Augmented Reality based Multimedia Learning for Dyslexic Children

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Abstract— **Augmented reality is a visual technology which combines virtual objects into the real environment, in real time. In this research work, a heuristic model of multimedia learning would be developed using Augmented Reality for a type of neurological disorder known as Dyslexia. Dyslexia is complex mental brain related syndromes, affecting the children in various ways including verbal and nonverbal communications, social interactions, understanding instructions, reading, writing, learning, problems, etc. The use of interactive Augmented Reality based multimedia application to facilitate and provide pedagogy for such type of special children would ascertain a unique and new dimension of treating and helping such young hearts in overcoming their disabilities in a very fun and easy way. The research encompasses designing a framework based on cognitive learning for interactive multimedia learning app using augmented reality technology, that would be centric to autism effected children's and would enable them to interact with such system.**

Keywords—Dyslexia, Augmented Reality, Multimedia Learning, Serious Games

I. INTRODUCTION (*HEADING 1*)

Dyslexia is a hidden neurological disorder; in which child has language based learning difficulties[1]. Such children feel difficult to fluently recognize same face letters like b and d, w and m, n and u, p and q [1], [2], due to which they misspell words and have bad reading and writing skills [3]. The causes of dyslexia are still unclear, whereas the research reveals that dyslexia is 54% to 75% heritable, 68% in identical twins and 50% in people who have parent or sibling with dyslexia[4]. Commonly, a dyslexic child face difficulties in pronouncing words, confused in direction, rapid naming issues, phonological awareness issues, phonemic problem, stumbled through long words, fell difficult to put ideas in paper and a specific writing pattern[1], [5]–[9]. Dyslexia is not a disease, hence there is no cure for dyslexia but timely diagnoses and repetitive remediation, that has been recommended by international organization through assistive technologies, a child can combat that language based hidden disorder[1], [5]. Traditional teaching methodologies in schools where there are a large number of students are there in a single class, it's difficult for a teacher to assist and repeat instructions for specific individual [10] assistive multimedia applications play a vital role in educating through activities, games and videos to such children[11]. In this age of digital media early childhood educators should train the use of interactive technology as a multimedia learning tool to develop an opportunities for young children in cognitive, emotional, physical, social and linguistic development according to their mental model[12]. Interactive learning through multimedia is used to change the conventional learning environment in this new era [13]. Interactive learning based onto sketches, images, graphics, maps, diagrams, symbols and their objects in activities with specific attributes.

Augmented reality in another interactive learning tool for cognitive learning in advance field of multimedia. Augmented Reality (AR) describes a concept of real world with 2D and 3D graphics with hand-held and anchored to the objects position with shows graphics in the form of real world [14]. As shown in An example of augmented reality (source: [14]) .

Fig. 1. An example of augmented reality (source: **[14]**)

Advancement in augmented reality (AR) is growing rapidly in education sector to reflect the idea of rapidly growing ratio of smart devices in past years and a result of creating a subset of AR applications. The fact about cognitive learning with smart devices AR learning system is its early stage[15].

Aim of this research work is to provide a pedagogical Augmented Reality application for teaching and training of Dyslexic children. As still we have a traditional teaching style in our schools this assistive mobile app will help the children's who have dyslexia for improve their cognitive skills.

Through this research, we aim to provide a platform for children suffering from dyslexia, providing them with technological tools and applications that would facilitate in

enhancing the mental abilities. This research work focuses on development of Multimedia learning application using Augmented reality based on cognitive theory of learning, targeted toward special children suffering from neurological disorders known as Autism.

The research goals are centric toward the benefits of society, especially towards the special needs children. The research very specifically focuses on the development and educational treatment of children's suffering from Dyslexic disorders. After the completion of the research, we would have a mobile application that would allow parents, teachers, social workers and educating such type of special needs children's.

II. Literature Review / Similar Work

Research reveals that multimedia interactive learning playing a vital role as remedial training for the students suffering with neurological disorder[16]. Visually learning through 2D and 3D graphics has a great impact into e-learning environment of interactive cognitive learning. A child is allowed to learn specific complex problems in fun and easy ways, that make education much easier and interesting for special need children[1], [10]. In this era of software industry children cognitive learning games are widely used and developed in which pedagogy of education is implemented in a graphical interactive environment according to their mental ability of learning. Previously many applications have been developed for children in whom cognitive learning has been done with 2D and 3D graphics some of them are described below.

A. Dyslexia Baca
Dyslexia Baca is a mobile gaming application for the children suffering with dyslexia. Dyslexia Baca is developed in Malaya language. Which is developed to use to identify same face letters like b and d, p and q, m and w through cognitive games[2] as shown in Sample of interface (source:[2]) basic user interface of Dyslexia Baca .

Fig. 2. Sample of interface (source:**[2]**)

B. EasyLexia
EasyLexia is a mobile application developed to teach basic reading, comprehension, mathematical problems with the help of orthographic coding and used to improve fundamental skills of dyslexic children and try to manage their short term memory problem. Gaming cognitive Activities are used in *EasyLexia* to teach a dyslexic child[17] UI of EasyLexia is shown in EasyLexia basic UI (Source:[17]).

Fig. 3. EasyLexia basic UI (Source:[17])

C. MyLexic
MyLexic is a mobile and tablet based application developed in Malaya language and based onto a courseware. MyLexic based on scaffolding instructional techniques and dual coding theory. This courseware is based on five basic modules pre-assessment, Alphabets, Symbols, Words, and post-assessments. This multimedia courseware helps the dyslexic child to learn through a verity of multimedia options that assists them to use easy navigation and structured presentation of *MyLexic* courseware[9]. User interface of Mylexic is shown in MyLexic UI (source:[9]).

Fig. 4. MyLexic UI (source:[9])

These all application is based onto 2D and 3D graphics with the help of actions and animations an interactive effect is show when any action has been performed. Augmented reality (AR) is an advanced field in mobile interactive gaming in which a whole UI is show as real world environment where objects are shown in more realistic form[18]. Augmented reality (AR) applications enable users to sense gaming activities in real time, use visual, audio and haptic means overlaid in real world with wearable devices[18].

III. What causes dyslexia
Exactly what causes dyslexia is still not clear. Dyslexia is not due to either lack of intelligence or desire to learn [9]. They are often capable or even gifted in areas such as art, computer science, design, drama, electronics, math, mechanics, music, physics, sales, and sports [9]. It has been found that an average of 1 person in every 10 suffers form Dyslexia, as shown illustrated Figure 5. Dyslexia is strongly (54 to 75%) heritable, occurring in up to 68% of identical twins and 50% of individuals who have a parent or sibling with dyslexia [10].

Figure 6 shows some of the famous and well known celebrities that have been known to be affected with Dyslexia in their early ages.

Fig. 5.   Affected people by Dyslexia

Fig. 6.   Famous people with Dyslexia (Source: http://www.dyslexiaonline.com/famous/famous.htm)

IV.   AUGMENTED REALITY (AR)

Augmented Reality is defined as the technology which combines two dimensional or three-dimensional virtual objects into the real-world environment in real time. Augmented Reality (AR) is a technology that exactly overlays computer generated virtual imagery on physical objects in real time as shown in Figure 7. It is different from virtual reality (VR), where the user is completely immersed in a virtual environment. AR lets the user to interact with the virtual images using real objects in a seamlessly. AR can be viewed as a computerized extension of our reality.
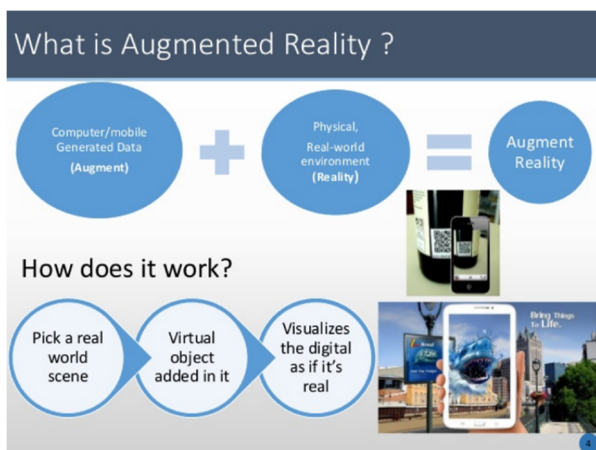

Fig. 7.   Augmented Reality process

Ronald Azuma defines AR as systems containing these three characteristics [2]:
1. Combines real and virtual World

2. Interactive in real time
3. The 3D information is displayed in registration with the physical world.

Thus, to avoid limiting AR to specific technologies, Azuma defines AR as systems to the seamless embedding of virtual content into the real world.

A.   Examples of AR Technology

You have to register the AR marker with the AR application. Once the app detects the Marker in real-world, only then the 3D object will be displayed on that particular marker location (This is called registration process). Figure 8 shows the examples of AR used in various fields.
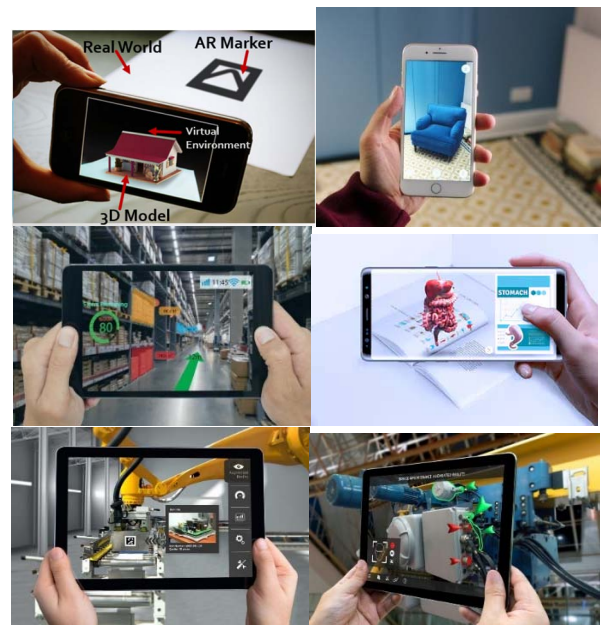

Fig. 8.   Various example of AR in industry

The potential of combining smartphones and Augmented Reality for education is big, though it still has to be fully discovered.
- AR, in various ways, could grant students extra digital information about any subject, and make complex information easier to understand.
- Nowadays we may find some excellent examples of augmented reality in education worldwide.
- Ability to connect reality and digital content has been steadily improving, opening more options for teachers and students.

V.   RESEARCH DESIGN AND METHODOLOGY

The Research design consist of several phases starting from analyzing and studying the learning patterns and behaviors of dyslexic children. This information is then used to develop a 3D Designs and Models of educational concepts with animation based on pedagogical principles. The Implementation will involve developing an AR app that uses 3D models and Animations to train children and teach them about specific topics.

The methodology adopted in this research work is derived from Design Science Research Methodology (DSRM) proposed by (Peffers et al., 2007) and is illustrated in figure 9. According to this model a systematic approach is used to solve a specific problem, which in our case would be to achieve a framework for developing multimedia based Augmented Reality app for Dyslexic Children, to enhance their cognitive learning and mental development.
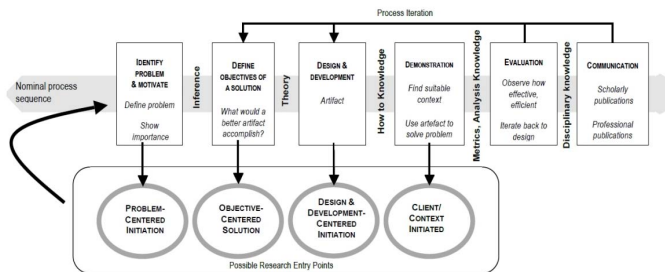

Fig. 9. Design Science Research Methodology (DSRM) (source: Peffers et al., 2007)

In this model, the research development is divided into 6 main stages.

Stage 1. Is to Identify the Problem and find the Motivation.

Stage 2. Is to Define the Objectives of the research and what the proposed solution to the problem is.

Stage 3. Involves the actual design and development of the research.

Stage 4. Is Demonstration phase which involves testing of product and getting user opinion and feedback.

Stage 5. Once the testing is done them the actual evaluation is conduction to determine the usefulness and effectiveness of the System.

Stage 6. is the final stage that requires the Communication and distribution of the research work.

A. AR System Design Process

The Design will be developed that will use various targeted rules catered for special children like user interface aesthetics involving text size, font style, color and graphics, all incorporated with cognitive learning.

The system design involves, identifying Dyslexic disorder parameters. Then Pedagogical learning rules adopted from IDA will be used to design AR software and Special Needs app. This app will be based in the principles of USER interface, Text Size, Color, Graphics, and Course Material.

The proposed system design is illustrated in Figure 10. The system would involve specially created marker images, printing in a booklet form that would be detected by the application using standard mobile camera. The Marker images once identified, will be processed by the system and then will overly of 3D animated objects will be augmented on the screen representing the image in 3-Dimensions.
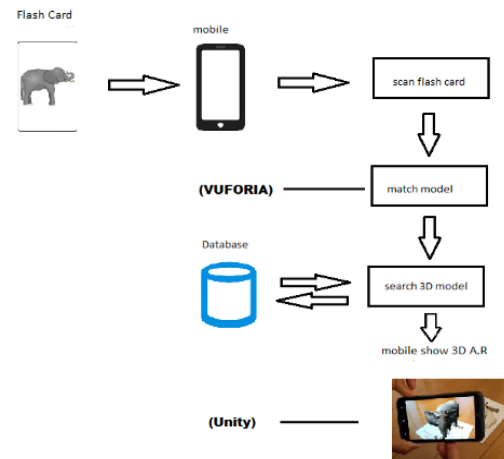

Fig. 10. Design process of AR system

1. User use the Marker Cards to scan the 3d model of objects with the help of mobile laptop or Tablet etc.
2. Then with the help of Vuforia match the 3d model which is saved in the database of Vuforia.
3. Send the Information to Unity Software.
4. If the model is match then it shows 3D model of the Particular object and creates augmented reality environment with the support of unity.

B. Research Implementation

The research implementation is based on several key steps as given below:

1. Create 2D design of cognitive learning material for children in Booklet form using Photoshop.
2. 3D models of objects, shapes & faces.
3. Creating AR marker identification key in in Vuforia.
4. Create mobile application for AR.

C. Preparing Teaching Material of Dyslexic Children

For teaching Material, We will design and Create a simple course booklet that will be based on Cognitive guidelines as proposed by IDA for Dyslexic children. Each chapter and page of the book will be a Marker, which will be used to generate Augmented Reality objects. As illustrated in Figure 11.

Fig. 11. Booklet based AR apps

D. The Dyslexic Booklet

The AR based booklet for dyslexic children consists of following main sections:

- Alphabet letters
- Alphabet shapes
- Numbers

- Shapes
- Sentence with Smiley (I am Happy)

The booklet we will design will be based on various chapters composed of these lessons. The course is divided in 3 main levels, 1. Basic for Beginners, 2. Intermediate level and 3. Advance level.

E. Letter Exercise

The figure 12, shows the Beginners Level Exercise based on alphabets. Each book page will behave as a Marker
For example, the basic alphabet will contain letter which once detected by AR will show 3D object, Sound, and allow user to move finger over the 3D object to practice the shape of letter.
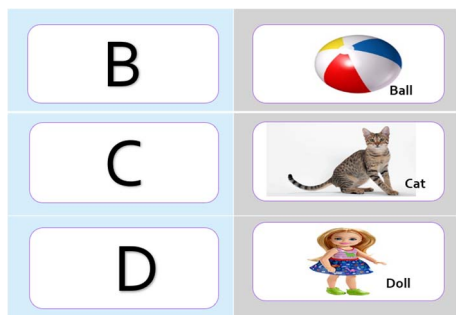

Fig. 12. Intermedia level letter exercise

Similarly, all alphabets will have phonetic sound, 3D shape representation, and full word pronunciation. Also the child will be asked to move or trace his finger over the 3d object on mobile screen.

F. Hearing Exercise

The second part will have Hearing exercise, which will be interactive and based on sound, shown in Figure 13. The once the child to enters in this mode, a sound will be played and user will have to move their mobile on correct shape to be identified based on understanding sound. This will allow the child to practice words based on sound to hearing skills.
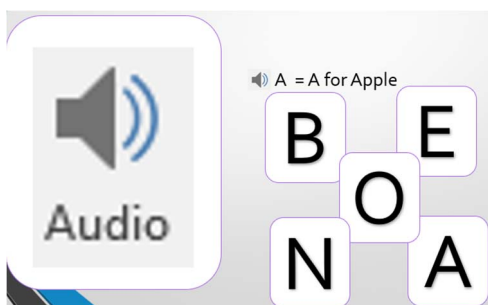

Fig. 13. Phonetic exercise based on hearing skills

Similarly, the exercise will contain many other shapes and objects based on student's skill level
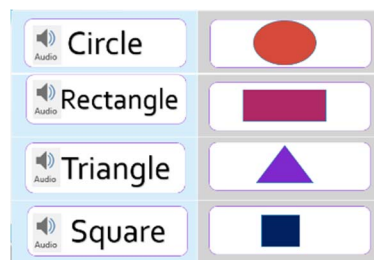

Fig. 14. Phonetic exercise using shapes

The hearing exercise will also contain simple terms and sentences, with simple pronunciation for developing phonetic skill, shown in Figure 15.

Fig. 15. Phonetic exercise for expressions and feelings

G. The booklet design

The Third Main phase will involve multiple lessons based on complex shapes and sentences, with 2D and 3D graphics. The final booklet design consists of colorful graphical images of various different topics and subjects to involve cognitive learning of dyslexic children in fun way. These topics are illustrated in figures, 16, 17, 18, and 19.

Fig. 16. AR booklet design for HATS topic.

Using these booklet the words, and sentences will be shown in 3D on AR app. The user will hear the sound and 3D model.
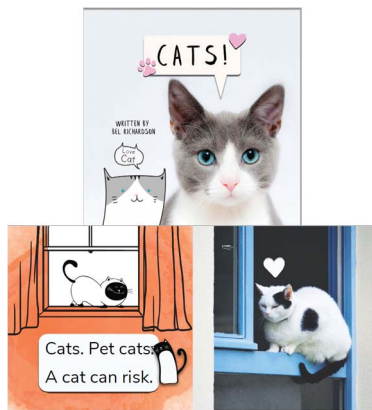
Fig. 17. Book design for CATS lesson

Fig. 18. AR book design for DOGs lesson

Fig. 19. More book lesson

VI. CONCLUSION

Using Augmented Reality for teaching tool is rapidly becoming popular due to its unique mix of real and virtual world. The use of AR for teaching special children's suffering from Dyslexia, would be a great way of teaching and training these children. In this research work, the Augmented Reality technology is therefore used, to develop a comprehensive app for children with Dyslexia. The App is specifically based on pedagogical rules as proposed by International Dyslexic Organization (I

DA). The system will create a unique set of lessons in form of a booklet, which would allow the child to use and learn in combination with AR. The AR system will contain 2D and 3D objects.

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