

# EduSense-AR: A Sensory Learning Solution for Autistic Children

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**Abstract**— Innovative teaching-learning techniques, in combination with computer assistive devices, can be useful solutions for children with autism and mild developmental delays. These devices augment the learning content through audio and video. Augmented Reality (AR) technology has been quite useful in creating such teaching-learning aids for autistic children. This paper proposes EduSense-AR, an AR application that can be used to familiarize autistic children with everyday elements of nature in real-time. The application can be run on any basic android device. The virtual 3D graphics with embedded audio call for the receptor sense organs of the children and facilitate their recognition and learning of the taught content. This app assists the autistic children to learn seasons with learning material presented on screen with the help of AR markers. The paper also discusses parents' opinions about the usefulness and acceptance of the application.

**Keywords**— Autism, Augmented Reality, 3D Graphics, Innovation, Receptor Sense Organs, Technology Acceptance

## I. INTRODUCTION

Since autistic children learn better through audio and video, numerous scientifically proven audio-visual teaching methods can be used, such as Picture Exchange Communication Systems (PECS)[1], visual patterns, social storytelling, and Multi-Level-Fading based decoding. All of these techniques are paper based and rely on picture cards and printed hard copies. Teaching children with special needs is a customized activity that necessitates the construction of precisely designed Individualized Education Plans (IEPs). These IEPs address every learning need of the autistic children like academics, social interaction, and personal cleanliness. The designing of these IEPs entails need-specific lesson plans and instructional content while keeping the progress logs of the learners. According to the National Institute of Mental Health (NIMH), the United States, autism is a set of developmental brain diseases, commonly known as autism spectrum disorder (ASD) [2]. "Persistent difficulties in social communication and social interaction across different contexts characterize ASD. The production of visual schedules, the creation of social stories and picture albums covering various events such as birthdays, visits from friends, attending weddings, visiting relatives, etc. are all teaching tactics for autistic children. This is usually accomplished using visuals of a set of sequenced actions pertaining to some daily life situation with each action describing what it means and how to behave or respond in such situation. The modern age of digitalization has exposed the learners to various digital learning platforms. Mobile phones, tablets, laptops, etc. are a few modern learning gadgets frequently used by the children. AR may be

used to build real-time teaching/learning tools incorporating everyday tangible things such as food, household goods, creatures, plants, and social objects such as personal/family images, movies, etc. These digital tools can assist the youngsters to link real-world things and their descriptions to comprehend abstract concepts related to them. AR technology employs sound effects and cartoon characters to create a fun learning experience for autistic children and assist them with their sensory and comprehension issues. Augmented reality textbooks are being used as an innovative medication for the autistic children who struggle to read and write. "Angel's Awesome Alphabet Book," written by Angelique Marshall, is one of such AR books which aids autistic children memorize English alphabets through text, images and sound. The paper describes the basic framework of the Edu Sense-AR in section-II. Section-III discusses the technological design-development and implementation of the application; section-IV discusses the parents' opinions in the form of results while Section-V concludes with some ideas on future work.

### 1) Augmented Reality

Augmented Reality (AR) may have different realizations depending upon its use. AR, however, at the core is a technology that augments digital content over real world tangible objects and provides a rich learning experience [3][4][5][6][7][8]. The addition of visuals, sounds, and other sensory augmentations to real world tangible objects allows learners to interact with graphical or computerized information put in the reality domain. There are four types with the help of which AR app can be build.

These are:

1. Marker Based
2. Marker less
3. Projection Based
4. Superimposition Based

Marker based system recognizes the image and then produce the virtual picture of system [9] [10]. When user see the marker using camera then it works. But in case of object, the whole object is work as marker. The user can move the marker and object in all directions according to requirement and moves the virtual scene also.

Another extensively used AR application in the industry is marker-less augmented reality. Some latest smartphones have location recognition feature known as Location-based AR [11][12]. This application assists tourists with their excursions and site-seeing. It helps users in discovering fascinating sites in their journey. Mobile GPS gives the real

time location with 3d scenes. Augmented reality works as guide in tourist places [13][14].

## II. RELATED WORK

Innovations make AR an excellent tool to be employed to assist autistic children [15]. Augmented Reality can help autistic children by enhancing their audio-visual conceptualization through developed

features and capabilities that correspond to reality. The AR handheld devices include a phone, a wireless connection, and position-based technologies. With 3D virtual artifacts, AR can be used to enhance the functioning of educational modules to learners. AR allows youngsters to repeat the activities in their education modules as often as they wish and thereby minimizes their dependence on instructors. As a result, teamwork may be improved. It also frees up the instructors' time by allowing them to rely on AR for simple and repetitive teaching tasks. This in turn allows them to provide multi-level programs to satisfy the specific needs of the learners. As autistic children are hypersensitive to new information and changes in routines, the amount of time they spend with a device is crucial in determining the program's impact on them [16][17][18][19][20]. As a result, an autistic user's initial reaction to a game as a stimulus or motivator may differ when the program is acknowledged. The beneficial influence of increased simulation, which is significant in repetition, time, and engagement with AR, has resulted in a wide range of simulation plays [21]. Instead of real play, the ASD child prefers simulation play. AR displays a system that is well-executed [22]. AR based modeling story book increases the social abilities and attention.

## III. DESIGN AND IMPLEMENTATION

Edu Sense-AR application design and development involved mainly 5 main steps, shown in Figure 1. This research has been carried out in two stages. The first stage incorporates the design and development of the AR system and educational materials followed by the second stage, where the application was deployed among the children and a teaching experiment was carried out. We have started with creating a storyboard according to the concept and designed User Interface (UI) wireframes.



Fig. 1. Edu Sense-AR Development process

UI wireframe is the skeleton of the eventual user interface, used to describe the main features and function of UI. These are low fidelity sketch without and visual design, and very helpful to quickly design User Experience, the way

user can interact with app. In stage 2 we started designing UI design based on wireframes, we have worked on color, theme, and style of the UI, elements like main menu, buttons etc. UI designing can be done with any 2d application, we have chosen Adobe Photoshop a most popular software for image editing and graphics designing. Based on storyboard, we have created 3d models like trees, flowers, houses, and island etc. using Blender an open source 3d application. For making 3d models realistic we have unwrapped 3d models in Blender and designed their textures in photoshop. After completing all 3d and 2d assets we have imported them in Unity3d a game engine. Where we have done scene setup for each season, scene setup involves importing assets, positioning assigning materials, linking textures etc. In this we also designed animations for these 3d models and visual effects like flowing water, particle effects in Unity3d. This step also involve marker designing. Figure. 2 showing 4 different markers for each season. Stage 3 involve system architecture design, here we planned and designed the application system. Planning and designing flow of screens, required controllers, scene elements, Implementing UI creating events and linking UI events. Designing relationship among game objects, UI elements etc. Figure 3 shows the user interface for the application.



Fig.2 Markers



Fig.3 User Interface of Edusense

UI plays important role in every mobile based application. It is the first thing to attract the user's attention. The terms 'user interface' and 'user acceptance' are terms that contribute to the user's satisfaction of the game experience. The most engaging aspect is the specific level of comfort that is offered by UI/UX in addition to provide a wonderful gaming experience. Stage 4 involved main development part, where functionality and interactivity developed. For designing interactivity, we have used C# scripts and events. These events create links between objects, models, animations with UI elements or other user inputs. We have developed augmented reality feature using Vuforia Unity3d AR plugin. Vuforia provide different type of tracking objects, like image tracking, basic shape tracking,

ground tracking and object tracking. However, as we required marker-based tracking for track 4 different markers, so we have used marker-based tracking. Figure 4 and Figure 5 show the augmented view of summer and autumn seasons. Chirping birds and beautiful butterflies add a realistic beauty to the scene. The flowing river gave mindful experience to user. The EduSense-AR is a marker-based application. Figure 4 and Figure 5 show the augmented view of the application. Stage 5 carried out testing the application, fixing issues, adding features, improving functionality, and deploying it. Before deployment we have taken feedback from experts, teachers, and parents. According to given feedback we have improved application and deployed.

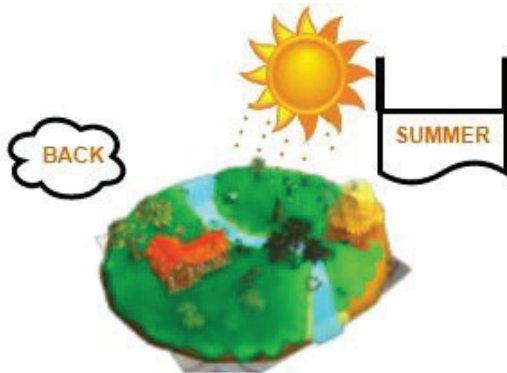


Fig.4 Summer ARView



Fig.5 Autumn ARView

The application designed by us was tested on 20 parents by applying System Usability Testing (SUS) approach. Technology Acceptance Questionnaires were designed on the basis of Likart scale in which 5 options were given to the parents to specify their experience. Earlier parents were not ready for this process but with continuous hard work and dedication we were able to convince them and they got ready to experience our application and gave their inputs as well. 13 questions were designed for our survey which are described in Table 1. Special children need is different as compared to normal children. This application results that AR has great potential as compared to Virtual reality and videos. AR based innovative application is easy to handle by teachers and parents. Manual is provided with this application. So, Parents can easily install and execute application by their self. Rainy and winter season explores the precautions to be taken and all information regarding these seasons. Table1 summarizes the all effects of this application. In table, 92.4 % shows the Edusense application accepted by parents.

TABLE I. PARENTS FEEDBACK ABOUT APPLICATION

S. No.	Questions	Score (%)
<b>Usefulness</b>		
1	EduSense-AR application is an enriching learning ability.	87.7
2	This increases the Knowledge of child.	81.4
3	The learning mechanism provides a streamlined learning process.	73.3
4	The learning system helped children to familiarize with the environment.	73.3
5	The learning method assist special children to gain more.	84.2
6	The learning method is better than traditional digital methods.	85.2
<b>User Friendly</b>		
1	It is not difficult to operate.	84.2
2	It only took a short time to fully know how to use the learning system and help the kids.	85.7
3.	Easy to understand and follow.	86.9
4.	Easy Usage	90
5	My child could use the application comfortably and learned the content easily.	87
6.	Flow of instruction is easy.	79.8
7.	The learning system is quite easy and simple and makes the learning a fun.	92.4

Below figure 6 shows the teachers feedback regarding this application. We approached those teachers who teaches the special children.



Fig. 6 Teachers Feedback

Teachers found this application very useful for autistic children. They suggested us the material of book. They discussed about the challenges what they faced during teaching.



#### IV. CONCLUSION AND FUTURE SCOPE

As stated earlier, AR and VR are an integral part of any field specially education because people tend to learn more through visualization rather than theoretical approach. Therefore, EduSense-AR, an AR based application for displaying various seasons has got tremendous appreciation from parents. The parents were struggling extremely in terms of education as their autistic children were not able to grab anything in traditional teaching, but this application came as a ray of light in the lives of parents dealing with children suffering from Autism. They have recommended this application to many of their friends and are eagerly waiting for the response of their children when they will use this application. They even suggested us to make a newer version of this application which can be run on large display. According to the suggestions given by parents our application can be updated and can be made portable so that it can run on various platforms to maintain cross-platform independence.

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