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Augmented Reality Integration for Interactive Digital Textbook

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ABSTRACT: The project aims at integrating virtual 3D elements to transform the monotony of learning traditionally with textbooks into a new and revolutionary way. Research has proven that the concepts that are visualized by the learners are more likely retained by them.

The current AR Systems are not accessible to everyone beyond the classrooms and are often expensive. Our project aims to be able to bring this technology to every phone or device and access the knowledge that is on the application. By collaborating with teachers and educators we are able to ensure the reliability of the content as well as the uniformity of it. The project applies the ARI2VE model and uses SIFT algorithm along with tesseract OCR to recognize textual markers and then augment the 3D models made using blender and augmented using Unreal with spatial and temporal registration.

KEYWORDS: Augmented Reality, OCR, Tesseract, Unity, Blender, Markers, Database

I. INTRODUCTION

Augmented Reality can be defined as the technology that is used to superimpose virtual elements onto the real world Elements in real time. AR ensures seamless blending of the 2 worlds so as to create a completely new environment with varied levels of immersion and interaction.

In this project we have chosen to augment textbooks using text markers. The content that we have decided to augment is the physical textbook used for the curriculum and are approved by the educators of the course to ensure consistency of content in future this can be changed to be applicable for various textbooks of the same subject based on the keywords. The book is scanned by the input device- camera and following which the Tesseract OCR algorithm is applied to find the words from the input that is in image form. The SIFT algorithm is then chosen to convert these texts to markers that are cross checked with a database of markers. The database chosen is MySQL that is available in a plugin with unreal. Unreal will be used to detect the markers that are valid and found. The user is indicated that an augmentation of the marker is available. The user can then choose to either play the visualization or continue to read without it.

The 3D visualizations are to be created in blender and then exported to Unreal to be used when the marker and the user makes a suitable choice. The visualizations must also be available for replay if so chosen by the user. The text that is obtained by text recognition is also used for a second functionality of dictionary lookup. If the user points to a word on the page, the application will look up the word obtained in the dictionary and provide a response with the same. To implement the project parts of the ARI2VE model as studied in the project. The rest of the paper will describe the methodology, architecture, and algorithms along with the results of the model as expected.

II. RELATED CONCEPTS

Research says the human brain effortlessly understands information presented in interactive audio-visual format than simple interaction less reading. There are different ways of integrating AR with real world, the technology has been improving for a decade. AR book allows users to see 3D visuals of content on the physical book itself thus enhancing the understanding. These AR books can be Story books, Architecture and illustration books, Engineering or medical books.

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Most of these applications use accelerometers and gyroscopes for virtual object positioning and its orientation in the real world using coordinates. Use of markers is also widely done which triggers the objects to augment. Most of the solutions use a physical book and some factors as markers to augment the objects on the book itself. There is a database which works as a library to store different objects and modules, video and audio data which is to be augmented. AR augmentation requires smartphones to run the applications to take input and show output as well.

In most of the applications Unity Game Engine is used to create 2D and 3D objects it also provides asset store for different components and can be used with vuforia SDK and database. The scripting language used is C# it is an object oriented and aspect oriented programming language its fast and with no memory limitations
Many of them mentioned the use of blender which is a 3D graphics software toolset which allows easy creation of 3D objects and its rendering. Alo blender supports many file formats such as PLY, OBJ, and STL etc.

General flow for the application as studied is:

1. Creation of target
   One needs to have a target in the form of markers. These can be anything from text to images to QRs that can be captured by mobile cameras.

2. Development of 3D models and digital content
   One needs to create 3D content which is to be displayed or rendered on the physical book this can be done by using various tools like Unreal, Unity game engine, Blender etc.

3. Store the content
   After creating the digital content and 3D modules along with markers they need to be stored in a database. AR core is widely used as a link to connect these modules. Vuforia SDK is used as a database to store the markers and objects.

III. PROPOSED METHODOLOGY

Tools and Algorithms:

1. OCR: Optical Character Recognition (OCR), is a technology that recognizes text in images or scanned documents. In the context of augmented reality (AR), OCR can be used to extract textual data from the real world and integrate it in a virtual environment.

2. SIFT: Scale-Invariant Feature Transform (SIFT) is a computer vision algorithm for feature detection and description. SIFT is widely used in many computer vision applications, including augmented reality (AR)

3. Unreal Engine: Unreal Engine is a popular game development engine developed by Epic Games. It is a powerful tool for creating augmented reality (AR) experiences. Unreal Engine provides many features for AR development, including powerful 3D graphics rendering, physics simulation, and multi-platform support.

4. Blender: Blender is a powerful open source 3D design suite that includes modelling, animation, rendering and other features. Although Blender itself is not specifically designed for augmented reality (AR) development, you can use it in conjunction with other tools and techniques to create 3D content for AR applications.

5. MySQL Plugin: The MySQL and Maria DB Integration Plugin is a powerful and versatile tool designed specifically for developers and creators who use Unreal Engine.

Working

The proposed system of augmented book is dedicated to students and teachers for better understanding of engineering concepts. It uses textual markers and then augments the 3D content on the physical book itself. The basic architecture of application is as shown in Figure

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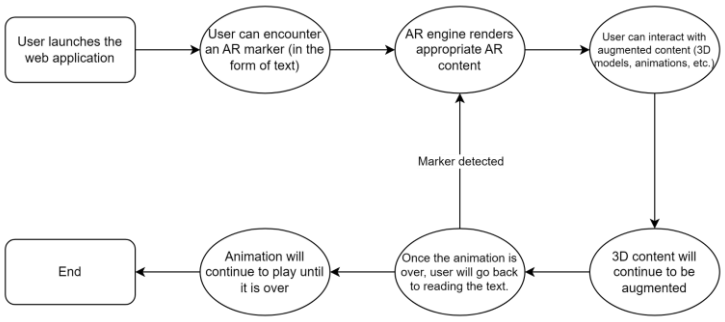

Fig: Architecture

A. Creation of Markers

It all starts with creation of markers. In this project we are going to use text as markers from physical books which will be detected using smartphone cameras. These textual Markers are certain keywords related to a particular concept and will be recognized by the system using Optical Character Recognition (OCR) algorithm and will be stored in a database. It will be used to extract the text information from the real world and thus help in projection of 3D modules. The textual markers will be stored in the database which is MySQL plugin for Unreal Engine.

B. Creation of 3D objects

For our project we need different objects and blocks for visualization of concepts. For example, when explaining the concept of sorting we need to design various blocks containing numbers on it which will be stored as an array to visualize this concept we will create objects using the Blender tool. Blender allows easy navigation and editing options. Next we need pointers or Arrows to perform hand gestures to allow zoom in and out while visualizing.

C. Processing of digital content

All the objects once created in blender will be converted to unreal acceptable format and will be clubbed together for final visualization. The process is done to convert objects to images, video clips or animated modules or 3D models. Video content will be the prime focus of the project as it allows detailed understanding and interaction. This includes using AR plugins - a third party software used to provide additional features. At the end of this step the content is ready to render. For this project we have used two software's i.e. Blender and Unreal Engine along with MySQL plugin as Database.

D. Exporting the Application

Once a project is created it needs to be exported for deployment for its use on mobile devices and check its compatibility with Android and iOS devices.

E. User Interaction

The work flow of the application goes like, the user will use smartphone camera to scan the textual markers and as soon as the marker is detected by the software at the back-end 3D module for that marker will be traced and it will start the projection of 3D modules on the phone. Users can play, stop, zoom in, and zoom out on the screen. The user interface will be simple and minimalistic where all the information will be shown in brief. The projected animation will be translucent so that the user can see the images and get a complete understanding of the concept. A user can simply gesture zoom-in, zoom-out, play or replay, looking up the meaning of a word, etc.

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IV. APPLICATIONS

The primary application of 'Augmented Reality Integration for Interactive Digital Textbooks' that has been discussed in this paper is for education. However it is not limited to it. Additional applications of the project can be:

1. Learning with disabilities: The project can be modified to be used for people with some disabilities for example dyslexia, Auditory Processing disorder, etc.

2. Banking brochures: Banks can make AR integrated brochures for customers to scan in which various banking procedures and their help guides can be visualized.

3. Stock market: Each investment scheme could be treated as a marker and a brochure can be catalogued for the user to scan following which the past trends of that particular investment can be augmented for the user.

4. Help manual for products: New electronic devices like printers, washing machines, etc. can have AR integrated guides and manuals for users to scan the particular functionality and see the tutorials augmented without having to watch a long video or several videos to find the right one.

V. FUTURE PROSPECTS

Digital Textbooks will be capable of incorporating Artificial Intelligence (AI) and Machine Learning (ML) Algorithms. This will help in enhancements in visualization to create more realistic and detailed 3D models. Students will be able to explore concepts in a hands-on, virtual environment by making the simulations more immersive. Moreover, we can incorporate wearable technologies such as Oculus Rift, Microsoft HoloLens. As for the medical field, 3D object recognition can be implemented so that real-world 3D objects can be scanned and detected. This will be useful for students studying anatomy where students can manipulate 3D models.

VI. ADVANTAGES AND BENEFITS

Personalized Learning: Adaptive AR content can be adjusted based on individual student's progress and learning abilities, providing a personalized learning experience.
Up-to-Date Content: Digital textbooks can be easily updated, keeping the content current and relevant. This is especially useful in rapidly evolving fields where traditional textbooks will quickly become obsolete.
Easy Understanding: Digital textbooks will explain the content in a visual manner, which is proven to be an easier way to grasp knowledge compared to plain reading.

VII. CONCLUSION

The paper studies the development of a mobile AR application deployed using textual markers. It will help every student access AR technology with no barriers of money, time constraints, location and frequency. A wide range of topics can be added and customize the application for various courses and streams. Our project further dives into the technical aspects of content creation for the application, augmenting and marker creation. The development of which can ensure better Interaction, retention and understanding of concepts rather than static content.

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