Augmented Reality Sandbox With Play Based Learning For Preschool Children

S.Vasanthi[1], S. David Samuel Azariya[2], S.Kanish[3], S.Dhanush Prabhu[4]

[1]Associate Professor, Department of IT, Sona College of Technology, Salem, India
[2]Assistant Professor, Department of IT, Sona College of Technology, Salem, India
[3,4]III year IT Student, Department of IT, Sona College of Technology, Salem, India

Abstract

Augmented reality (AR) and virtual reality (VR) are the new hot trends in education. Applying the concepts of AR/VR can transform an ordinary learning environment into an engaging experience for children. AR helps children of all ages to better remember the information they have learned. This paper proposes an AR 3D learning toolkit for kindergarten children that make learning fun filled and improve their motor senses. The Kindergarten children's are made to inscribe English alphabets on the Augmented reality sandbox which is scanned using the azure Kinect depth sense camera . The alphabets impression on the sand are recognize and the proposed system will guide the children's to write the letter probably by projecting the letter impression on the sand along with the proper pronunciation . This helps the kindergarten children to learn to alphabets in the playful manner. The toolkit is a combination of a few hardware components - a 3D camera, a short throw projector and a box of sand and employs a sophisticated learning algorithm which helps in recognizing the letters engraved in the sand, displays them with color effect to make it interesting for the children and pronounces the English alphabet for them to improve their speaking skills. This prototype of the AR application provides a natural way of experiential learning with interactive feedback by enabling the children to get familiar with the recognition of letters, pronunciation of letters and enhances their motor skills.

Key words:

Augmented Reality, Learning Environment, Handwritten Text Recognition ,Speech Recognition, Depth Sensing.

1. Introduction

Play mode of learning is important for a child during the early childhood days. Therefore, the development of various play gives teaches and parents a base to different teaching strategies. Play being important element in kindergarten child life. Play mode of learning helps the children to develop different skills such as sensory and motor skill at the young age. Our focus is to improve the learning environment by incorporating latest technologies in the classroom.

Augmented Reality is most effective tool that has direct view of real learning environment with virtual setup implemented by the computer software. Kindergarten children can gain much knowledge and experience by learning in classroom using the AR technology. An AR application called AR Sandbox is used to test the effectiveness of AR technologies in the early stage of childhood learning. The benefit of using the AR technology in the kindergarten classroom will enhance the traditional classroom learning method.

2. Augmented Reality in Educations

Augmented Reality can help us to attain, progress, and recollect the information to the students. Moreover, it creates learning with more attractive and entertaining technologies. In AR technologies the sound ,graphics and animation can also be added to get a realistic view of the world . According to Azuma and Feng et al. [1][2] has proposed an Augmented reality technologies which enables computer-generated virtual picture information to be superimposed in real time onto a direct or indirect live real-world environment.

H. Lee and Lee (2008) [3] proposed a system in which the education when combined with AR technologies will make learners to experience and learn with fun. This method of learning will improve understanding of the concept. This proposed system developed a mathematical educational game which has more effect on the learner and they enjoy learning the concept easily.

Scrivner et al [4] has proposed an AR design which uses an effective teaching tool offering powerful virtual learning experiences in language classroom settings. According to Arcos et al [5] the students are allows to learn from experiences and provides a more authentic way of learning experiences in the real world .

Furthermore, an AR system developed by Huang [6] applies a new educational learning model to teach the ecological education by integrating real world images with anthropomorphic educational tool. Yilmaz [7] has AR, which has the ability to provide a variety of learning opportunities with a number of benefits in learning and teaching situations.

Manuscript received June 5, 2022
Manuscript revised June 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.6.95

The Article A new path to education reform: Playful learning promotes 21st-century skills in schools and beyond [8] which emphasizes on six characteristics playful learning. Children grasp better when they are active and engage themselves in learning that is joyful, meaningful and interactive.

More specifically, many research studies and systematic reviews has given an insight into the AR applications for improving the performance of the children's by enhancing the concentration power for children on specific tasks. AR technologies provide new learning and teaching environment and also motivate the students to make available in the new environment. AR technologies also reduce the workload of the teacher and save lot of time in preparation. Finally, it helps in developing students' logical and creative thinking.

3. Methodolgy

3.1 ARSANDBOX for Play Based Learning

The primary objective of this model is to build an AR 3D learning toolkit which acts as a hands-on, active learning tool for providing an effective and efficient learning experience with the following significant features:

- A play way study & activity environment to enhance children's creativity and promote learning in children involving visual and motor skills
- Create patterns in AR Sandbox, which is then scanned by the Azure Kinect depth camera to recognize the pattern and then project the pattern using color map.
- It help children understand the way of creating and recognizing patterns
- To enhance the learning of alphabets, numbers, shapes and objects in kindegarten children.

The proposed project combines augmented reality, Virtual reality and 3D learning toolkit technology to come up with an interactive learning module for the students. This augmented reality (AR) 3D learning toolkit combines visualization applications with a real-time experience.

The AR 3D learning toolkit helps the students to learn letters by this guided tool. The system recognizes the letters by employing a sophisticated learning algorithm and the identified English alphabet are projected on the AR Sandbox and also pronounced through the audio system. If there is any slight variation in the English alphabet letter pattern, the system tries to project the correct pattern with the color code. This helps to students to recognizes the letter and make correction in the letter pattern.

The AR 3D learning toolkit is built with the following hardware units such as computer system with graphics card, Azure Kinect 3D camera, short throw projector, speaker and sandbox.

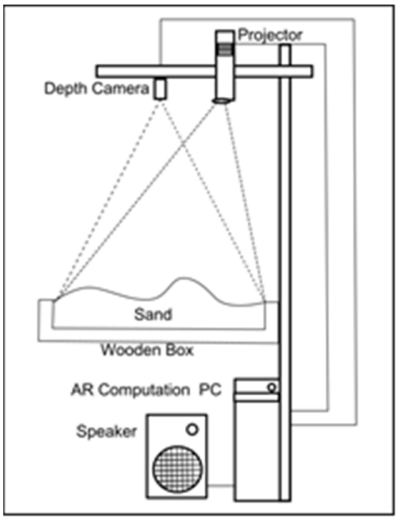

Fig. 1 System Framework of AR 3D Learning Toolkit

4. Experimental Procedure

Building the 3D learning toolkit and depth camera and projector are mounted above it requires a proper design of the layout sketch indicating the accurate measurements and dimensions. The wooden box is designed to be waterproof and rot-resistant. The projector and camera head assembly is suspended above the wooden box. The setup should offer restricted adjustment for projector and camera position so that the depth images are captured accurately and minimizes the distortion effect and focus problems.

The Azure Kinect 3D depth camera and short-throw projector will be fixed at the same height above the wooden box to scan for above-axis projection. The system receives 30 raw depth frames per second from the depth camera and then processed in the evaluation filter with fixed buffer size.

The captured sand surface is processed for recognizing the English alphabet pattern on the sand and recognized English alphabet will be rendered to the short throw projector suspended above the sandbox which exactly matches real sand pattern.

The software uses a color map to add white color to the recognized letter and the Handwritten Text Recognition (HTR) algorithm recognizes the English

alphabets which is then convert into audio and given to the speaker.

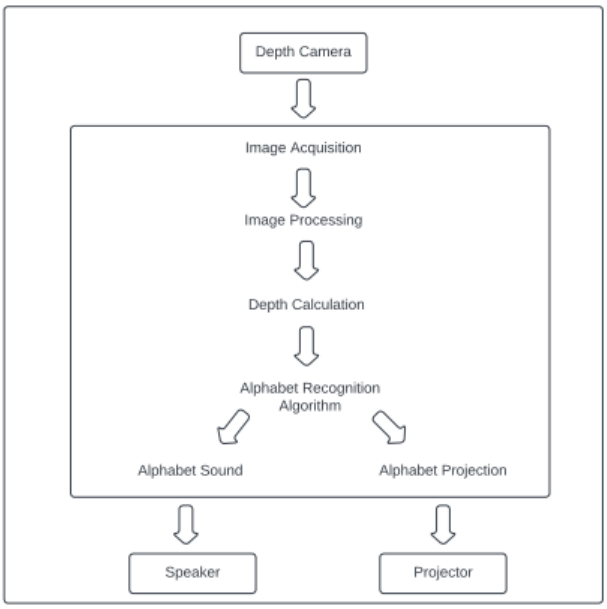

Figure 2. Flow Model of the Proposed System

Figure 2 depicts the flow of information in the learning toolkit. The depth camera senses the elevation made in the sand present in the wooden box which is then used by the depth calculation algorithm and pattern recognition algorithm to find the pattern made in the sand. The learning toolkit employs a novel and sophisticated deep learning algorithm to add colors and audio effects which is fed to the projector and the audio system.

The proposed Augmented Reality (AR) based natural interactive learning will allow students to see how changes in 3-D surfaces are represented in two dimensions. The AR 3D learning toolkit is a hands-on, active learning tool that allows direct interaction of students with technology that demonstrates important basic learning of alphabets, shapes and numbers.

Playing with the sand helps the children to have unstructured play time which is filled with fun way of learning. AR sandbox helps the students to improve the fine motor skills and sense of textures. This new technology is arguably the best means to teach student these important skills.

5. Implementation and Simulation Results

Initial setup for camera and the projector is done and then connected with the computer. The camera and the projector need to be perpendicular to the sandbox for accurate capturing and projection. After the hardware setup we need to install the software's in the computer for processing the information captured from the camera. PyKinect Azure API and python libraries are installed in Python IDLE to communicate with the Azure Kinect camera. Initial configuration of the camera is done before starting the recognition process.

The Kinect 3D camera senses the changes in height and depth that are being made on the sand. Using the depth value received from the camera the Word Beam Search Algorithm Recognizing the letter which is drawn by children in the Sandbox. This algorithm uses IAM Dataset which has different handwritings of multiple writers across the world. The system uses Tensor Flow Module in Python and trains a model which can detect the Hand Written text and Convert it into digital text (or editable text). Word Beam Search algorithm has less error rate when compare to Best Path Decoding and Vanilla Beam Search. Word Beam Search algorithm uses CNN, RNN and CTC algorithms for implementing the hand written text recognition. The Recognized alphabet is then converted into voice using gTTS (Google Text-to-Speech) library.

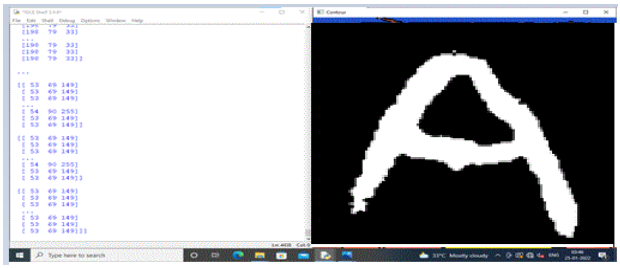

Fig. 3 Depth values for the projection region in the sandbox

With interactive toolkit, children can learn 6 C's principles of playful learning which makes education Active, engaged, meaningful, socially interactive, iterative, and joyful. Children can work with the physical sand with their bare hands and create their own English alphabet using their creativity. AR Sandbox helps in recognizing the English alphabets and guides the children with interactive feedback by projecting the English alphabet on the sand and pronouncing it in a speaker. This research work uses color map for projecting color on the sand based on the depth values.

Figure 4. Recognized letter from ARSandbox

This toolkit aims to enhance the learning of alphabets, numbers, shapes and objects in kindergarten children and can benefit students, educational institutions experimenting with Augmented Reality.

6. Conclusion

The simulated model can be further extended to create a miniature model to be used in houses and kindergarten schools. The toolkit is to be experimented with kinder garten children in preschool and in elementary government schools in the district of Salem as part of CSIR activity. An effective measuring tool is to be employed to find the effectiveness of the learning mechanism and to refine the procedure considering the feedback from students, children and teachers. As the system gets refined, we will study the effectiveness of regular classroom learning and AR-based learning. The future research work will be to develop a toolkit which will be helpful for the disabled children in the kinder garten level.

References

[1] Azuma, R. T. (1997): *A survey of augmented reality. Presence*: Teleoperators and Virtual Environments 6, 4 (August 1997), 355-385. Cambridge,MA: The MIT Press.

[2] Feng, Z., Duh, H. B. L., & Billinghurst, M.: *Trends in augmented reality tracking, interaction and display*: A review of ten years of ISMAR. In Mixed and Augmented Reality, 2008. ISMAR 2008. 7th IEEE/ACM International Symposium on, 15-18 Sept. 2008 (pp. 193-202). doi:10.1109/ismar.2008.4637362.

[3] Lee, H., & Lee, J. (2008). *Mathematical Education Game Based on Augmented Reality.* In Z. Pan, X. Zhang, A. Rhalibi, W. Woo, & Y. Li (Eds.), Technologies for E-Learning and Digital Entertainment (Vol. 5093, pp. 442-450, Lecture Notes in Computer Science): Springer Berlin Heidelberg.

[4] Scrivner. O, Madewell. J, Buckley. C, Perez. N, "*Augmented reality digital technologies (ARDT) for foreign language teaching and learning*", In Proceedings of the FTC 2016—Future Technologies Conference, San Francisco, CA, USA, **(2016)** December 6–7, pp. 395–398.

[5] Arcos. C, Fuertes. W, Villacis. C, Zambrano. M, Noboa.T, Tacuri. A, Aules. H, Toulkeridis. T, "*Playful and interactive environment-based augmented reality to stimulate learning of children*", In Proceedings of the 18th Mediterranean Electrotechnical Conference (MELECON), Lemesos, Cyprus, **(2016)** April 18–20 pp. 1–6.

[6] Huang. T.C, Chen. C.C, Chou. Y.W, "*Animating eco-education: To see, feel, and discover in an augmented reality-based experiential learning environment*", Comput. Educ., vol. 96 **(2016),** pp.72-82.

[7] Yilmaz. M.R,"*Educational magic toys developed with augmented reality technology for early childhood education. Comput*", Hum. Behav. , vol.54, **(2016)**, pp. 240–248.

[8] Kathy Hirsh-Pasek, Helen Hadani: *A New Path To Education Reform: Playful Learning Promotes 21st Century Skills In Schools And Beyond,* brookings.edu/policy2020

[9] Banu, J. F., Rajeshwari, S. B., Kallimani, J. S., Vasanthi, S., Buttar, A. M. et al. (2022). *Modeling of Hyperparameter Tuned Hybrid CNN and LSTM for Prediction Mode*l. Intelligent Automation & Soft Computing, 33(3), 1393–1405.

[10] Radosavljevic. S, Radosavljevic. V, Grgurovic. B, "*The potential of implementing augmented reality into vocational higher education through mobile learning*", Interact. Learn. Environ. **(2018)**, pp.1–15.

[11] Huang. T.C, Chen. C.C, Chou. Y.W, "*Animating eco-education: To see, feel, and discover in an augmented reality-based experiential learning environment*", Comput. Educ., vol. 96 (2016), pp.72-82.

[12] Chokkanathan K, Shanmugaraja P, Siva Shankar Ramasamy, Rujira Ouncharoen, Nopasit Chakpitak, *"A survey on role of block chain in smart cities*", International Journal of Computer Science and Network Security, Vol21, No.7, pp. 1-7.

[13] B.Saravanan, V.Mohanraj, Dr.J.Senthilkumar "*A fuzzy entropy technique for dimensionality reduction in recommender systems using deep learning"* Soft Computing –Springer Vol. 23, No. 8, pp.2575-2583, April 2019

[14] G.Mohanraj,V Mohanraj, J Senthilkumar, Y Suresh*," A hybrid deep learning model for predicting and targeting the less immunized area to improve childrens vaccination rate ",* Intelligent Data Analysis 24(6):1385-1402,2020.

[15] Thiyaneswaran, B., Anguraj, K., Kumarganesh, S., Thangaraj, K." *Early detection of melanoma images using gray level co-occurrence matrix features and machine learning techniques for effective clinical diagnosis*", International Journal of Imaging Systems and Technology, 2021, 31(2), pp. 682–694.

S.Vasanthi, currently working as an Associate Professor cum Researcher in the Information Technology Department of Sona College of Technology with more than 20 years of Experience in Teaching & Research field. His current research focus is in the field of Network security, Augmented Reality and Virtual Reality, Internet of Things and Wireless Sensor Network.

S. David Samuel Azariya has more than 16 years of experience in teaching and her current research focus on a computer vision, Machine learning and Data mining. He is currently in the Department of Information Technology, Sona College of Technology as an Assistant Professor.

.

S.Kanish is a III year student studying in Department of Information Technology, Sona College of Technology, Salem. Currently he is involved in research and consultancy projects. His area of interest is Full Stack Development, Cyber security and Image Processing.

S.Dhanush Prabhu is a III year student studying in Department of Information Technology, Sona College of Technology, Salem. His area of interest is Networking, Full Stack Development, and Cyber security.