BODO AR: The Bodo Language Learning Mobile Application

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in

Computer Science and Engineering

by

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5th Semester, 2020-21

April 10, 2021

DECLARATION

We certify that

(a) The work contained in this report has been done by us under the guidance of our supervisor.

(b) The work has not been submitted to any other Institute for any degree or diploma.

(c) We have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.

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CERTIFICATE

This is to certify that the project report entitled "**BODO AR: The Bodo Language Learning Mobile Application**" submitted by **Debojeet Das** (Roll No. GAU-C-18/055), **Sourav Kr. Biswas** (Roll No. GAU-C-18/057) and **Preeti Ramchiary** (Roll No. GAU-C-18/086) to Central Institute of Technology Kokrajhar towards partial fulfilment of requirements for the award of degree of Bachelor of Technology in Computer Science and Engineering is a record of bona fide work carried out by them under my supervision and guidance during 5th Semester, 2020-21.

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Abstract

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Degree for which submitted: **Bachelor of Technology**

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Project supervisor: **Dr. Ranjan Maity**

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Our project aims to provide an easy way to learn the Bodo language, one of the official languages of our country. For this we have used Augmented Reality technologies which has already been recognised as an alternate or supporting means in the field of education, besides the traditional way. We created an application which teaches Bodo Vowels and Numbers from scratch. We have used audio as well as 3D objects in our app, which will create a lasting impact on the mind of learners. One quiz section is also included in our app to check how much the reader is able to grasp the content.

Acknowledgements

We would like to express our deepest gratitude to our guide, Dr. Ranjan Maity for his valuable guidance, consistent encouragement, personal caring, timely help and providing us with an excellent atmosphere for doing our research. In spite of the busy schedule, he has extended his cheerful and cordial support to us, without which we could not have completed our project work.

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Abbreviations

2D	**2** **D**imensional
3D	**3** **D**imensional
API	**A**pplication **P**rogramming **I**nterface
AR	**A**ugmented **R**eality
GIMP	**G**NU **I**mage **M**anipulation **P**rogram
GNU	**G**NU's **N**ot **U**nix!
SDK	**S**oftware **D**evelopment **K**it
VR	**V**irtual **R**eality

Chapter 1

Introduction

1.1 AR and VR

Traditionally two definitions of augmented reality are used by academics: Those made by Milgram and Kishino in 1994 and Azuma in 1997.

- Milgram et al. [7] have defined augmented reality using Reality-Virtuality (RV) Continuum. According to their definition, AR and VR are related and AR is a part of mixed reality, and an environment in the mixed reality area could define its position in the continuum.

FIGURE 1.1: Milgram's Mixed Reality continuum. [Milgram and Kishino, 1994]

Milgram and Kishino [1994] introduced the concept of "Mixed Reality", which is the merging together of real and virtual worlds, and a Mixed Reality continuum which is a taxonomy of the various ways in which the "virtual" and "real" elements can be combined together (Figure 1.1). On the right end is

the Virtual Environment (VE), where the user's view of the world is completely replaced by computer generated virtual content. On the opposite left end is the Real Environment (RE) where none of the user's view is replace by virtual content. Towards the VE end is Augmented Virtuality where most of the user's view is replaced by computer graphics, but there is still a view of the real world available. Finally, Augmented Reality is closer to the RE end, where virtual cues enhances the user's view of the real world. As more or less virtual content is added to the AR scene the interface moves closer or further away from the VE or RE endpoints. The main lesson from this taxonomy is that AR interfaces don't exist as a discrete point between Real and Virtual experiences, but can appear anywhere along the Mixed Reality continuum.

- In another most commonly accepted definitions, researcher Azuma [2] says that Augmented Reality is technology that has three key requirements:

  1. It combines real and virtual content.
  2. It is interactive in real time.
  3. It is registered in 3D

  These three characteristics also define the technical requirements of an AR system, namely that it has to have a display that can combine real and virtual images, a computer system that can generate interactive graphics that responds to user input in real time, and a tracking system that can find the position of the users viewpoint and enable the virtual image to appear fixed in the real world. Itshould be noted that Azuma's definition doesn't place any limitations on the type of technology used.

1.2 Bodo Language

The Bodo language has its written record from the last part of the 19th century. This language was introduced in the primary level of education in Assam from the

year 1963 and presently is the medium of instruction upto 10th standard in the state of Assam. It was recognized by the government of Assam as official language in the Kokrajhar district and Udalguri sub-division from the year 1984. The language also got Indian govt. recognition as scheduled language from 2003. According to the census of 1991 it has a total of 11,84,569 speakers. The Bodo population has basic concentration in the northern part of the Brahmaputra valley of Assam. They have also thin concentration in the southern part of the valley. Besides that they have also concentration in small number in the border areas of Meghalaya, Nagaland, North Bengal, Nepal, and Bhutan adjoining Assam.

Characteristics The Boro language has a total of 30 phonemes: 6 vowels, 16 consonants, and 8 diphthongs (figure 1.2). Use of the high back unrounded vowel phoneme /w/ is very frequent in Bodo language. The Bodo language has different special characteristics such as: It has intonation pattern, juncture and two types of tones. The words in Bodo are highly monosyllabic. It has agglutinative features also.

1.3 Objectives and Motivation

The main aim and motivation of our project is to create something which can be used freely by users to learn Bodo Language. For this we chose to develop an application to learn the Bodo language. Although anyone with out any prerequisites can use this app, but it can used effectively for :

- ☐ The school going students who are trying to learn Bodo.
- ☐ The Bodo people staying outside BTR
- ☐ The people residing in BTR but don't know how to speak or write Bodo.

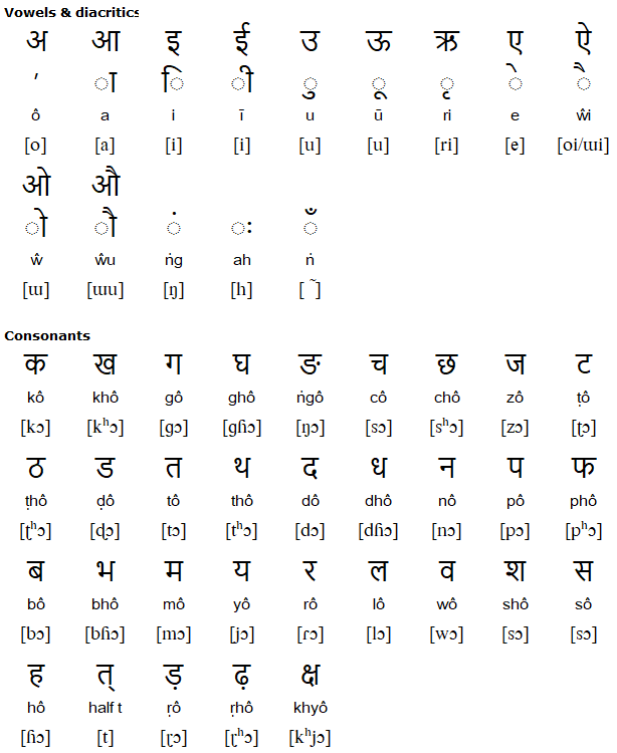


FIGURE 1.2: Bodo Alphabets

We wanted the application to support the traditional learning methods so that it can be used very effectively to learn the Bodo language in a simplified, interactive and systematic manner.

Chapter 2

Literature Survey

"If I have seen further it is by standing on the shoulders of Giants."

– Sir Issac Newton

As pointed by one the best mind to ever walk on Earth, we too started our work by going through the papers which seemed related to our idea. Most of the papers that we studied were either based on the educational aspect of AR or on the practical implementation of AR i.e, how the AR technologies actually work and how they can be implemented in our app. Most of the papers also included surveys with a positive result on the impact of AR Technologies on education, which further motivated us. In most of the papers it can be seen that AR eased the traditional learning system and also improved the performance of students. Moreover students found it more interactive which increased their curiosity to learn new things.

2.1 Related Works

These are the different works on AR that we went through while working on our project idea.

2.1.1 Augmented Reality in the Classroom

In this article the authors Billinghurst and Duenser [3] studied the evaluations of AR experiences such as Augmented books and Mobile AR applications in an educational setting to provide insights into how this technology can enhance traditional learning models and what obstacles stand in the way of its broader use. The authors also analyzed one storytelling workshop, by the HIT Lab NZ, where teachers showed 10 to 14-year-olds an augmented book version of Giant Jimmy Jones by Gavin Bishop.It helped them check whether AR might be most effective as a complement to traditional learning methods or not. They concluded that:

- AR is a valuable teaching tool.
- AR's high level of interactivity enhances learning.
- But there is lack of content-creation tools.

2.1.2 AR-based Remote Video Learning System

Online Video Classes transfers video and audio over Internet but it lacks interaction. It is difficult to transfer some abstract knowledge or experiment phenomena in real environment to students. So in this paper the authors Cai and Song [4] proposed a one-to-many remote video learning system based on AR technology where teachers can transmit learning content to remote students. The system shields the complexity of AR technology, it just needs a desktop, laptop or mobile device with camera connected to the network. They concluded that:

- Integration of virtual and reality, real-time interaction, three-dimensional immersion - AR properties make augmented reality environment different from traditional learning management platform.

- Teachers and students without any technical basis are able to apply the learning system and meet the need of interaction with learning content and visualization display of abstract knowledge in distance learning.
- The system has still considerable space for system performance improvement and its future development is the focus of their further study.

2.1.3 Augmented reality mobile application and its influence in Quechua language learning

Many languages are in danger of disappearing over time due to the blending of cultures and migration. Native speakers of such endangered languages dies before teaching their next generation. The Quechua language is one of such endangered languages which belongs to the peruvian culture. To save such endangered language educational institutes should teach such language on the first years of elementary and secondary school since it is known that a person at early age is more receptive for learning a language. So the authors Montellanos et al. [8] designed an AR mobile application for Quechua language learning which can teach fruits, colors, animals, etc. using AR. After that they conducted a quasi - experiment to assess what extent the augmented reality mobile application will improve the Quechua language learning and to demonstrate its influence on the understanding of information, motivation, satisfaction and performance. They concluded that:

- The use of the Mobile Application with Augmented Reality increases the motivation, influences the understanding and performance and improves the satisfaction of learning the Quechua language.
- It is recommended to apply more subjects about Quechua in the application so that the language learning with augmented reality technology would be more covered. It was demonstrated that the use of this tool influences positively in Quechua learning.

- It is recommended that the future works could complement the research with new alternatives of native languages for a greater diversity. New alternatives that will help to the language preservation and its learning.
- Finally, regarding the importance of augmented reality in several areas of knowledge, it is recommended to use this technology in a playful way. In fact, it is possible to apply more interactive games that contribute in learning.

2.1.4 AR Flashcards for Asian Language Learning

Bilingualism has been reported to improve significantly the quality of life of individuals in varying age groups, especially the elders. Therefore, in this paper the authors Wu et al. [10] demonstrates an augmented reality framework to render 3D objects over corresponding Chinese or Japanese words, with or without the respective pronunciation. The application can identify 5 different logograms from their doubles, making it a potential auxiliary tool in the second language learning process. The authors concluded that:

- The developed application was successfully demonstrated to describe 5 different Chinese and Japanese logograms and could distinguish them from their doubles.
- The low processor utilization suggests that the framework can be further migrated to the smartphone for a learning on-the-go experience.
- Moreover, new words from the list of must-know logograms of Chinese and Japanese proficiency tests shall be presently added to the learning contents so the application can offer a wider learning range of both languages.
- Besides, by creating proper patterns, this framework also can be modified to support other languages in the future.

2.1.5 Marker Tracking and HMD Calibration for a Video-based Augmented Reality Conferencing System

In this paper the authors Kato and Billinghurst [6] described an augmented reality conferencing system which uses the overlay of virtual images on the real world. Remote collaborators are represented on Virtual Monitors which can be freely positioned about a user in space. Users can collaboratively view and interact with virtual objects using a shared virtual whiteboard. This is possible through precise virtual image registration using fast and accurate computer vision techniques and HMD calibration. The authors proposed a method for tracking fiducial markers and a calibration method for optical see-through HMD based on the marker tracking. They concluded that:

- In this paper they have described a new Augmented Reality conferencing application and the computer vision techniques used in the application.
- Their computer vision methods give good results when the markers are close to the user, but accuracy decreases the further the cards are from the camera.
- Also their HMD calibration method which does not require a non-moving user give good results without user's patience.
- In future, they will improve the AR conferencing prototype and execute user testing for its evaluation as a communication system.

2.1.6 Augmented Reality for Education; AR Children's Book

In this paper the authors Hossain et al. [5] demonstrated a system that provides users with two different user interfaces for both English & Bangla version where they can learn alphabet and fruits using AR. The app takes access of the smartphone camera to detect any target image and shows a 3D model in the real-time (background).

2.1.7 The development of an electricity book based on augmented reality technologies

In this research the authors Permana et al. [9] aims to produce an electricity book using augmented reality (AR) technology. This book can support observation, experimentation, and stimulation activities because AR technology can display animation, sound, and video. The method used in this research is 4D model research and development whose stages consist of: define, design, develop, and disseminate. The disseminate stage was done by uploading the application to the Google PlayStore. The AR book has passed the validation test stage with the percentage of achievement of 80.44% according to the material expert, 91.75% according to the learning media expert. The test results to 10 students showed the performance of 82.48% with 0.68 of gain value. Based on validation test and filed test, give the conclusion that the development of electricity book based on AR technologies has fulfilled the learning process and requirement as physics teaching materials.

2.1.8 MyVision AIR : An Augmented Interactive Reality Book Mobile Application

In this paper the authors Al-Ali et al. [1] presents an Augmented Interactive Reality book (AIR) application, aimed to enhance the reading experience of adult-learners by incorporating Augmented Reality (AR) technology to improve the interaction of normal books. Various features and characteristics of Augmented Reality (AR) were applied to the chosen book, “My Vision” written by H.H. Sheikh Mohammed Bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai. Education was not given much importance in UAE especially the girls education. The education rate among girls in UAE in less and so is the case for adult education. The authors wanted to tackle this scenario, they used AR technologies for this. Their research showed that AR technologies can be used to increase the rate

of adult learning as it uses more interactive method compared to other traditional way of learning.

Chapter 3

Software Development

The development of this project included the implementation of AR mobile application. It consists of five phases:

- Literature Review: Each one of our group members went through published papers related to our idea.
- Initialization: In this phase we started setting up our environment for the creation of our mobile application. Here we collected 3D models and other requirements.
- Production: Production corresponds to the software development where we explored different prototypes to implement our desired application.
- Stabilization: In this phase we further improved the application with new features and better stability and performance.
- Tests: Finally we tested our application with 13 internal testers who provided suggestions for further development.

3.1 Software Tools

The application was implemented using C# in Unity 2018.4 with the help of Vuforia SDK. The 3D objects used in the application were downloaded from Google Poly beforehand. The audio used in this application was recorded by native Bodo speaker for exact pronunciation and the image editing was done using GIMP software.

3.1.1 Unity and Vuforia SDK

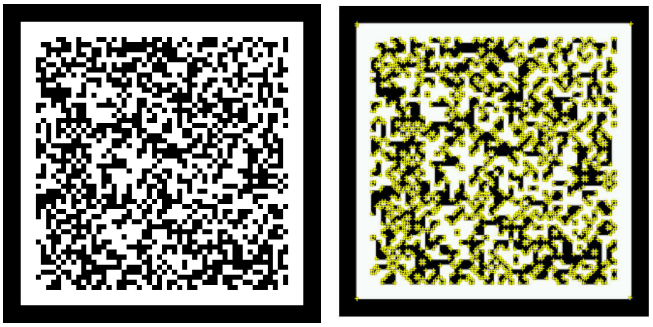
3.1.1.1 Unity

Unity gives users the ability to create games and experiences in both 2D and 3D, and the engine offers a primary scripting API in C#. In our application Unity was used to create a 3D environment which acts as our AR environment where we can place 3D objects.

3.1.1.2 Vuforia

Vuforia is an augmented reality software development kit (SDK) for mobile devices that enables the creation of augmented reality applications. It uses computer vision technology to recognize and track planar images and 3D objects in real time. This image registration capability enables developers to position and orient virtual objects, such as 3D models and other media, in relation to real world objects when they are viewed through the camera of a mobile device. The virtual object then tracks the position and orientation of the image in real-time so that the viewer's perspective on the object corresponds with the perspective on the target. It thus appears that the virtual object is a part of the real-world scene.

In our mobile application an image target was used as an anchor for the Vuforia SDK to track and superimpose 3D objects in real time. The image target is shown in figure 3.1(a)



(a) Image Target (b) Trackable with feature points

FIGURE 3.1: Trackable

Working Vuforia tracks the pose and position of the image target or the trackable in real time video captured by camera using feature points. The trackable with feature points is shown in figure 3.1(b)

The trackable also has some properties associated with it like detected, tracked and no pose. The properties changes according to the status of the trackable. It is shown in table 3.1. These properties are used by the trackable event handler to track and augment 3D object in real world with proper scaling and alignment.

TABLE 3.1: Trackable Properties

Properties	**Description**
Detected	The trackable was detected.
Tracked	The trackable is being tracked and indicates normal operation.
No Pose	No device pose available.

3.1.2 Other utilities

Many tools and utilities were used for this project some of them are given below:

Google Poly Google Poly is a website created by Google for users to browse, distribute, and download 3D objects. It is intended to allow creators to easily share and access 3D objects. It features a free library containing thousands of 3D objects for use in virtual reality and augmented reality applications.

3D objects were downloaded from the Poly website on free license for use in our AR application.

GIMP GIMP or GNU Image Manipulation Program is a free and open-source raster graphics editor used for image manipulation (retouching) and image editing.

It was used to edit and generate all graphics elements of the application.

3.2 System Design

According to our actual demands, our AR app needs to augment 3D objects onto real world robustly with proper scaling and alignment. In our application the real world scene is captured by the camera and Vuforia tracks the trackable using feature points. The Trackable Event Handler (Figure 3.2) comes into play and finally, our app represents the graphics of the virtual content to be displayed on the device's screen, where an object of augmented reality is observed.

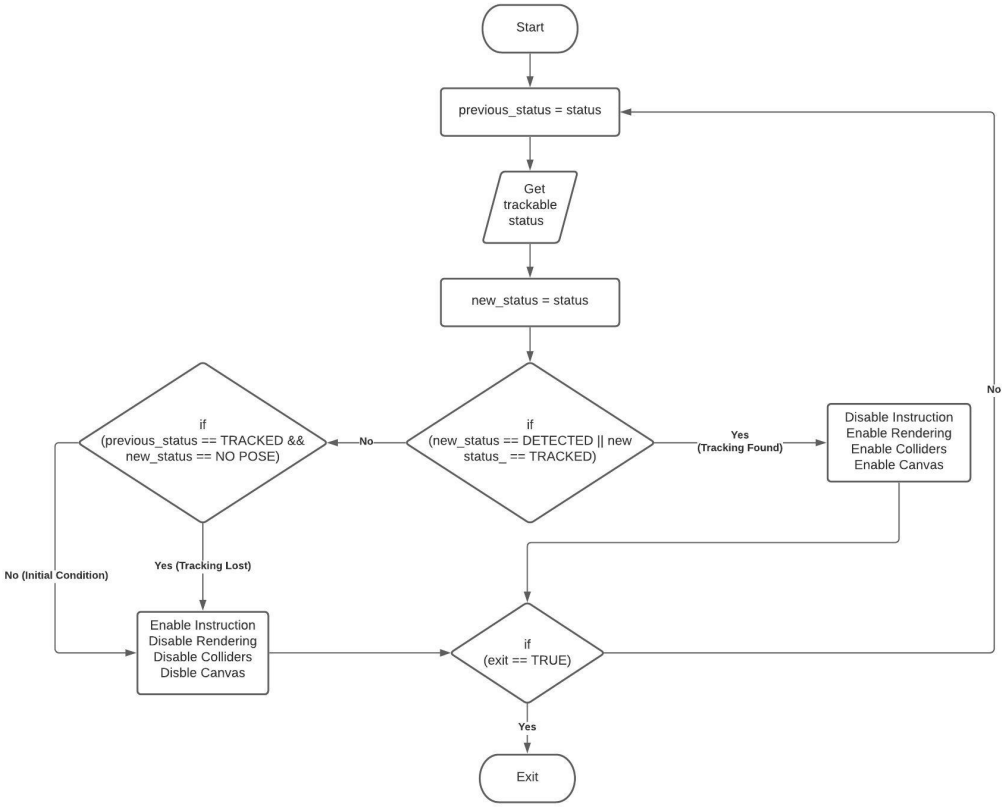


FIGURE 3.2: Trackable Event

Chapter 4

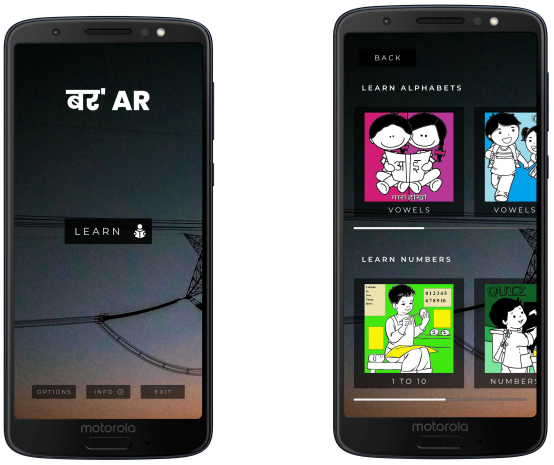
Implementation and Results

4.1 Implementation

At present our application supports vowel learning as well as number learning from 1 to 10. Our Application also provides quiz modes for both of the learning modes. Figure 4.1(a) shows the main menu which contains the learn button. It redirects us to the selection menu (Figure 4.1(b)) where we can choose to learn or try quiz of vowels and numbers. In addition, a info, a options and a exit button are included. The first one describes the operation of augmented reality. The options button contains all settings, credits and a option to download the image target or the trackable.

4.1.1 Learn Mode

To use learn mode first, we must select the category we want to learn and navigate between scenes until we reach the AR Scene. After pointing the camera towards the AR Marker or Image target we can interact with the AR scene. We are visualising vowels and numbers using 3D models. Pronunciation and spelling are also provided for ease of learning. In the figure 4.2(a) and figure 4.2(b) we can see the application



(a) Main Menu (b) Selection Menu

FIGURE 4.1: Application Interface

running for the vowels Elephant and Bamboo Tree. And in figure 4.2(c) and 4.2(d) we can see the visualisation of the numbers 5 and 7 using 5 balls and 7 crayons.

(a) Elephant (b) Bamboo Tree (c) 5 Balls (d) 7 Crayons

FIGURE 4.2: Visualisation of different 3D objects

4.1.2 Quiz Mode

In addition to learn mode, there are quiz modes for vowels and numbers within the application. Each quiz has a five number of questions where five 3D objects are shown at random with associated question and options. The user will have to select

(a) Unanswered (b) Correct Answered (c) Wrong Answered

FIGURE 4.3: Quiz Mode Scenarios

correct option for which marks are granted. When an correct or wrong answer is selected, the application will provide feedback and add the marks accordingly. In the figure 4.3 the quiz can be seen in unanswered, correct answered and wrong answered scenarios. For every correct answer 1 mark is granted and for every wrong answer 0 mark is granted. At the end, a result menu is shown (figure 4.4) with grade and scores obtained from the quiz and options to restart the quiz or go back to the selection menu. The grading criteria is shown in Table 4.1

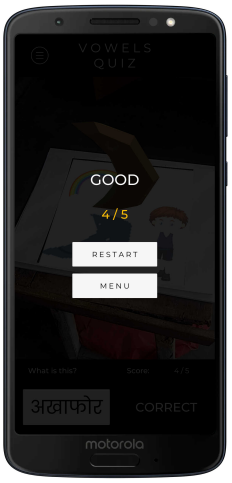


FIGURE 4.4: Result screen

TABLE 4.1: Grading Criteria

Score	**Grading**
0-2	Try Again
3-4	Good
5	Perfect

4.2 Results

As observed in AR scenes (figure 4.2), the image target or trackable was correctly identified and the AR objects were properly rendered. All tests were smoothly performed in real-time, demonstrating that the developed application is indeed processor-friendly. Moreover, since the image target was positioned with random rotation and scale factors, one concludes that the framework is robust to orientation and scale.

Chapter 5

Conclusions and Scope

5.1 Conclusions

At this moment our app contains only a part of our idea. Our main aim is to design an app which would be capable of teaching all the alphabets and the basic number system. We completed the vowel part completely. But the number system has to be extended upto 50 and the consonant part is still untouched. The quiz section has to be updated accordingly.

The next major change which we are considering is to design our own 3D objects.Right now we are using the 3D objects available in Google poly. Moreover we are also looking forward to provide animations in certain areas, which can make our app more interactive for the learners, especially the kids.

We can increase our reach by launching our app in ios and android platforms. By doing so we can reach those who are native Bodo people but are staying outside Bodoland. It can be of great benefit to those people.

Lastly we can introduce this app to the school authorities. We know how AR technology can be used as a great booster to the learning experience. By using

this app side by side with the traditional learning system, we can ignite a sense of curiosity and fun to the new learners.

5.2 Scope

Numerous paper on AR technologies have shown us how it can be used in education. This app along with the traditional learning methods can be used to learn Bodo language in an interactive manner which would of great use to the small students. Moreover, any one who is interested to learn the Bodo language can use this app to begin their journey.

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