ReadAR – An AR Mobile Application Extended for Future Reading

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***Abstract**: Augmented reality is a technology which is still getting explored for its vast range of applications in real life. Augmented Reality is capable of being used almost everywhere from entertainment to education due to the wide range of applications it provides. Augmented Reality book is one of the many applications of this exciting field. An AR book merges traditional text with digital content using a piece of technology like a Smartphone to make the reading experience more immersive and engaging. AR Book can bring back the rewarding reading habit among youngsters as it provides greater interest and curiosity. In this paper, use of Marker Based AR is done, as we require the 3D scene to be displayed when a Marker is triggered which in our case is pages of the book. The Cross-platform Mobile AR Application developed presented in this paper will scan the pages of the book to display the respective 3D scene in Augmented Reality on top of that particular page of the book. The use of Unity with Vuforia for cross-platform AR App Development and Blender for 3D scene creation is done.*

***Keywords**: Augmented Reality, AR book, Blender, Cross platform, Future reading, Marker based AR, Mobile app, Unity software, Vuforia.*

1. Introduction

Before getting acquainted with Augmented Reality, here's a quick take on what it truly is. A human's physical body and mind exist in a mix of space and time which we perceive as Reality. As technology advanced, humans could exist inside a computer-generated mix of space and time. That imaginary environment is called Virtual Reality. However nowadays technology has evolved to a point where both reality and Virtual Reality interact together to a particular extent. This mix is termed as Augmented Reality (AR). The problem statement that we plan to face is "Declining Reading habit among youngsters." So the traditional management of this problem which the world followed was to issue online based learning. But it was soon known that online based learning is basically just a medium shift for the same 2D reading illustrations so as to save users some time to find resources quickly. The interest slowly waned off as online resources seemed like an unsolved solution to the massive problem being the loss of interest in reading from youngsters. As a result, the traditional solution to cultivate reading habit in youngsters was not enough. We came to the realization of implementing AR as we found some solutions which tackle the problem statement [1], [2].

- Creating awareness
- Making reading more interactive and entertaining
- Physical books over e-books
- Merging digital content with books

All of the above-mentioned solutions are achieved by the use of Augmented Reality. An augmented reality book would be the best option to restore the reading habit and showcase the creative part of education which youngsters would love to be a part of. With ReadAR, we would help to provide long-term memory within students to help their growth in the understanding of the basic concepts of education which would make their education foundations very firm [3].

2. Problem Definition

Books have always been used as a tool to support learning and as a means for acquisition of knowledge. However, sometimes these books are unable to explain clearly the concepts. This is due to the limitations of paper books like static content without any interactive nature. Buying and storing books is looked upon as a waste of precious space at home especially in metropolitan cities like Mumbai and it may even be considered as old fashioned. It can be said that most of the children have no patience to sit and read books or enjoy literature. But thankfully still there are a small percentage of parents who read books and they are keen on inculcating reading habits in their children. If this habit is formed when they are young it continues throughout their lives. School libraries make provision for good literature but all children are not inclined towards reading. Children have too many distractions and they are pushed into too many activities by their parents to keep up with the rat race as a result of which reading takes a back seat. This Paper proposes "Augmented Reality Book" which makes the use of augmented reality to make the reading and learning process more interactive and interesting.

3. Proposed Solution

A. Block Diagram and Working

AR Book App make use of Marker based AR. As soon as a user opens the AR Book App, they would need to scan the page

of the book and the relative 3D scene according to the page appears on the front. Here the image of the pages of the book acts as a trigger to show the respective 3D scene in AR on top of the book. Figure 1 shows the workflow of the app at the user and system side in a block diagram.

The user first needs to install and open the AR Book App in their Android/iOS device. Once the application starts, the camera module of the mobile device will turn on and enable the camera. Now the user will have to scan the intended data using the device's camera. The intended data can be either a predefined trigger image or a predefined text. The App may also make use of markers if necessary to display the 3D scene in AR. Once the intended data is scanned and detected by the Application through camera, it will immediately display the 3D scene in AR on top of that respective page in the book. This is done using Vuforia and Unity Engine which provides the SDK to develop Augmented Reality Application.
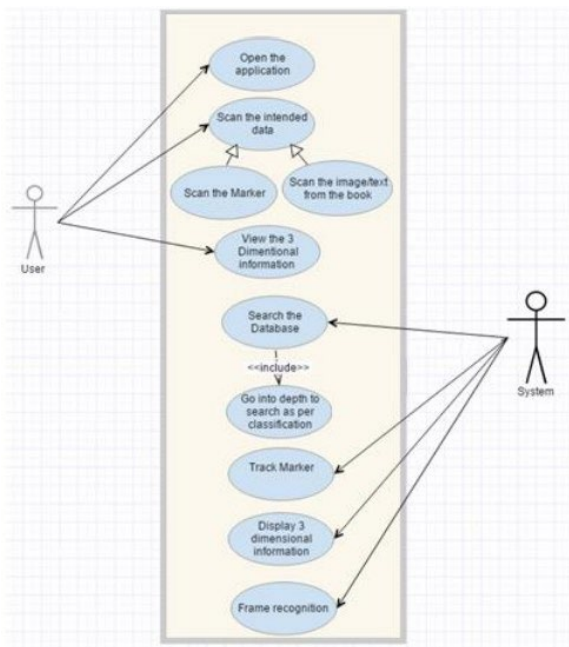

Fig. 1. Block diagram

The trigger images are predefined in the Vuforia Image target database. The AR Application will now search for the trigger image in the database. Once it recognizes the image or text through the camera using Computer vision and image tracking technology of Vuforia, it will display the respective 3D scene on top of the detected image which in our case is the page of the book. Now until the trigger image remains in the frames detected through camera, the App will continue showing the respective 3D model in Augmented Reality. Now the user can move to the next page by turning the page of the physical book and repeat the same steps to view the other 3D scenes in the book respective of each page. The App will scan and detect the pages and display the 3D scenes on top of each page respective of the content on the page.

B. Hardware Description
The hardware requirement for the AR Book App is only a computer for the development and a Smartphone for deployment. The PC can be Windows or Mac and the smartphone can be Android or iOS. We will be installing Blender, Unity and Vuforia in our PC for the development of the AR Book App. A big part of why smart phones have become so common placed is because they combine a camera and a display. AR is just another new way for us to augment what the video camera sees. To implement AR we need three things:

- World Tracking,
- Scene Estimation, and
- Anchored Overlay Rendering.

Smartphone's GPU and Display are used for rendering virtual content and the camera provides the background to overlay it on. AR Apps use Spatial Computing which means that the app is aware of its location in space and aware of movement, device orientation, and its relationship to the environment. In order to do spatial computing, smart phones contain a device called an IMU, which stands for Inertial Measurement Unit. IMU stands for Inertial Measurement Unit. An IMU contains several miniature gyroscopes and several miniature accelerometers, and it can measure both linear acceleration and rotational acceleration. An IMU also often contains a magnetometer. Using the magnetometer, the phone can tell which way is north. So, the IMU is able to provide what is called Inertial Pose Tracking.

C. Software Description
To create an AR Book application, we require three major entities of software. The following mentioned software is the fundamental building blocks of the proposed method. All of which focus on either modelling, implementation in the 3D world and then application deployment integrated with AR fundamentals [4]-[8], [11].

i. *Blender:* Blender is a free and open-source 3D computer graphics software toolset used for creating animated films, visual effects, art, 3D printed models, motion graphics, interactive 3D applications, virtual reality, augmented reality and computer games. In the proposed method, Blender for the development of 3D models and 3D animations in the initial stages is used. By understanding the emotions and the morals of the book, 3D models will be created using Blender and then animated. These 3D animated scenes will be displayed on top of the pages of book once the trigger image gets detected by the App. We will be exporting the 3D models created in Blender to Unity for the further process.

ii. *Unity:* Unity is a cross-platform game engine developed by Unity Technologies; Unity3D is a powerful cross-platform 3D engine and a user-friendly development environment. Unity can be used to easily create 3D games and applications in VR/AR/MR for mobile, desktop, the web, and consoles, etc. Proposed method uses Unity to create and customize our AR Book Application according to the needs and requirement. Unity is a powerful tool which when combined with Vuforia Engine makes it capable of

developing high performance Augmented Reality Applications.

iii. *Vuforia:* Vuforia is an augmented reality software development kit 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. In the proposed work, Vuforia engine in Unity is used to give the trigger images and set the 3D scenes accordingly for each page of the book.

D. System Architecture

Figure 2 shows the architecture of the proposed system, where two-tier client server architecture is selected. The main reason for selecting the said framework is that if all the data is stored on the client side, the system size would increase thereby making the system to lag on low-end mobile phones. Hence a separate server is required to store and process all the target image and text. The server database also helps in mapping the corresponding model for the identified text or image target. The work of the client side is to display this mapped 3D model or video over the identified image and textual data. The architecture of the system is thus divided into two layers, namely, the client-side layer and the server-side layer.
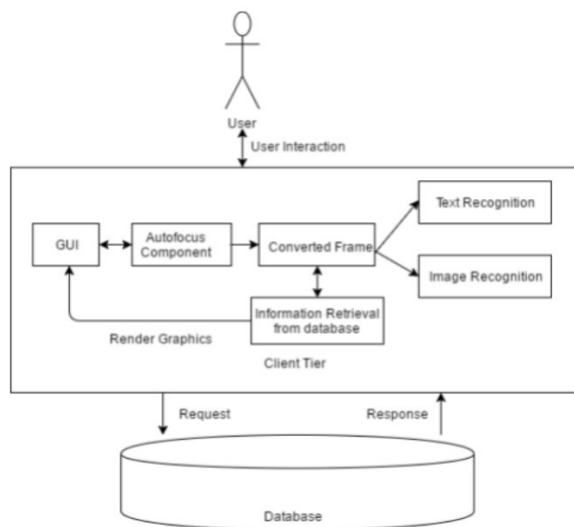

Fig. 2. System architecture

At the client side, the user interacts with the system using the Graphical User Interface (GUI) which in this case is simply the display rendered from the camera module. The user hovers over the image/text with the help of the autofocus module which focuses the camera on to the target. Further, it is identified whether the target is an image target or text target. This is also done by the client side which identifies the type of input and then forwards it to the server-side layer. The second layer is the server-side layer which consists of the database.

Once the image target has been identified, the corresponding information is retrieved from the database and forwarded back to the client. The user directly provides the input to the system at the client side while the processing of the input is done by the server side. Let us see the role of each module in the system.

i.   *GUI module:* This module invokes the camera on the smart phone. It lets the user hover over the image of which he/she wants to understand the concept. This module is of prime importance as the data is recognized solely by the camera.

ii. *Autofocus module:* This module focuses the camera on the content so that the content can be tracked easily. It lets the system to be used with any range of mobile phones. Also, it is a basis for the further text recognition module.

iii. *Content tracking:* The camera module is not useful without the content tracker which identifies the required content that is to be tracked and used for augmentation. It identifies the images with or without markers and for text recognition; a blue box appears around the identified text.

iv. *Marker detection:* The detection method will depend on the design of the marker. Square markers are detected searching for lines and contours while circular markers are detected searching for blobs. The contour detection algorithm for square markers takes advantage of the fact that the markers are four-sided quads with a black border. To keep the algorithms as low-cost as possible a fast rejection/acceptance test is often followed by the detection to ignore obvious non-markers [9], [10].

v.   *Text recognition:* The Text Recognition feature allows developers to create apps that detect and track printed English words. The words are matched with a predefined list of words. The developer can build a better user experience by handling text recognition events. Vuforia can detect words that belong to a pre-defined word list. One can define a custom word list.

vi. *Image recognition:* Image target represent the images that can be recognized by the Vuforia SDK. These image targets do not require to have special regions to be recognized. Instead, these images are recognized on the basis of feature points which help the system to identify an image. Each image is rated by Vuforia on the basis of its feature points. Higher the rating, the faster the image is recognized by the system. After target detection, the image will be tracked as long as it falls under the camera's purview.

vii. *Information retrieval from database:* After text detection using Vuforia SDK information is retrieved from the database by matching of the keywords. When an appropriate match is found the information is displayed to the user.

4. Results and Discussion

The application developed has following stages at UI level.
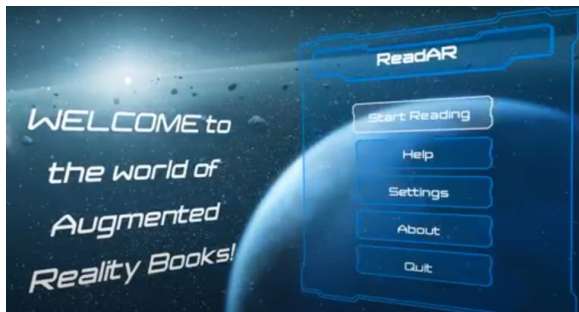
Fig. 3. App page

Fig. 4. AR Book UI page (Here Start Reading input depicted)

Fig. 5. Scan the page

Fig. 6. Result after scanning Alphabet B

Fig. 7. Exit page

5. Advantages, Limitations and Applications

A. Advantages

1. AR experience provides greater interest and curiosity in reading books.
2. AR Book converts the traditional book experience into a new joyful, interactive and engaging learning experience.
3. Helps in Cultivating rewarding Reading Habit instead of just consuming digital content.
4. Reading helps in strengthening the brain, psychological development, relieves stress, increases empathy and much more.

B. Limitations

1. Old low end smart phones do not possess capability of working on AR.
2. Requirement of Vuforia for Android: Minimum Android 6.0 or higher.
3. Requirement of Vuforia for iOS: Minimum iOS version 12.0 or higher.

C. Applications

1. AR Book app is used to create interest in reading and this application can be further stretched to educational books, conceptual books where it is really difficult to understand the concepts. AR book can help to visualize the concepts which are usually difficult to sink in human's mind via textbooks.

6. Conclusion and Future Scope

Augmented Reality is a Technology which is still being explored and new creations are on the line up because of its vast capabilities. By creating an AR Book, the reading habit which is declining day by day can be given a boost again as it is the best hobby one could possess. Reading habit strengthens brain, reduces stress, increases empathy, expands vocabulary and much more and for all this, AR Book can help by cultivating the reading habit. Augmented Reality Books have the potential to make the traditional reading process more interactive and interesting and can be proven helpful in multiple ways.

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