A New Dimension of Learning: 3D Animated Augmented Reality Books

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Abstract*— In this era people have more access than ever to 3D views and pictures of virtual objects due to emerging trends and technologies. Both students and instructors find it simple to learn new things and impart them to their pupils through the use of virtual learning methods. The traditional way of teaching with books is draining, not very stimulating, and doesn't give pupils any opportunities for visualization. As a result, the majority of pupils won't be able to understand that specific theme or subject. Students rush to learn a lot of material in a short amount of time during semester examinations, competitive exams, assignments, and other periods, but because there is a limited amount of learning time, it is difficult for students to study all the books. The book is targeted towards students, educators, and professionals in various fields, including science, technology, engineering, and mathematics. A digital visual aspect is used to create augmented reality (AR), which is a rendition of the actual world that is enhanced. The core of augmented reality (AR) is 3D modeling, model rendering, etc., which broadens the user's view on learning. Nowadays, businesses use augmented reality extensively to market their goods and services. Because users can see models and products in three dimensions, this makes for an interesting user experience and increases sales. A live animated image of models and items is added by augmented reality to improve your environment. The student's perspective of studying any specific topic or concept is enhanced by 3D models. Students can see the object's visualised model by using 3D models made with the aid of augmented reality. By offering simulated information in a distorted perspective of the real world, augmented reality (AR) simplifies the lives of users. AR makes the book diagrams appear in three dimensions, which is a pleasant and interesting experience.

Index Terms—*3D modeling, Image recognition, Augmented reality*

I. INTRODUCTION

An ARbook is a software or application. With the aid of augmented reality, the student can examine the image and view a 3D animated model that corresponds to it. Even if you only know the topic's name or subject, learners can use the search feature to quickly find the information they need to grasp the idea even in the absence of a picture.You will find two perspectives on every topic you learn about in the text.

1) 3D View, With this, you won't have to survey the surface or look through space.

2)AR View, With the aid of a virtual button, you can engage with the 3D moving model while viewing it in the real world with AR View. The Description View under those topics allows students to study knowledge about that topic at the same moment. The students will see more practise tests, numerous MCQs, and other items in the text.

In order to improve and enrich a user's experience, augmented reality (AR) concentrates on rendering, modelling into 3D models, or superimposing additional information over the real world. Augmented reality is used by users and other businesses to promote goods and services, start marketing campaigns, and gather specific user data for future development. Your circumstances are improved by augmented reality (AR), which incorporates a real-time picture of products and models. Virtual reality gave rise to augmented reality, a major area of research. It becomes incredibly challenging to efficiently and effectively create a large number of 3D models.[8] The use of information in the form of writing, pictures, audio, and other synthetic additions in conjunction with the real world and objects is known as augmented reality, or AR. Through its powers, AR primarily combines and enhances the user's interaction with the real-world surroundings.

Issues with Learning:-

Learning a challenging course or specific topic costs a lot of time and money. We are unable to completely comprehend some crucial concepts or diagrams because we are unable to visualise or envision them. To better grasp some concepts, students maintain a lot of physical learning materials close at hand, but carrying them around takes up a lot of room.

When a learner is interested in learning about a diagram or subject in a different field but is unfamiliar with that field and is unable to comprehend the topic. They pay for practise exams or multiple-choice questions, among other issues, to see if students have learned the material correctly and thoroughly.

Utilizing our ARBook to resolve that issue:-

It only requires a few minutes of free time to comprehend complex or narrow subjects. ARBook enables students to quickly visualise some important concepts or numbers that they find difficult to comprehend. Because ARBook eliminates the need for additional learning materials, ARBook now saves the room you previously used for all of your educational resources. ARBook has scanning capabilities that make it simple to learn about any subject. Below the subject you are learning in ARBook, you will find

free practise exams, MCQs, and much more. ARBook is a learner's best companion because it provides solutions to all of the issues that students encounter.

The user-friendly human-computer interface of augmented reality technology significantly expands its application potential and benefits customers. Convolutional neural networks with deep learning have been extensively used in the area of computer vision and have grown to be an effective instrument for dynamic image recognition tasks that are also advantageous in many companies. Combining deep learning and traditional machine learning techniques, this paper uses convolutional neural networks to derive features from image data. [1] As the most common 3D registration method in AR technology, the artificial marker-based approach is extremely competitive in terms of processing efficiency, dependability, and usefulness. [6] Image recognition refers to a comprehensive analysis of the spectral and spatial characteristics of various features in the image, based on some means to select the features that can express the features, and finally divides the features into different feature categories through a certain recognition algorithm. [2]

AR in Education:-

In 2020, it was predicted that the global market for augmented reality in education will be worth US 3.9 billion dollars but has since been revised to US 201.5 billion dollars, is expected to expand at a CAGR of 75.5 percent from 2020 to 2027 in the altered post-COVID-19 business environment. One of the report's segments, higher education, is anticipated to grow at a rate of 78.1 percent CAGR and hit US 122.9 billion dollar by the end of the study era. Growth in the Primary and Secondary Education sector is readjusted to a revised 73.3 percent CAGR for the following 7 years in order to account for the continuing post-pandemic recovery.Additionally, the growth of the global e-learning market, which exceeded USD 315 billion in 2021, is anticipated to grow at a CAGR of 20 percent from 2022 to 2028.

Aspects of ARBook:

1. Each learning resource will now be made accessible in a language you are familiar with.

2. Easy-to-understand UI: ARBook's user interface is very straightforward and clear, making it accessible to all users.

3. Unlimited Learning: You can learn about any subject or area using ARBook in a matter of minutes.

4. Platform Independent: ARBook will be accessible on all platforms and devices.

5. Totally Free: All of ARBook's essential functions as well as a tonne of educational materials are free.

As part of the feature extraction procedure, high-dimensional features are transformed or mapped to low-dimensional features to characterise them .[1] The following academic material gaps are filled by this study: Finding 3D augmented reality (AR) applications for pupils is the original objective in order for them to rapidly pick up new technology. Increasing the use of augmented reality (3D model) for pupils with weaker comprehension levels is the second objective. The third objective is to contrast the paper and 2D touch computer environments with the 3D (three-dimensional) augmented reality environments. [4] The fourth objective is to provide students with instructional resources that they can access in a 3D perspective that will help them understand ideas by utilising augmented reality (AR) technology with cellphones and tablets.

How to select a subject and view it in 3D is shown here:-

Simply select and press the mouse button to rotate the 3D picture in any orientation required. Now, You can focus in on the 3D picture and see the finer features by pressing the scrolling cursor button on your mouse. After that by clicking the camera symbol, you can capture a photo. Visualization of your selected goods are shown in the actual world using augmented reality.

ARBook helps students, instructors, institutions, and material publishers, and thus it may be the future of education. It can improve learning and make it more engaging, enjoyable, and effective. Including virtual reality can have a lot of advantages, particularly for pupils who are motivated to learn. With more interactivity, it can also bring new teaching techniques and change educational environments. However, it can also help pupils and improve their ability to retain knowledge. Traditional learning techniques can be changed and improved thanks to ARBook, particularly since it can handle the problem of people's deteriorating attention spans, which has become a problem over time. It can be used for learning in businesses, colleges and schools, the medical field, and by all different types of learners.

II. LITERATURE SURVEY

We have studied important topics such as Dynamic image recognition, augmented reality, integrated learning from paper “Augmented Reality Dynamic Image Recognition Technology Based on Deep Learning Algorithm”. When the user's viewing angle shifts, the image they see in the augmented reality system changes. The user's position, line of sight, and other information must be precisely and constantly tracked by the augmented reality system. How well the tracking system performs determines how well the augmented reality system performs. The qualities of the picture serve as the foundation for dynamic image recognition and machine vision, and these properties also influence how well a model performs. A specific visual element often has a huge number of unique expression techniques. Because everyone has a unique subjective interpretation of what it implies, there isn't just one best way to explain a specific attribute. In reality, several picture characteristic expressions describe different features of the feature from diverse angles. [1] We studied from the paper ”Simultaneous 3D Object Recognition and Pose Estimation Based on RGB-D Images” that, the primary distinction between 2D and 3D feature-based recognition is that the

former is based on 3D geometric data, such as point clouds, triangular meshes, etc., while the latter is based on local picture texture data[3].In this paper "Exploring Simple and Transferable Recognition-Aware Image Processing", we investigated simple yet highly efficient methods for improving the recognition accuracy of image processing outputs by downstream recognition systems, and we showed that these methods produce transferable accuracy gains across various recognition architectures, categories, tasks, and training datasets[4].We studied how to do the dimensions verification including challenging scales, rotation changes, perspective changes, motion blur, occlusion, and out-of-view object from paper ”A Hybrid 3D Registration Method of Augmented Reality for Intelligent Manufacturing”[6]. During studying image recognition, we learned that it involves first processing and evaluating a picture before describing and categorizing it. There are other techniques for recognizing images, including techniques based on picture key points and methods based on image texture recognition, which are both much more useful in our case, from paper "Image Recognition and Analysis: A Complex Network-Based Approach" [7]. We learnt about 3D original model, energy function, feature lines, image, mesh deformation from ”Developing an Image-Based 3D Model Editing Method”[8]. Mobile Web 3D, rendering interactive computing, on-demand loading, interfacing data services is some information we took from paper ”Rendering Optimization for Mobile Web 3D Based on Animation Data Separation and On-Demand Loading”[9]. 3D model retrieval, knowledge graph, graph embedding, multi-view representation are some findings from paper ”3D Model Retrieval Based on a 3D Shape Knowledge Graph”[10].

III. OBJECTIVES

1) Easy solutions to complex issues and better learning.

2) A greater desire to acquire new things and ideas thanks to examples that can be seen.

3) Draws on students' natural interest in 3D models to help them improve their ability to concentrate, think critically, and analyse information.

4) Improving user comfort is one of the ARBook's major goals in order to make everyday living for students and teachers easier.

5) Time and money are saved because users can study online without having to purchase books.

6) The ARBook enables users to engage actively with texts or illustrations.

7) This project's primary goal is to offer a Visual Advanced Concept of Any Subject in a Simple Way.AR helps kids focus on reading texts carefully, which improves their comprehension and critical-thinking skills and promotes their natural joy of books.

8) Improving user comfort is one of the AR Book's major goals in order to make everyday life for students and teachers easier. The two main forces behind the worldwide AR Book are time and money benefits. The AR Book enables users to actively engage with schematics or texts.

9) ARBook will make it easier for students to gain knowledge easily by just viewing the 3D models.

IV. METHODOLOGY

ARBook is an augmented reality-based Android application designed to fully understand difficult learning topics, visualize key concepts and reduce learning time. This project uses Vuforia Engine to implement AR technology in an application. AR technology uses SLAM (simultaneous localization and mapping). This algorithm is commonly used to map and monitor the environment by comparing visual features between camera images, collecting point data from the physical environment, and sending that data to the machine.

1) Data Collection: In the book AR initiative for feeding data into computers, vision technologies use SLAM to extract visual information in the form of points and dots from the actual environment. Even now, the camera is recording pictures.

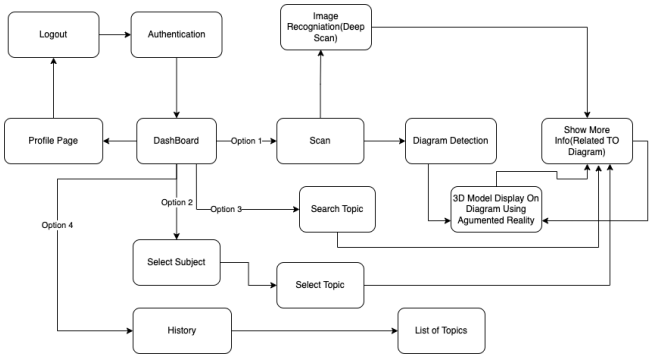
2) Image or object recognition: The first step, recognition, requires sensors and cameras to recognize real-world objects or spaces. The sensors collect data about the user’s actual interactions, such as: B. Head movement, direction, size, and coordinates/position

3) Tracking images or objects in space: Tracking software determines the position of virtual objects/vehicles in its real 3D space by running algorithms. Depth sensors are useful for depth detection technologies and 3D modelling for rendering.

4) Blend (combine) virtual media with real images or objects via overlay: The merging of virtual and real worlds is accomplished in simulated or optical AR devices using the advanced processing power of AR combiners, hardware, and functions. AR software by running AR algorithms.

5) Test data: Here we test the 3D image or model that matches the real scene.

6) Analysis results: data are processed in real time and may be animated.



ARBOOK with the help of Vuforia, utilizes several computer vision algorithms to enable robust image target tracking. Vuforia uses a variant of the SIFT algorithm for feature detection and matching, which enables the detection and tracking of visual features on an image target. The RANSAC algorithm is then used to estimate the position and orientation of the image target relative to the camera. To improve tracking stability and accuracy, Vuforia uses a proprietary algorithm called Smart Terrain, which takes into account the geometry of the surrounding environment to prevent tracking errors due to occlusion or lighting changes.
In addition to these algorithms, Vuforia employs advanced image recognition algorithms that can identify image targets based on their visual characteristics, even if they are partially occluded or distorted. This enables automatic detection and tracking of image targets in real-time, which is essential for a seamless augmented reality experience. Overall, Vuforia combines these algorithms to create a robust and accurate tracking system that is specifically designed to work with the unique challenges of real-time augmented reality applications. By utilizing these algorithms, you can create an engaging and interactive augmented reality book that will captivate your audience.

Architecture :-

For Text Recognition ARBook app uses OCR.Space API. OCR.space is an Optical Character Recognition (OCR) engine that uses several computer vision algorithms to recognize text from images. Here is a list of some of the key algorithms used by OCR.space, and where they are used:-

Preprocessing: OCR.space uses several preprocessing algorithms to improve the quality of the input image before text recognition. These algorithms include image resizing, noise removal, and contrast enhancement, which help to improve the accuracy of the OCR engine.

Text detection: OCR.space uses algorithms to detect text regions within an image. These algorithms locate text areas by looking for characteristic patterns, such as areas with high contrast or areas with similar color gradients.

Character segmentation: After the text regions have been identified, OCR.space uses character segmentation algorithms to isolate individual characters within the text regions. This process is essential for accurately recognizing text from the image.

Character recognition: OCR.space uses advanced character recognition algorithms, such as neural networks and support vector machines (svms), to recognize individual characters within the text regions. These algorithms analyze the visual features of each character, such as its shape and stroke pattern, to identify the correct character.

To create an augmented reality book with Firebase, you can utilize Firebase Realtime Database and Firebase Storage, which employ various algorithms to store and manage data and assets.

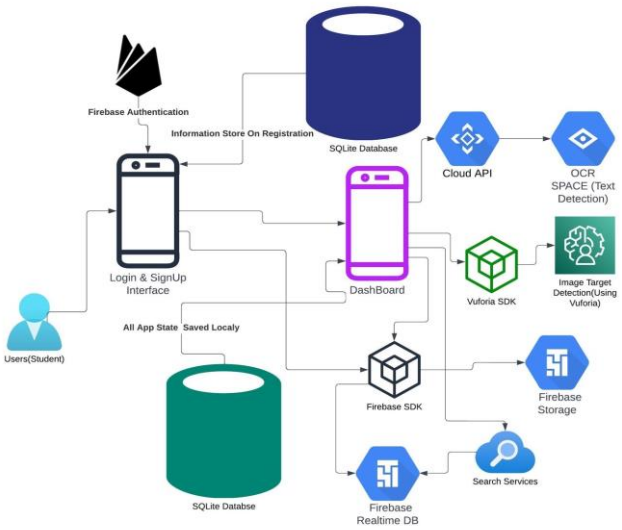
Firebase Realtime Database uses a JSON data structure to store and retrieve data in real-time. This means that any changes made to the database are immediately propagated to all connected clients. Firebase Realtime Database also employs a caching algorithm to improve read performance by storing frequently accessed data on the client-side, reducing the number of round trips to the server.

Firebase Storage uses advanced algorithms for data management, such as data compression and encryption, to ensure that data is stored securely and efficiently. Firebase Storage also utilizes a chunking algorithm to upload large files in smaller pieces, reducing the chance of errors during the upload process.

Additionally, Firebase Storage offers an image manipulation API that uses advanced algorithms to transform images, such as resizing, cropping, and compression. This enables you to optimize images for different screen sizes and resolutions, providing a more seamless and engaging augmented reality experience for users.

Overall, by using Firebase Realtime Database and Firebase Storage, you can create a robust and reliable infrastructure for storing and managing data and assets for your augmented reality book. The algorithms used by these services ensure efficient data management and delivery, providing a smooth and engaging experience for users

Language model: Finally, OCR.space uses a language model to analyze the recognized characters and to infer the most likely words and phrases based on the context of the input image.



CONCLUSION

Through the use of augmented reality and the pictures, we are creating 3D models. These three-dimensional models can make it simple for students to learn new material. Our application will provide all the information necessary for comprehending any subject, saving students from having to look through numerous webpages with 3D models and images. The method for editing models proposed in this research utilises the easily available 2D picture data to guide

model makers in effectively and quickly converting 2D models into 3D models.

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