A Mobile Application with Augmented Reality to Enhance Sinhala Learning Experience for Children

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Abstract

Augmented Reality has gone from science fiction dream to possible emerging technology in the modern world. This futuristic technology has the ability to blend the real world with digital world. This paper presents an Augmented Reality based mobile solution for children to enhance their Sinhala alphabet learning experience. With this tool, children can interactively learn letters, pronunciation and usage of letters in real world scenarios. Generally, teaching preschool children could be difficult since they only focus on an activity for a short period of time. Therefore this solution mainly focuses on adding fun and entertainment while addressing cognitive skills of the children. This application adds totally new learning experience for its users. A survey done with pre-school children and teachers proved that using Augmented Reality based solution with latest technologies are very helpful for learning things and teaching things efficiently. Most students requested to use the Augmented Reality application repeatedly. Teachers showed high level of enthusiasm and over 85% of the respondents gave extremely positive feedback

Key Terms:

Sinhala, Handwriting Recognition, Preprocessing, Character Segmentation, Classification, Neural Networks, Image Processing.

1. INTRODUCTION

Sinhala language is considered as one of the beautiful languages in the world and at the same time, one of the difficult languages to pronounce and write [1]. In early days, parents and teachers used sand boards or black boards to teach Sinhala alphabet to Children. With the development of technology, electronic devices came into the education sector as well. Even though the technological developments are rapidly increasing the learnability of a language, there aren't many modern technological solutions for enhancing the learning experience of Sinhala Language.

Use of electronic devices to learn or teach Sinhala language is a good approach to protect Sri Lankan native language without letting it to be a dead language in future. Currently most of the children, parents as well as teachers are very familiar with smart phones and mobile applications. In this context, the solution is based on a smart phone mobile application with the use of Augmented Reality technology to give a unique and interactive way of learning Sinhala language fundamentals for children.

Augmented Reality has recently been a trending technology, with the invention of wearable devices. But since wearable devices in the market are not very affordable for general public, the solution is based on android mobile devices. Therefore most of the general public will get the opportunity to experience the solution with their own smart phones. The Solution is focused on teaching letters in Sinhala alphabet to children, improve their cognitive skills and language fundamental with interactive activities.

Next section critically evaluates the research area and third section describes the approach and design of the solution. Under fourth section, the implementation details are described. Section five describes about the evaluation of the results and discussion. The final section contains the conclusion of the study and further work.

2. RELATED RESEARCH WORK

In local context, there are no Augmented Reality based mobile application research similar to the solution. But in global context there are few related researches.

2.1 Fun Learning with AR

For children, Fun and Interactive learning is a powerful pedagogical factor which could yield to create the interactive and engaged learning environment [2]. Children need simulations to absorb facts quickly [3]. Adding some fun is also very important aspect of teaching things to Children. In this research the main intention is to create an environment for learning things with fun and motivational background for children.

2.2 Augmented Reality in Education

The first attempt to use AR in Education is a popup book called "Magic Book" [4]. Later a research was done to simulate Sun, Moon and Planets using AR simulations for educational purposes. These projects were tested with students and results showed that students interactively learned using AR because it was portable, gave a detailed view and it was interactive. "Live Solar System" was aimed to help children to remember solar system and galaxies. Results showed that they have learnt facts effectively from the AR application than traditional text book and materials[5].

Based on the literature review in this area, there were few projects have been carried out. Almost all of these researchers have mentioned that there is a higher potential in AR to support literacy, epecially learning alphabet in a particular language for children.

3. RESEARCH APPROACH

After the research on children learning and their psychological factors affecting for understanding things, the solution is an attractive mobile application which can be run on Android operating system. There is an alphabet printed on paper. When the user runs the mobile application, the camera of the mobile phone will be turned on. Then user needs to focus the camera on to the printed paper. Suppose the camera is focused to "ඇ" letter in the alphabet, then the user can see the letter

as a 3D letter floating on top of the paper while hearing the correct pronunciation of it. And also an object which is related to the letter will be displayed on top of the paper. User can interact with the letter and learn the writing patterns of a letter, pronunciation and usage of a letter through the solution.

The following diagram describes the augmented reality approach for the solution using a model of an animal. The generated 3D model can be seen through the device display when the camera is focused to the image The following flow

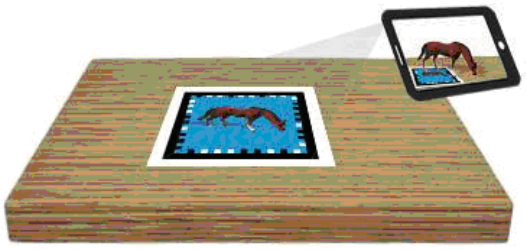

Figure 1: Augmented Reality Based Mobile Application Running on a smart phone is focused to a printed image, and its AR model is showed through the mobile phone display

chart shows the process of how the camera detects an image target from the capturing stream and drawing of the virtual 3D object according to it.

In next chapter, we discuss about the implementation of this

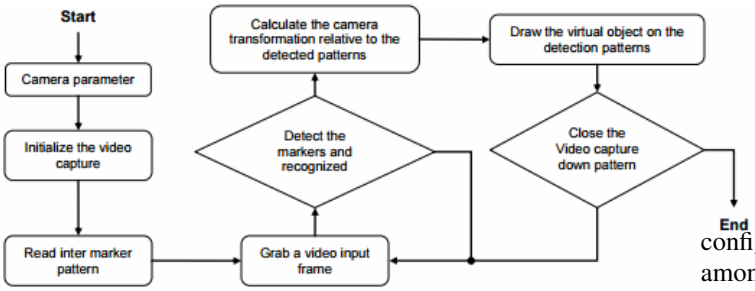

Figure 2: Overall Augmented Reality System Design

solution as an Android application.

4. IMPLEMENTATION

As this application is implemented for mobile devices, there are specially considered factors including memory usage, optimization of processing, storage and capacity of the application as well as increasing the accuracy of the image recognition and speed of rendering objects as Augmented Reality models. Battery consumption of the solution is also taken into consideration.

For the implementations, Vuforia SDK V2.6 of Qualcomm was added as a library and C# and JavaScript languages were used for implementing application logic. Unity 3D game engine was used as the development environment. The data communication between the Android application and MySQL DBMS was handled using PHP and XML.

The following diagram presents the architectural design of the solution including the system development kits, APIs and core libraries. The implemented augmented reality system was tested in the following H/W & S/W environment: CPU Dual Core 1.2GHz Cortex A-9, 1GB RAM, Android 4.1.2 Jelly

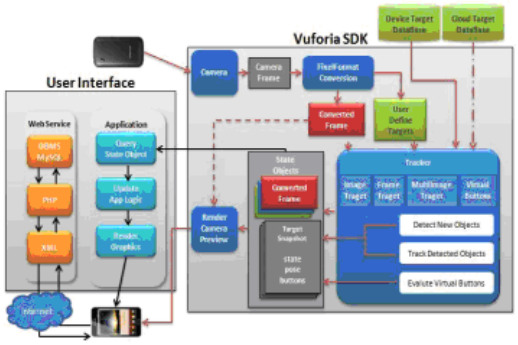

Figure 3: System Architecture of the Solution

Bean, Built-in memory 16GB, and the resolution of 480×800 In the solution, a printed image or a diagram is used to generate the 3D model in augmented reality. That image is called the image target. Image target can be either black and white or color image. Once this image target is tracked by the camera at the mobile phone, it uploads the JPG image of it to the SDK, downloads the matching coordinates from the extracted image character points from Unity application package. Figure 3 shows the capability of identifying pre-

Figure 4: Identifying Image Targets

configured image targets by matching character point patterns among other images. After identifying the correct image target, It keeps the image tracked and generates a three dimensional object based on the tracked image target.

There are marker points at any detected image. These marker points are used to keep the detected image always under the control with the augmented reality 3D model.

Figure 5: Matching Character Points of an Image Target

Character points are used to generate patterns by calculating angles and curves of the captured image. As in the figure 4, the application can generate character points for each and every significant detail in the target image.

Figure 6: Sample Image Target and Generated Character Points

The solution has the printed Sinhala alphabet with all the Sinhala characters. They are the image targets like in figure 6 for the application. The image will be captured and compared with the database by the SDK itself. Unlike the conventional fiducially implemented markers, data matrix codes and QR codes, these image targets can even be complicated color images.

Figure 7: Full image target of Sinhala Letter

SDK compares the naturally detectable features of the image against the known target image database. If it is correctly mapped with it, application can track the target even if it is partially visible like in figure 7.

Figure 8: After successfully detecting the image target, Application still keep the image tracked even it is partially covered.

After tracking the image, the mobile device's sensors like accelerometer and gyroscope is used to determine the tilt and bearing of the device and those values defines the perspective of the Augmented Reality model.
"Prefetching" technique is used to manage memory. As in the figure 8, the position values from sensors will be taken and calculate the perspective of the model to be rendered. Then only necessary objects are loaded from the main storage to the memory to prevent lagging and application crashes.

5. DISCUSSION

The Augmented Reality based mobile solution can be run on a smart phone having 800 MHz or more processing power

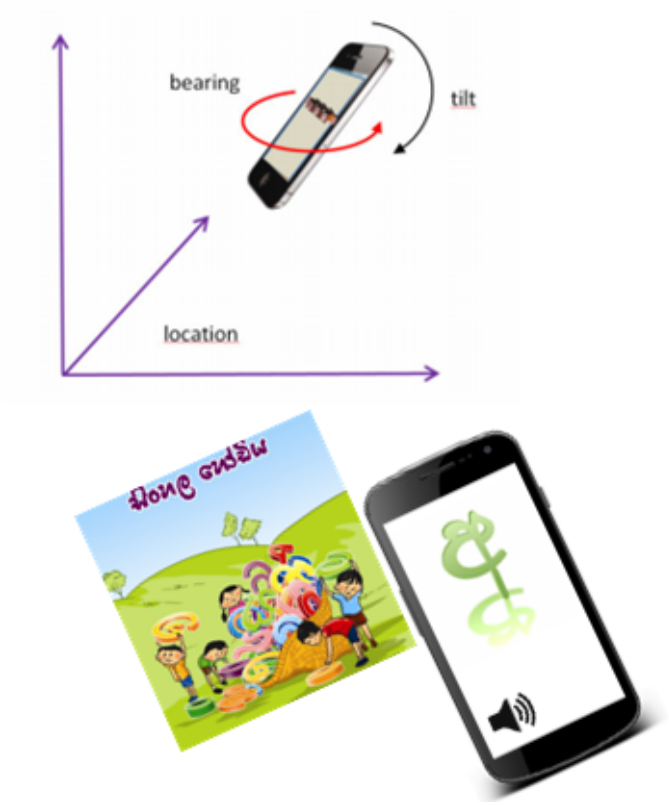

Figure 9: Application shows AR 3D Sinhala letters with animations, pronunciation and letter usages after determining the device's position and angle

with Android 2.2 or above operating system. The average initializing time to generate a model from an image target in black and white is 50.670 ns.

This application can identify only pre-programmed images. So the users need to use a printed book designed especially for the purpose with the application. And initially children may require some guidance of a parent to get familiar with the mobile application.

After implementing the prototype, it was subjected into several tests and demonstrated at public exhibitions and also displayed at seven national schools to get feedback from students. Over 85% of the users including parents, children and teenagers gave positive feedback while around 10% suggested to use this technology for other purposes. Others didn't give positive or negative feedback.

6. CONCLUSION

In this proposed solution, the main objective is to enhance Sinhala alphabet learning experience of children using Augmented Reality approach. The surveys and demonstration feedback showed that this solution is an effective and interactive tool. Therefore the future goal is to develop this with Audio-Visual content and improving the interactivity of the application while maintaining the processing requirements and optimizing the Android application. After finalizing the solution, this will be introduced to elementary schools and primary schools with the intention of deploying the app on online app stores as well.

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