development later.

*Table 5.1 : Pros and Cons of waterfall software development methodology*



<b>Agile Software Development Methodology for Mobile Application Development</b>	
<b>Pros</b>	<b>Cons</b>
A sprint like team based approach	If mismanaged, projects can turn out to be code sprints with no end in sight.
Allows you to make changes, add new features and keep up with the evolving trends.	Lack of definite plan calls for management vision, strong insistence on sticking to the plan, and the final project would be something totally different to what was planned at the beginning.
Testing can be performed at each stage. Meanwhile project priorities can be evaluated at the end of each sprint.	The team based, sprint like approach might look much like shooting a movie. For outside it is almost impossible to say who is working on what.
Since testing happens almost simultaneously, projects can be launched sooner.	Lack of emphasis on documentation.

*Table 5.2 : Pros and Cons of agile software development methodology [4]*

Considering the above comparison and time constraints it is decided to develop the Mobile application using Agile Software development methodology. Agile practices allow adapting procedures and practices to the unstable needs of the mobile domain. Agile methods give freedom to understand the market, structure the product and release it in quick time frames. [5]

Iterative approach of Agile software development methodology allowed easy adaptation to changing requirements during the project.

In the preliminary stage of this mobile application system two main functionalities are included. One is an interactive 3D architectural visualization experience for the user to have a 360 look of the University premises with touch controls and ability to explore further in to different places. The other one is online live streaming TV channel for the University to broadcast Buddhist and Ayurveda programs to a larger audience. Both of these features had to be included in a single mobile application.

## **Android Studio**

Android Studio is the official Integrated Development Environment (IDE) for Android app development. Android Studio offers features that enhance the productivity when building Android apps, like flexible Gradle-based build system, fast and feature-rich emulator, unified environment where the developing can be done for all Android devices, Instant Run to push changes the running app without building a new APK, extensive testing tools and frameworks, lint tools to catch performance, usability, version compatibility, and other problems, C++ and Native Development Kit (NDK) support, and built-in support for Google Cloud Platform, making it easy to integrate Google Cloud Messaging and App Engine.

## **Minimum Software Development Kit (SDK)**

Android operating system (OS) versions are backward-compatible which means if the Application is developed using an older SDK version the app is capable of running without much compatible issue on all the other SDK versions release after that. For an example if your minimum SDK Version is set to Android version 4.0, the application can run on Android 5.0, 4.4, 4.3, 4.2, 4.1, and 4.0. The benefit of choosing the 4.0 framework is that the application is exposed to a much larger market share. [11]

At the same time selecting an older version by targeting an older framework can limit the access of functionality. **This app Minimum SDK Level 21.**

## **Target SDK**

The Target SDK Version should set to the most recent version of Android that the app is tested on. Whenever a new version of Android comes out, the app target SDK Version should set to the latest Android version and test the app to fix any problems. If the app is not Android devices will assume that your app wasn't tested on the latest version of Android, so they may introduce some backward-compatibility behavior for your app to make sure your app still looks and feels the way you designed it for that older version of Android. It gets a little tricky, so the best policy is to always keep the Target SDK Version up to date with the latest versions of Android. [11] **Target SDK Level 26**

## **5.2 Interactive 3D Architectural Visualization component of Mobile App**

### **Adding interactivity to the 3D Architectural model of University premises**

It is required to incorporate various multimedia data into one platform when developing a virtual 3D environment by using game engine. The characteristic of game engine that is preinstalled with interactive and navigation tools allows users to explore and engage with the game objects. 3D game engines provide standard 3D navigation tools as well as any programmable view to create engaging navigation thorough the virtual environment like C# and Javascript scripting facilities in Unity game engine.. By using a game engine, it is possible to create other interaction such as object manipulation, non-playing character (NPC) interaction with player and/or environment. In addition to visualization, virtual environment also has the potential to engage users with interactive and communication systems. [14]

### **Implementing Interactive 3D Architectural Visualization component**

As the first step of interactive 3D architectural visualization component, a textured 3D model of the whole University premises is created using professional 3D modeling and animation software. Then the model was imported to the cross platform game engine called Unity. A 3D terrain, water effects and trees were added in the Unity and touch controls for mobile interactivity were added to the main camera through a C# script so that the user can swipe the mobile phone interface and rotate the university premises interactively. To give more information regarding different places of the University premises a double tap option was also included so that when a user wants to learn more about a particular place, user can double tap on that place and then a different scene will be loaded including in-depth details of that particular place. User can hit back button once he finished going through information of the selected place and come back to the previous scene of full 3D view of the University premises. C# scripts were added to necessary objects for the interactive inputs.



### 5.3 Live Streaming TV channel component of the Mobile App

#### Live Streaming Audio Visual Studio Setup

As clearly mentioned in the literature review Youtube livestreaming is used as the live streaming technology platform. From the studio setup the videos will be livestreamed to Youtube and through Youtube API in Android Studio, video will be broadcasted through the mobile application to user. Previously recorded programs will also keep in the Youtube channel and access for them will also be provided through the Mobile App.

First it was decided to hardcode the Youtube link to the mobile application but there were some practical issues like every time there is a new video is added to Youtube channel the application code had to be changed and new update had to be sent to the user. To overcome this issue a JSON file is created and maintained in a server with a link to mobile app so whenever there is a new video the JSON file can update and due to the link between JSON file and mobile app users no need to install updates.



*Figure 5.2: Program livestreaming using Blackmagic multimedia studio setup*

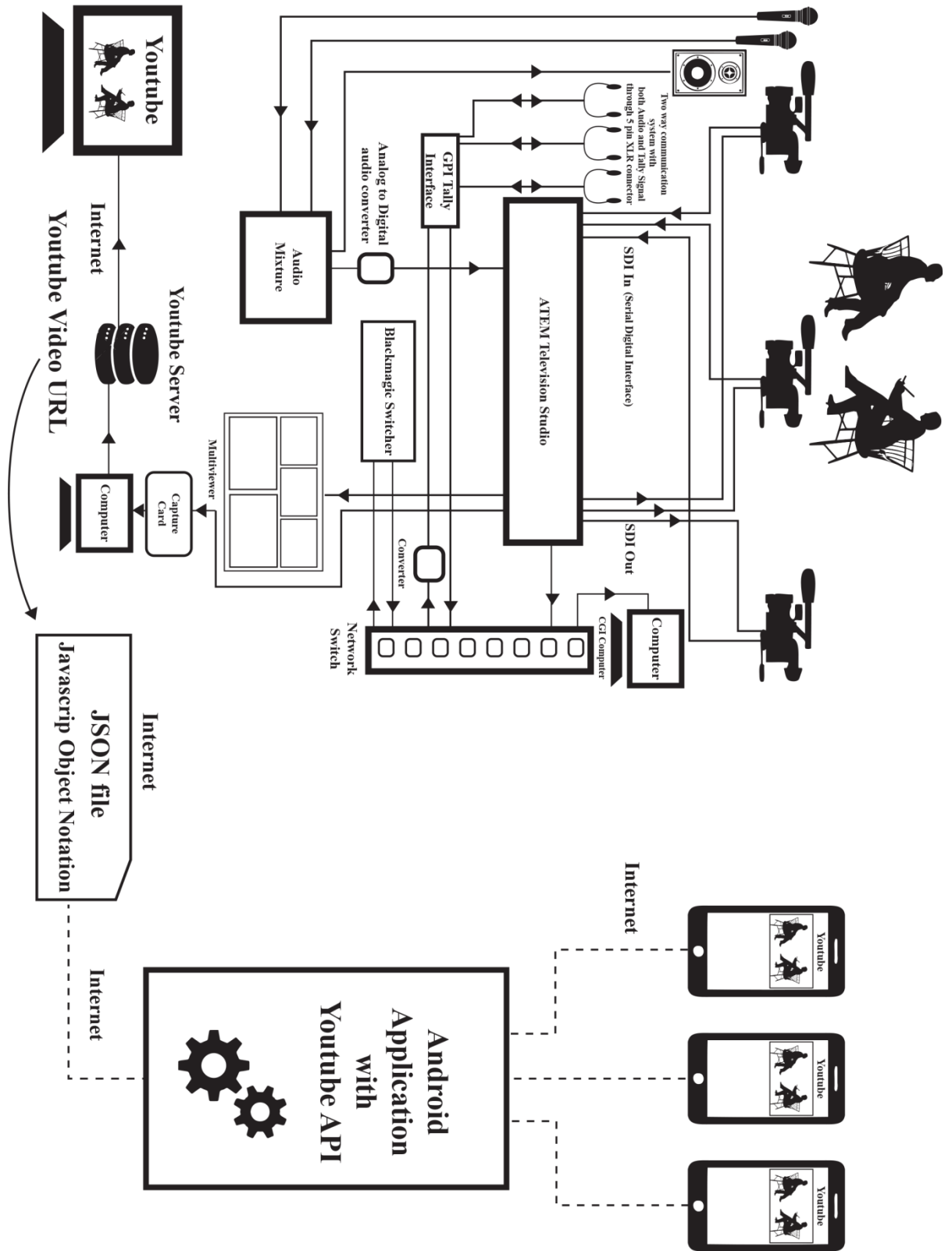


Figure 5.3 : Activity workflow of implementation of Live Streaming TV channel component of the Mobile App





Figure 5.4 : Activity flow of the completed interactive 3D architectural simulation

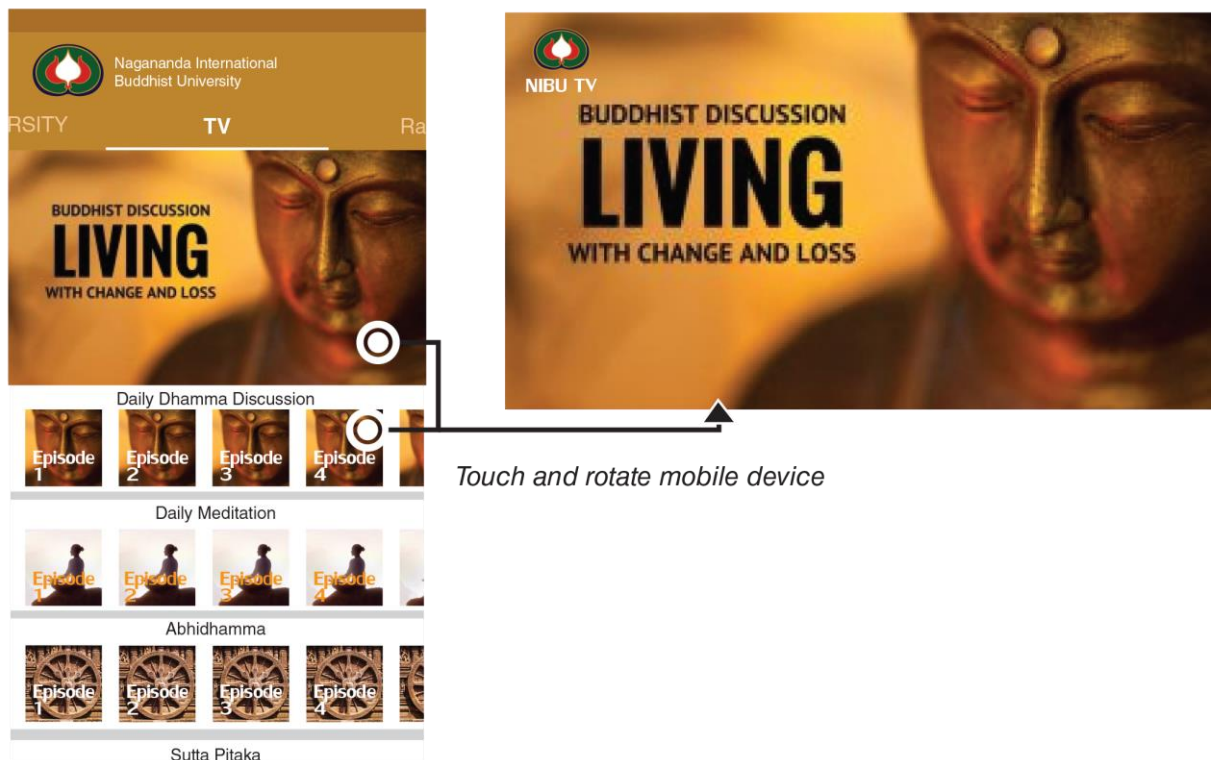


Figure 5.5 : Activity flow of Live Streaming TV channel component of the Mobile App

## 5.4 Activity workflow of the finished Mobile Application for NIBU

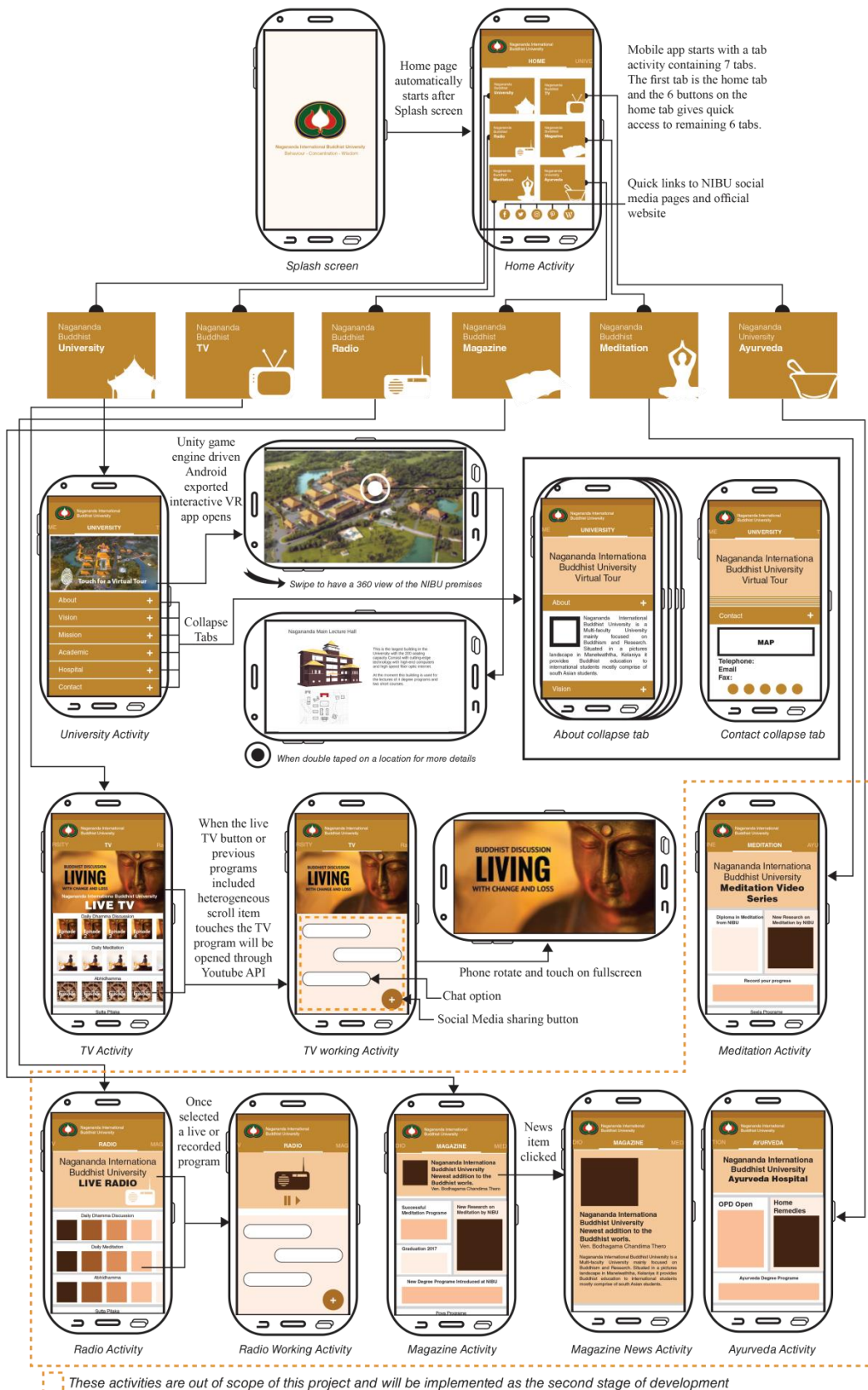


Figure 5.6 : Activity flow of the finished NIBU Mobile App



## 5.5 Error messages and user support

Displaying error messages in necessary situations is a good software development practice (Figure 26). User guiding through the application is also important feature when it comes to the user friendliness of the mobile application (Figure 27). Developer should make sure that the user is guided properly through the application to expose the user to all the content of the application. Usability testing in the testing phase of the mobile application development helps to identify the situations where it is necessary to use error messages and user guidance.



*Figure 5.7* : Sample error message display when mobile data or Wi-Fi connection is not activated while attempting to watch live or recorded TV program



*Figure 5.8* : Informing user regarding extra activities embedded in to the system

## 6 Evaluation and Testing

### 6.1 NIBU Mobile Application Evaluation

Evaluation of the NIBU Mobile system was done in order to make sure that the application meets the client's requirements. System as well as user acceptance was tested. Lessons learned and problems encountered during the project were identified.

### 6.2 System Testing Objectives

Mobile application system testing is done to measure usability, performance, creativeness, usefulness, attractiveness and content effectiveness. Questionnaire was developed using SurveyMonkey application [12] to get the user feedback on application.

#### 6.2.1 Test Cases

Three test cases were used to do the usability testing. These test cases are covering total functionality of the current NIBU mobile system. Users were given satisfactory level of test steps and asked to give a feedback between -5 to +5 up on the user experience they gained.

#### Test Case 1: NIBU Mobile app navigation

		User feedback (0 to +5)
Test case ID	01	
Title	Navigation	
Pre-condition	None	
Test Steps	<ol style="list-style-type: none"><li>1. Going from Home tab to University Tab</li><li>2. Coming back to the Home tab</li><li>3. Going from any tab to Home Tab</li><li>4. Navigate to University places information window and back to Home tab</li></ol>	
Expected results	<ol style="list-style-type: none"><li>1. Easy to navigate from Home tab to other tabs and other tabs to home tab.</li><li>2. Easy to find the way back to the start with almost all the activity layouts apart from the interactive 3D visualization application activities through top University Logo.</li><li>3. Easy to find the location of the user in the app in any given time.</li></ol>	

**Test Case 2: Use of University Virtual Tour to find information regarding different places**

		User feedback (0 to +5)
Test case ID	02	
Title	NIBU interactive 3D visualization Tour	
Pre-condition	None	
Test Steps	<ol style="list-style-type: none"> <li>1. Touch the Image button on top</li> <li>2. Swipe left and right to see around</li> <li>3. Double tap on a place to see information</li> <li>4. Coming back to the University tab</li> </ol>	
Expected results	<ol style="list-style-type: none"> <li>1. Smooth rotation with swipe</li> <li>2. Satisfactory interactive 3D visualization experience</li> <li>3. Easy to find the locations and read information</li> </ol>	

**Test Case 3: Finding a desired video and play in TV tab**

		User feedback (0 to +5)
Test case ID	03	
Title	Finding a Video and play	
Pre-condition	<ol style="list-style-type: none"> <li>1. Internet Connection</li> <li>2. Youtube app had to be installed</li> </ol>	
Test Steps	<ol style="list-style-type: none"> <li>1. Navigate through heterogeneous view to find the desired video and play</li> <li>2. Use player controls to play and pose the video</li> <li>3. Rotate phone to go to full screen</li> <li>4. Error messages</li> </ol>	
Expected results	<ol style="list-style-type: none"> <li>1. Easy to find the correct category by swiping down and correct episode by swiping left</li> <li>2. Error messages are helpful e.g. When there is no internet connection an error message will display saying “No Internet Connection”</li> </ol>	

## 6.3 System Testing

### 6.3.1 Alpha Testing

Alpha testing is simulated or actual operational testing done by using potential users/customers or an independent test team at the developers' site. Alpha testing is often employed for off-the-shelf software as a form of internal acceptance testing, before the software proceeds to beta testing. [6] Alpha testing was conducted among a group and 10 colleagues participated this testing. The below Table shows average of each test cases steps and expected results.

	Test -1 <sup>st</sup> Step	Expected Result - 1 <sup>st</sup>	Test - 2 <sup>nd</sup> Step	Expected Result - 2 <sup>nd</sup>	Test-3 <sup>rd</sup> Step	Expected Result - 3 <sup>rd</sup>	Test-4 <sup>th</sup> Step	Expected Result - 4 <sup>th</sup>
Test Case 01	3.6	5	3.1	4	2.2	4	2.2	4
Test Case 02	4.2	3	4.6	4	1.7	4	1.4	3
Test Case 03	3.4	3	2.3	3	1.9	3	4.9	3

*Table 6.1 : Alpha test case results of NIBU Mobile App*

### 6.3.2 Beta Testing

Beta testing is done after alpha testing and can be considered as a form of external user acceptance testing. Versions of the software, known as beta versions, are released to a limited audience outside of the programming team known as beta testers. The software is released to groups of students so that further testing can ensure the product has minimum faults or bugs. Beta versions can be made available to the open public to increase the feedback field to a maximal number of future users and to deliver value earlier, for an extended or even indefinite period of time (perpetual beta)[6]. Following Beta testing results among the 10 real users from group of students. The below Table shows average of each test cases steps and expected results.

	Test -1 <sup>st</sup> Step	Expected Result - 1 <sup>st</sup>	Test - 2 <sup>nd</sup> Step	Expected Result - 2 <sup>nd</sup>	Test-3 <sup>rd</sup> Step	Expected Result - 3 <sup>rd</sup>	Test-4 <sup>th</sup> Step	Expected Result - 4 <sup>th</sup>
Test Case 01	4.2	5	3.6	4	2.5	4	3.8	4
Test Case 02	4.1	3	3.1	4	1.7	4	3.1	3
Test Case 03	3.5	3	2.7	3	1.2	3	4.5	3

*Table 6.2 : Beta test case results of NIBU Mobile App*

## 6.4 User Acceptance testing results summary

During this stage, a questionnaire (Please see Section 6.2) was given to the selected set of users and based on the results the following Pros, Cons and solutions of the NIBU mobile system were identified.

### NIBU Mobile System Pros

1. Splash screen at the start is helpful to understand the meaning of the NIBU logo and loading sound is soothing
2. Buttons in the home page are big enough and easy to recognize with the image on it.
3. It was good to add quick access buttons on Home page so the experienced user can select the desired tab directly from the home screen without swiping tabs. For an example if someone wants to go to daily meditation lessons it is easy to go to Meditation tab directly by clicking on the button on the home page.
4. Logo click directing to Home layout is a good design move.
5. Error messages are helpful
6. Minimal design and less colors are pleasing to eye

### NIBU Mobile System Cons and solutions

1. Video navigation in the TV tag through heterogeneous scroll view is good but scrolling is not that smooth  
**Solution:** Image resolution of image buttons were reduced and the scroll speed went up
2. Interactive 3D visualization 3D rotation is not smooth enough on some devices  
**Solution:** Complexity of the scene can be reduced to reduce the memory consumption
3. More content is needed in the application  
**Solution:** In the second phase of the development content for the other 4 tabs will be also included

## 6.5 Video Livestreaming issues

There were some difficulties with video Live streaming due to Internet data transfer speed issues. To overcome this resolution of output video was reduced. It was always a difficult task to transfer MP4 video format with H264 video codec compressed 1080 by 1920 resolution

video. With a better internet connection with higher bandwidth 720 by 1280 can be transferred.

## **7 Conclusion and Further Work**

Nagananda International Buddhist University is still in its early operational stage. In the future, the university is planning to introduce even more programs and facilities to educate nations in Buddhist practices, Meditation, Health and social wellbeing. As a starting point, University is satisfied with the mobile application and services provided by it to the community. As people moving away from traditional media and mainly focusing on online and social media, this would be a good platform to spread Buddhist teaching and philosophy and Ayurveda teachings worldwide.

It was a great experience because; there was an opportunity to focus on Buddhism and Buddhist teachings while focusing on the technological aspects.

In the second phase of this project, apart from University and TV features, another 4 features will be introduced namely: Online Radio, Online Buddhist Magazine, Meditation education and research and Ayurveda education.

Online Radio channel will broadcast most of the TV program's audio version and just like TV channel it will have both live streaming and recorded program listening facility. As mentioned previously, there is a Magazine issued monthly by the University regarding various topics related to Buddhism, Ayurveda, Self Help and news items. So, during further development stage of the app e-news version of this magazine will be included to the mobile app. Just like any other news app it will update continuously and provide temporary content frequently to the app user.

Furthermore, there will be a separate section for Buddhist Meditation and research in the mobile app in the future and it will include lesson series on Buddhist meditation. There will be a separate section for Ayurveda in the future app and it will provide simple Ayurveda solutions for common illnesses, good health habits, home remedies and, etc.

User registration and login will be also added later as there will be facilities to post comments, chat with other members and Administrator(s), send questions and get answers for personal and common problems. Sharing facility of App content will be also provided to the users on their social media pages.

Thus, this application could be considered as a mobile app which would help for the betterment of the society in its long run.

## **7.1 Lessons Learned**

Almost all the subjects learned in the Masters Degree program helped immensely to finish this project successfully. Android mobile app development using Java, XML and JSON scripting, Unity Game engine and C# scripting, establishment and functionality of a Multimedia Studio system are some of the areas got an opportunity to be mastered. Project planning and implementing in a given time period was also learned.



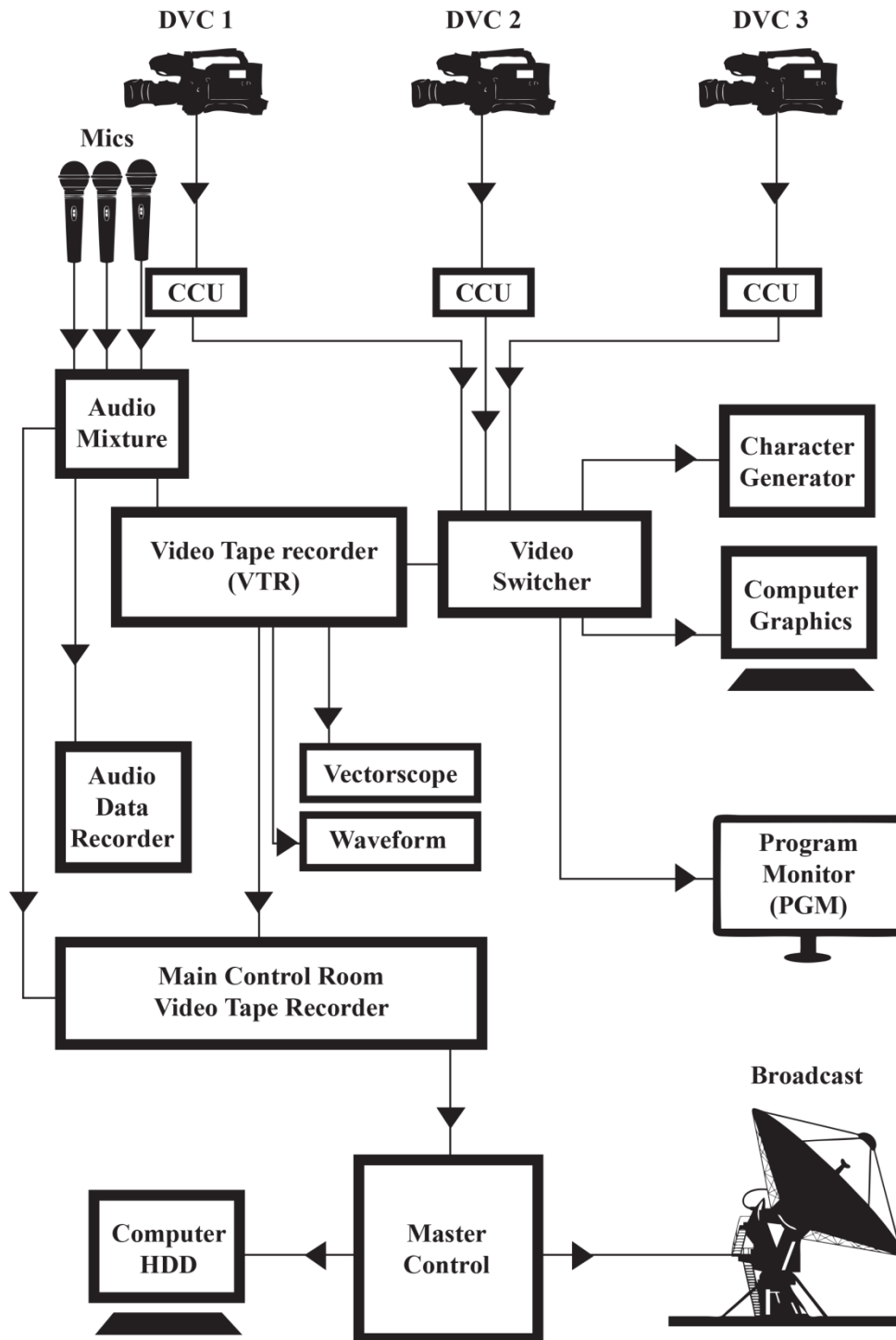
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## 9 Appendices

### Appendix A: Analog studio system of Sri Lanka Rupavahini Corporation (SLRC) (Author, 2017)



Analog studio system of Sri Lanka Rupavahini Corporation

## Appendix B: Questionnaire for the users to get user feedback on Mobile Application

### NIBU Android Mobile Application Feedback

This mobile application is a property of Nagananda International Buddhist University, Sri Lanka. We welcome your feedback on our application so that we can provide better content the way you like.

#### 1. What is the RAM size of your Smartphone

- |                                     |                                 |
|-------------------------------------|---------------------------------|
| <input type="radio"/> 128Mb or less | <input type="radio"/> 2Gb       |
| <input type="radio"/> 256Mb         | <input type="radio"/> 3Gb       |
| <input type="radio"/> 512Mb         | <input type="radio"/> 4Gb       |
| <input type="radio"/> 1Gb           | <input type="radio"/> Above 4Gb |

#### 2. What is the brand and model of your Smartphone?

#### 3. How easy to navigate in this app

- |   |                                     |
|---|-------------------------------------|
| <input type="radio"/> Best I have ever seen           | <input type="radio"/> Average       |
| <input type="radio"/> Better than most apps           | <input type="radio"/> Below average |
| <input type="radio"/> Good like most of the good apps |                                     |

#### 4. How is your VR Tour experience, did you enjoy?

- Yes very much
- I liked it
- Not that much
- Worst VR experience ever

#### 5. What do you think about Live streaming TV channel, was it useful and interesting?

- |   |   |
|---|---|
| <input type="radio"/> Yes very much, I loved it | <input type="radio"/> I didn't find it useful         |
| <input type="radio"/> It's good                 | <input type="radio"/> What live streaming TV channel? |
| <input type="radio"/> Average                   |   |

#### 6. What do you think about overall design of this app?

- One of the best I have ever seen
- Good
- Average
- Didn't like it

7. Do you find content of this app useful and interesting?

- Very useful and extremely interesting
- Good, useful
- Not that much
- Not at all

8. Which of the issues below was the biggest problem during your experience with the mobile app?

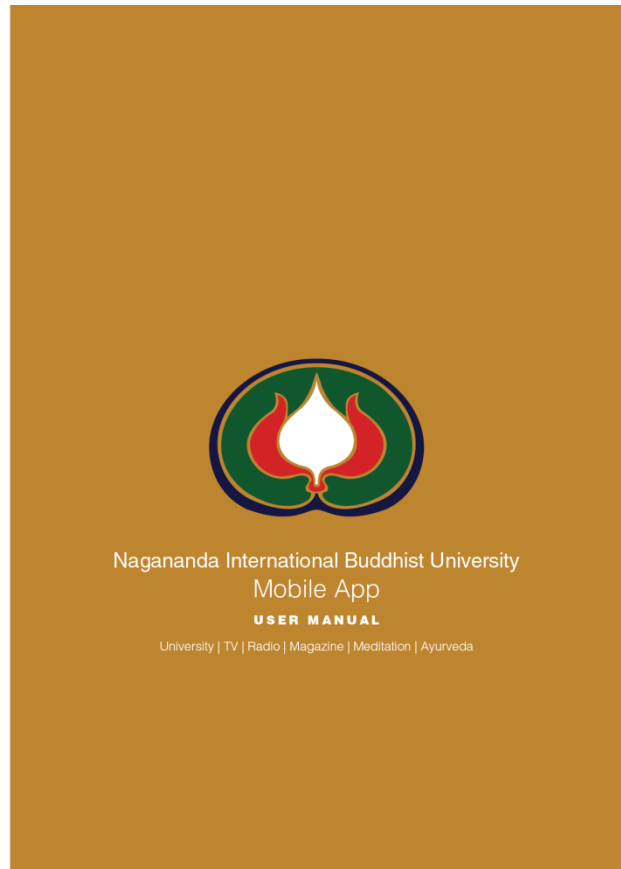
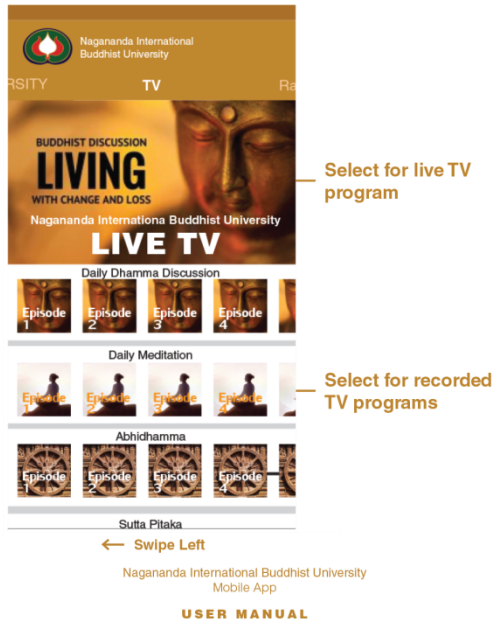
- I experienced bugs
- The app was missing features I needed
- The app was confusing to use
- Other (please specify)
- The app was visually unappealing
- The app crashed

9. Please describe the problem you encountered in more detail.

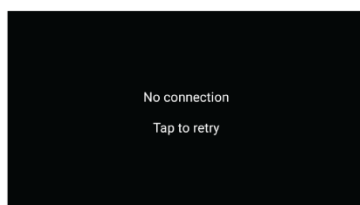
10. What is your overall idea about this app? What are there areas need to be improved?

## Appendix C: NIBU Mobile App User Manual – Front

### 6 TV Tab



### 7 Error messages



Check your internet connection.  
If not connected first connect and tap on the video to retry



### 1 NIBU Mobile App Installation

#### Hardware Requirement

Smartphone with  
RAM – Minimum - 1GB, Recommended – 3GB  
Storage – 16GB or above  
Screen resolution – 1080 \* 1920 recommended

#### Software Requirements

Smartphone with  
Android OS or any other operating system  
capable of running an Android App  
Youtube app should have been installed



# Appendix D: NIBU Mobile App User Manual – Back

## 2 NIBU Mobile App Installation

1. Make sure you have the Android operating system



2. Download and install the NIBU App



3. Double click on the app icon to run the app



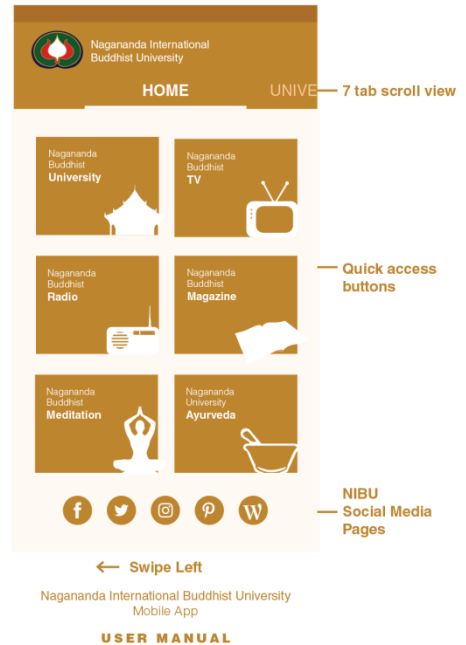
Nagananda International Buddhist University  
Mobile App  
**USER MANUAL**

## 3 Splash Screen



Nagananda International Buddhist University  
Mobile App  
**USER MANUAL**

## 4 Home Tab



Nagananda International Buddhist University  
Mobile App  
**USER MANUAL**

## 5 University Tab



Nagananda International Buddhist University  
Mobile App  
**USER MANUAL**