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# IMMERSIVE LEARNING EXPERIENCES FOR AUTISM USING AR/VR

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## ABSTRACT

Innovative computer-based solutions can serve as both effective instructional tools and assistive aids for children with autism and mild intellectual disabilities. By incorporating everyday objects in the environment and incorporating the parent's voice and virtual 3D images, the learning process can be improved. Augmented Reality (AR) is demonstrating to be a useful technology to meet these educational goals. This implementation allows for the creation of educational content using the inbuilt camera and speaker of any standard Android device. The application captures and associates images and videos of objects in the environment with AR content, displaying them on the screen with QR Codes. This mobile app enables parents or teachers to create personalized AR lessons in real-time without paper. The application provides features such as functional reading, visual schedules, and speaking albums, allowing children to learn from real-life situations.

**Keywords—** Augmented Reality, Virtual Reality,Assistive Training ,3D Model, Unity 3D, Flutter, Firebase

## I. INTRODUCTION

According to the National Institute of Mental Health in the United States, autism is classified as a group of developmental brain disorders, known as Autism Spectrum Disorder (ASD). It is characterized by persistent difficulties in social communication and interaction in various contexts. Instructional methods for children with autism include creating visual schedules, social stories, and picture albums to depict events like birthdays, visits with friends, weddings, and relatives, among others. This is typically done through illustrations that show a sequence of activities and explain how to behave or respond to each social situation.Since children with autism are visual learners, many evidence-based audio-visual teaching techniques, like visual routines, social stories, and Multi-Level-Fading based functional reading, are used. These methods rely on paper-based materials like picture cards and hard copies. Furthermore, teaching children with special needs is a highly personalized process, involving the creation of meticulously planned Individualized Education Plans (IEPs) that cover all aspects of daily life, from academics to social interaction and personal hygiene. The creation of IEPs, lesson plans, and content, along with progress tracking logs, requires a significant amount of paperwork.Utilizing Information and Communication Technology (ICT) and assistive aids can simplify and streamline these tasks. Mobile Augmented Reality (AR) is a multimedia technology that can make computer objects interactive and engaging to children using handheld smart devices. AR enhances reality by overlaying it with computer-generated information or virtual objects, and can be either marker-based or markerless.AR can be an effective technology in real-time teaching and learning using physical objects such as food items, household objects, social objects like photos and videos, and more. This allows children to understand abstract concepts by linking them to real-life objects and their descriptions. The following sections of the paper describe the architecture and components of the AR application, its technical implementation and current status, and the concluding remarks and future work.

## II. HISTORY & BACKGROUND

The earliest and most efficient AR frameworks that provided immersive mixed reality experiences for users were established during the mid-1990s, starting with the Virtual Fixtures framework developed in the United States. These innovative mixed reality experiences were initially introduced in the entertainment and gaming industries. Subsequently, AR has entered various industries such as education, communications, healthcare, and entertainment. In the field of education, content can be accessed through image scanning or recognition using a phone or markerless AR techniques. An example relevant to the construction industry is an AR helmet for construction workers that displays information about building sites. The integration of AR technology with educational content creates a new style of interactive applications, enhancing the efficiency and appeal of teaching and learning for students. Key technologies and methods are discussed in the context of education.When it comes to teaching children with autism, visual teaching approaches, such as Picture

Exchange Communication Systems (PECS), visual routines, social stories, Multi-Level-Fading based functional reading, are often used since they are scientifically proven to be effective for these children. These approaches are paper-based, using picture cards and hard copies. Additionally, teaching children with special needs requires a highly personalized approach that includes the creation of carefully crafted Individualized Education Plans (IEPs). These IEPs cover all aspects of daily life, from academics to social interaction to personal hygiene. Teaching also involves creating lesson plans, content, and progress tracking logs. Content creation alone involves a large amount of paperwork.

**The following are some of the crucial areas where AR plays a crucial role:**

### 2.1. Medical Treatment

Medical imaging has become critical for diagnosis and treatment in society. With the advancement of computer technology, we have been able to push the limits of innovation. Recently, medical training systems using virtual realities (VRs) and mixed realities (MRs) have been developed [1]. Medical students need to take various medical trainings to attain medical skills. The use of computer vision technology is expected to enhance medical training. Our team developed a medical training system using AR, including 3D anatomical objects and manipulable natural interface. We used marker-based AR in our system as it is easier than markerless-based AR [1].

### 2.2. Academic Research

Current academic research in the MR sector focuses on technology and user-interface research, but there is a gap in studying user experiences and decision-making alongside technology advancement and application development to understand their value-in-use. The user-value drivers are numerous and drive application development. So far, the key value drivers have been identified as cost-saving through out-of-home and out-of-office access, total control and high level of personalization, and going beyond reality, personal efficacy experiences. From this viewpoint, the main challenge for both VR and AR technologies is to demonstrate to users that the added value is high enough to compete with existing systems and offerings in desktops, notebooks, tablets, smartphones, and related video and game-like applications [3].

### 2.3. Robotic 3D Printer

As a designer creates a new model using the RoMA AR CAD editor, features are simultaneously developed by a 3D printing robotic arm with a similar structure volume. The partially printed physical model then serves as a clear reference for the designer as she adds new elements to her design. RoMA's proxemics-motivated handshake component between the designer and the 3D printing robotic arm allows the designer to quickly intervene in printing to reach a printed area or to show that the robot can take full control of the model to complete the printing process. RoMA provides clients with the opportunity to incorporate real requirements into a design quickly, enabling them to create proportional tangible artifacts or to enhance existing items.

## 3. FEASIABLITY & SCOPE

The software proposed in this project will be accessible on any Android smartphone. It will be developed using Unity, Blender, Android Studio, and a database which is an open-source platform. The VR headset that will be used for this project uses a mobile phone for processing and costs around 1 to 2.5k, making it an affordable option compared to other expensive VR headsets. This makes the project both technically and economically feasible for both the end users and the developers.

## 4. ARCHITECTURE & COMPONENT

Assistive technology for individuals with Autism Spectrum Disorder (ASD) has made great strides in recent years, particularly in the areas of augmented and virtual reality (AR and VR). These technologies have the potential to provide unique and innovative learning opportunities for people with autism by creating immersive, interactive environments that can engage their senses and help them better understand and process information.AR and VR can be used to help individuals with autism practice and improve social skills, such as making eye contact, understanding nonverbal cues, and engaging in conversations. For example, virtual reality environments can simulate real-life social scenarios, allowing individuals to practice and develop these skills in a safe and controlled setting.In addition, AR and VR can also be used to teach individuals with autism practical skills, such as basic arithmetic, money management, and life skills, such as cooking and cleaning. These technologies can make learning more engaging and fun by allowing individuals to interact with virtual

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objects and environments, making the learning experience more memorable and effective.Another area where AR and VR can be particularly useful for individuals with autism is in sensory regulation. Some individuals with autism may experience difficulties with sensory processing, and AR and VR can be used to provide a controlled sensory experience that can help them better understand and regulate their sensory inputs.Overall, AR and VR have the potential to be powerful tools for individuals with autism, providing innovative and engaging learning opportunities that can help improve their social, practical, and sensory regulation skills. It is important to note, however, that these technologies are not a one-size-fits-all solution and should be used as part of a comprehensive treatment plan, in consultation with a doctor or other professional. This mobile AR Application provides a content creation platform for the parents and special educators to create various lessons through their regular smart phones, which otherwise make the process tedious and time consuming. This allows to overcome the limitations imposed by conventional methodologies like, cutting and pasting pictures, writing descriptions and teaching the child orally. Since these can be handled by multimedia based images and audio-visuals, a mobile application supporting the implementation would be useful to the parents, teachers and children. Using mobile sensors like camera we can take pictures of day-to-day activities of the child and use the same in teaching by adding narrations through microphone. Teaching the child with AR application can be done in various interesting ways like creating an online album of a birthday event, embedding with voice recorded narration for each picture. This will make it interesting for the child to learn. This application supports demand based rendering of multimedia content like audio, video, voice narrations ofarents/special educators. 3D models can be overlaid over real objects on real time. The system architecture is depicted in the Figure 1. below. It consists of Graphical User Interfaces (GUI) which is designed in flutter via Android Development. Ahead there are 3 modules integratedly working named Blender, Unity 3D and Firebase. In Blender there are two components – Environment design and 3D Modelling.

## III. IMPLEMENTATION

There are main two stages in application first stage is Scanning and second one is Displaying 3D module with some data.

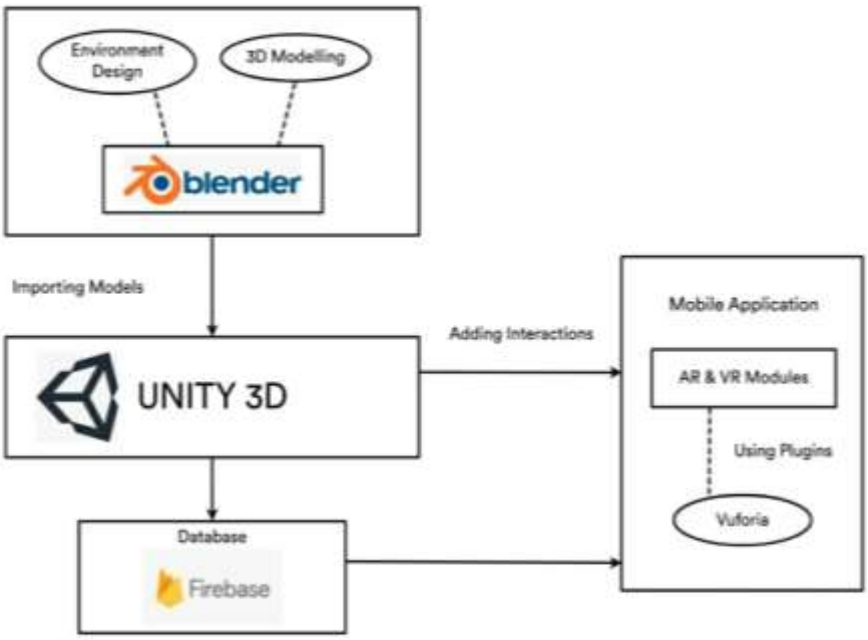


**Fig.1.** System Architecture

### 5.1. Blender

Blender is a free and open-source 3D creation suite that supports pretty much every aspect of 3D development. With a strong foundation of modeling capabilities, there's also robust texturing, rigging, animation, lighting, and a host of other tools for complete 3D creation. This software is great whether you want to deal only with static models or get into the world of animation

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**5.2. Displaying 3D models**

For display purpose or 3D rendering the IDE used is Unity 3D, after getting the development key and database it's easy to handle in unity. Firstly need to create some Targets or ImageTargets on that we can assign the images from Vuforia Database. And then we have to take specific 3D model and place on specific ImageTarget, so when we scan that target we will get desired 3D model. Also we playing specific audio on specific targets.

5.3 Unity SoftwareUnity is a cross-platform game engine developed by Unity Technologies, first announced and released in June 2005 at Apple Worldwide Developers Conference as a Mac OS X game engine. The engine has since been gradually extended to support a variety of desktop, mobile, console and virtual reality platforms.

**5.4 Firebase Software**

Google Firebase is a Google-backed application development software that enables developers to develop iOS, Android and Web apps. Firebase provides tools for tracking analytics, reporting and fixing app crashes, creating marketing and product experiment.

**5.1. 3D Creation Suite**

A free and open-source software that supports a wide range of 3D development, including modeling, texturing, rigging, animation, lighting, and more. It's a complete solution for 3D creation, whether you want to work with static models or animations.

**5.2. 3D Rendering**

The Unity 3D engine is used for displaying or rendering 3D models. With the development key and database, it's easy to handle in Unity. To display a specific 3D model, ImageTargets must be created and assigned images from the Vuforia database. When the target is scanned, the desired 3D model is displayed along with specific audio.

**5.3. Cross-platform Game Engine**

A game engine developed by Unity Technologies that supports a range of platforms, including desktop, mobile, console, and virtual reality. It was first released in 2005 and has since been extended to support multiple platforms.

**5.4. App Development Software**

Google Firebase is a software that enables developers to create iOS, Android, and web apps. It provides tools for tracking analytics, fixing app crashes, creating marketing and product experiments, and reporting. It is backed by Google.

## IV. RESULT AND ANALYSIS

**MODEL - EDUCATION**

From this project the training curiosity of scholars are increased and that they learn efficiently at school similarly as reception. It creates a learning by doing environment.

The following image describes how system is working when we scan ImageTarget the specific 3D model is displayed.The following are some other screenshots of implemented system-

1. If the Letter 'A' Image Target is Scanned the the Apple 3D model displayed.
2. If the Letter 'S' Image Target is Scanned the the Santa Claus 3D model displayed and so on.


**Fig.2.** Augmented Reality Own Created Module

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**Fig. 3.** S ImageTarget Scanne

## V. MODULE EXAMPLES

**Fig 4 -** Below shown is just an reference image

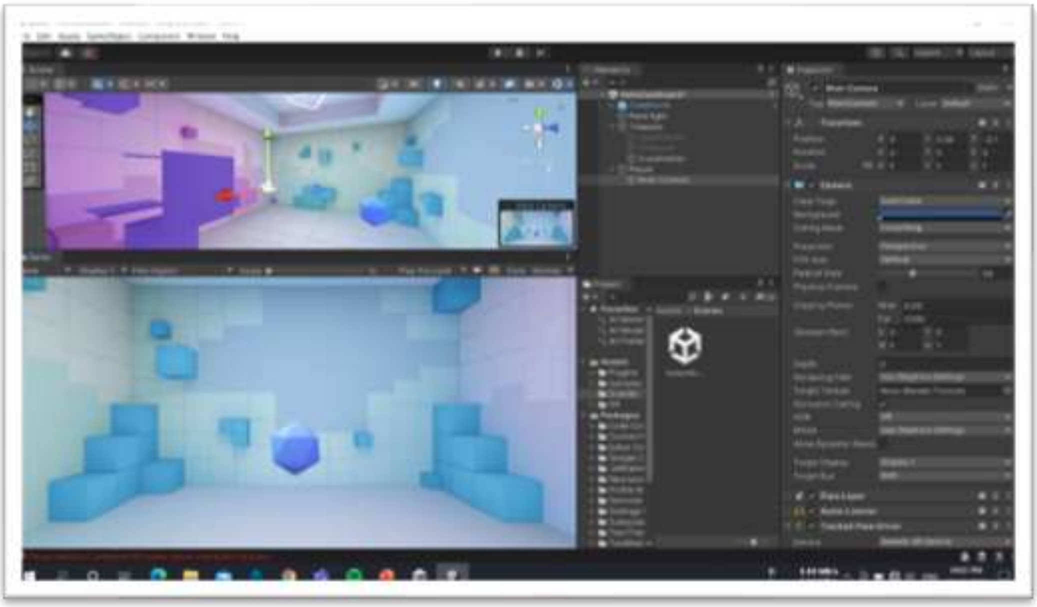

**Fig 5-** Model building

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## VI. APPLICATION MODULE


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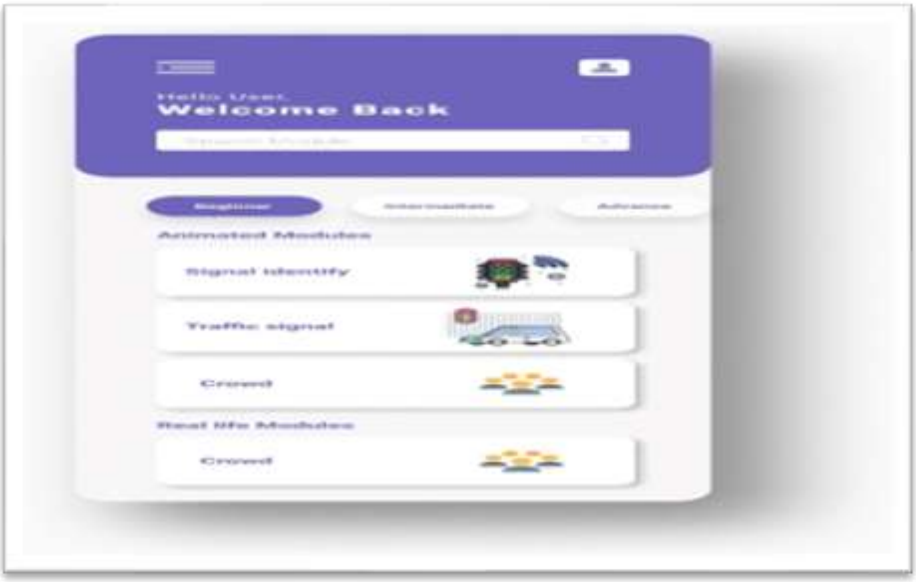


**Fig. 6 –** Screenshots of Android Application.

## VII. CONCLUSION

This research aimed to identify the key features of AR systems that can aid in diagnosing and treating children with autism. A literature review was conducted to understand the design criteria and challenges of such AR systems. Based on this review, a new AR system was developed as a case study, taking into account design decisions and appearance aspects. After evaluation, it was determined that the new design meets most of the necessary criteria for an effective AR system for autism. Further studies are required to test the system's effectiveness in diagnosing autism and improving the lives of autistic children, specifically with regards to tasks related to emotions, communication, and speaking. In the future, this work could also be expanded to cover other neurodevelopmental disorders such as intellectual disability, developmental delays without intellectual disability, or developmental coordination disorders to determine the applicability of the developed classif

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