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EDU-AR

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Abstract:
The paper explores the amalgamation of two domains i.e., Machine Learning & Augmented Reality with the central focus on education for kids from the age group 3-5 specifically. AR is a tool that can soar the rate of interaction and learning efficiency, which puts into practice their imagination. Alphabets are the building blocks of any language. This application encourages preschool students to have an understanding of letters, how to write it, their corresponding pronunciations, objects related to the letters i.e. 3D model, there is incorporation of sign language to make it user friendly it is designed to help kids with cognitive challenges and children with hearing and speaking aid. This application has handwriting analysis using OCR, the user also has an option to take a live photo of the object they want to identify which will be identified using Machine Learning (ML), the corresponding 3D model will be augmented along with the pronunciation and sign language. The software used in this application are Unity 3D, Android Studio, ARCore.
Key Word: Machine Learning (ML), Augmented Reality (AR), OCR, Education, Unity 3D.

I. INTRODUCTION

Augmented Reality has been a booming industry but there is yet to be a significant development in the sector of education and especially for pre-school going children, during the age of 3-5 children learn some important basic skills: reading, writing, long/short memory, overall cognitive development. Therefore, Edu-AR acts as a basic tool with an easy to use and interactive and simple environment. Augmented Reality is a relatively young technology and is the way of future technologies and innovations. It has large number of applications in the fields of medical[4][5], marketing[6], advertisement[7], entertainment, education and training, industrial design[8], manufacturing and maintenance[9], architecture[10], navigation[11], emergency, search and rescue systems[12], interactive gaming[13][14] and tourism[15].[16] In EduAR we have inculcated: 1) Marker less AR 2) Handwriting Analysis 3) Image recognition 4) Sign Language 5) Voice assisted pronunciation 6) 3D model rendering The Machine learning (ML) model used is Convolutional Neural Network (CNN) which was found to be the most accurate and was the fastest in term of time efficiency. The algorithm used is SoftMax. When EduAR applications starts, it asks for an image or to capture a live picture, this can also be handwritten or an image that is taken from the internet, this image will then be fed to the machine learning model which uses CNN to detect the featuring points to identify the object in the image and then it will be redirected to UNITY and ARCORE to augment the model that has been identified, this application is markerless AR app, hence it will use plane detection and enable the user to choose the plane on which they would like their 3D animated model to render, as an additional and new feature we have incorporated auditory voice which will pronounce the respective word and as a visual element there will be a pop up of 'how to spell' the respective word, along with the sign language. The proposed system enables detection of the element in the current dataset (that is: 10 animals) and then augment it on the screen, there is also an option to write the specific object name e.g.: elephant and then upload an image of this and the word will be detected and its corresponding model will be augmented. The future scope of this project is making an analysis based on the small activities and quiz that will be in the form of a memory game. This will test their memory power and keep them engaged and also in touch with learning in an interactive way.

II. LITERATURE SURVEY

The following research paper were selected keeping in mind the similar use of the technology with few or other dependencies.

Majority of these systems focus on just augmenting the 3D model for edutainment purposes. The study that inspired our system is: Leo AR Edu. The applications development revolves around a very interactive and fun approach towards education. There are thousands of 3D objects from which the children can select and learn from. Categories include math, science, space, alphabet, farm life, animals and more. This application allows user to place their 3D using plane detection i.e., it does not require a marker, it also allows the user to make a

video using these 3D models Shou-Ming Hou, Yan-Yan Liu, Qi-Bo Tang, Xiao-Guang Guo worked on developing a system to shift the use of traditional picture books into a more interactive and high learning rate experience using Augmented Reality. To improve the poor interaction and low learning efficiency, a picture book of a mobile augmented reality system (MARS) is implemented, it contains functions of painting, literacy, and listening to story, which helps children understand things from the perspective of vision, hearing and tactility. MARS is based on image recognition and Bi- directional matching technology and developed an interactive AR card named ARMonkey by MARS. The children can observe the 3D objects, color them and listen to their introduction, the updated color (i.e., the color that children colored the objects) will then be updated in the real time 3D model, e.g., there is a card with fish on it, this card when augmented before has no color in it, when the real time card is colored by the children and then scanned, the fish that was augmented before will have the color in it. [17]

Arnav Nigam, Milan Chandrakar, Kaushal Kumar Bhagat, Pramod Goswami worked on developing a tracing application (letters and numbers) for kindergarten students namely ART (Augmented Reality Tracing application). Most of the children use tracing activity sheets where some boxes are placed. In these boxes, dotted letters are provided, and children are expected to trace over them to learn to write correctly. However, this process is monotonous and inefficient to hold their attention and motivation for further learning. Therefore, they start to lose their focus and enthusiasm very soon. The application has been developed in Unity Engine with the support of Vuforia software development kit. The current version of the app is having capital letters 'A' to 'E'. The learner chooses a letter, which has to be traced, will be augmented over the paper. To evaluate whether the child has traced it correctly or not, the app has pre-traced every letter manually and fed into it. If a child has correctly traced it, the application will detect and graphics will be presented on the screen to cheer him/her. However, if he/she is unable to trace it, then the app will encourage the child to try again until he/she succeeds, hence, providing a self-analyzing factor.[18]

Yang Kuang, XiaoMei Bai proposed a study that provides characteristics of augmented reality technology and the characteristics of children's psychology, and the feasibility analysis of augmented reality technology in the field of early childhood education. Through the research and analysis of augmented reality technology in the field of early childhood education, augmented reality is a kind of technology which is beneficial to strengthen the reproduction of children's learning scene, has a solid theoretical foundation and technical support in the application of early childhood education scene, and will have a broad application situation in the field of kindergarten. It is found that in the teaching of young children, through the use of augmented reality technology to create real situations and learning materials, a three-dimensional display, teaching and learning process can greatly stimulate learning enthusiasm and enthusiasm for learning, to help young children more happy learning and more high-speed and effective learning knowledge [19].

Lucas Farias, RummeniggeDantas, AquilesBulamaqui proposed a software tool that provides an easy way to create augmented reality presentations. This tool allows the user to create his own presentation without the help of any dedicated person. The tool is supported by an internet portal that gives the account creation and a database to store the presentations created by the users. [20] Educ-AR allows the creation of classes using augmented reality techniques. With this tool teachers can use the virtual models to enrich and improve the explanation of abstract subjects in various areas. The tool developed in this work was created to be used as an API. With this API it is possible to create new layers of software above the Educ-AR. The main component, JARToolKitJ3D is the unique component with public visibility in this system. So, it encapsulates the use of the other components and defines the rules to create new components. Following are the steps to in the Educ-AR portal: a. Make a register in the web portal b. Create a class c. Submit markers to its class d. Submit 3D models e. Make associations between models and markers f. Start the Educ-AR g. Manipulate the markers and see the objects h. Create a new marker i. Associate a new marker with a model j. Test the association of the new marker.

Richard E., Billaudeau V., Richard P., Gaudin G. proposed a non-immersive recreational and educational augmented reality application (ARVe - Augmented Reality applied to Vegetal field) that allows young children to handle 2D and 3D plant entities in a simple and intuitive way. This application involves a task of pairing and provides visual, olfactory or auditory cues to help children in decision making. [21] The ARVe (Augmented Reality applied to the Vegetal field) allows young children to handle 2D and 3D plant entities such as fruits, leaves, flowers and seeds in a simple and intuitive way. These entities are presented in a Magic Book–like user interface. Rigid paperboards with eight printed square marker patterns are used. The ARVe application involves a matching task and provides visual, olfactory or auditory cues to help children in decision making. Indeed, users have to put in correspondence the 2D and 3D entities displayed on mobile patterns positioned on the right-hand page with corresponding 3D fruits displayed (on stick patterns) on the left-hand page. 93 children participated in this study, including 11 pupils with cognitive disabilities, participated in the study that aimed (a) to investigate children performance and behavior in using AR techniques, and (b) to examine specific attitudes

of disabled children confronted to such techniques. It was observed that disabled children were very enthusiastic when using the application and showed a high motivation as compared to most of the other pupils. [21]

III. PROPOSED SYSTEM

This section includes a brief description of the proposed system and explores the different modules involved along with the various models through which this system is understood and represented.

Modules of Proposed Application:

A. **Image Selection:**

When the user starts the app and clicks on the start button the phone will ask for the image. The image can be provided in 2 ways i.e. by clicking the image by opening the camera or can directly be taken from the saved images from Gallery. Fig. 1 shows the working of this module.

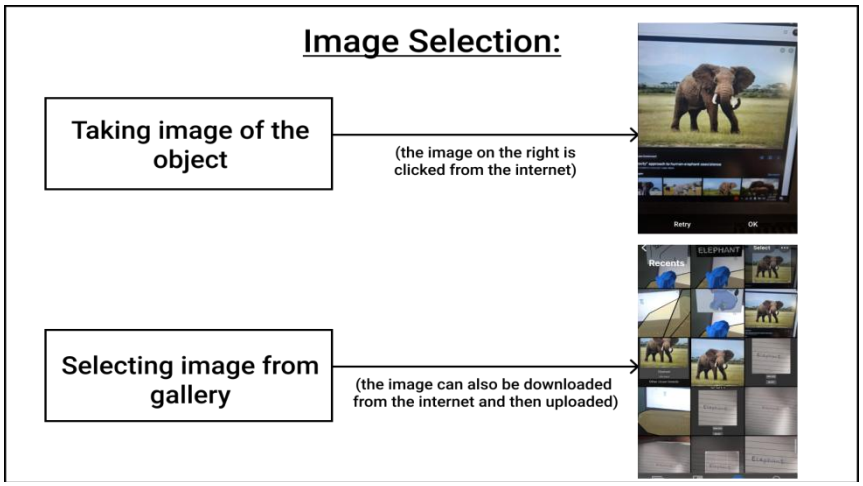

Fig 1. Image Selection

B. **Image Altering and Uploading:**

Once the image is selected by the user the image is later resized to the required size that is accepted by the Machine Learning Model and the required filters are applied to it so that it's not too heavy for the model to process. Fig. 2 Shows the working of this module.

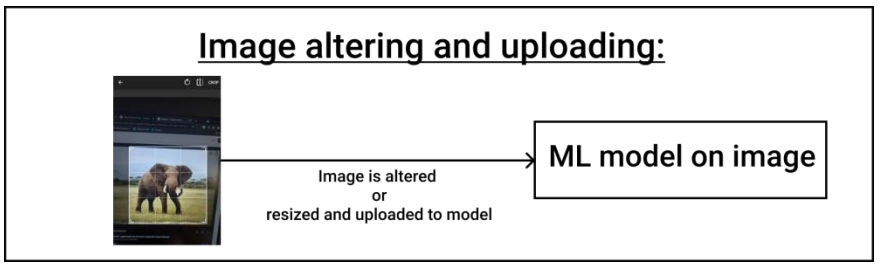

Fig. 2. Image Altering and Uploading

C. **Classification of the Image:**

The image passed to the Machine Learning Model now the Model will apply the required filters and will identify the class of the image and will give the output about the type of the object in this case name of the animal will be given. Fig 3 shows the working of this module.

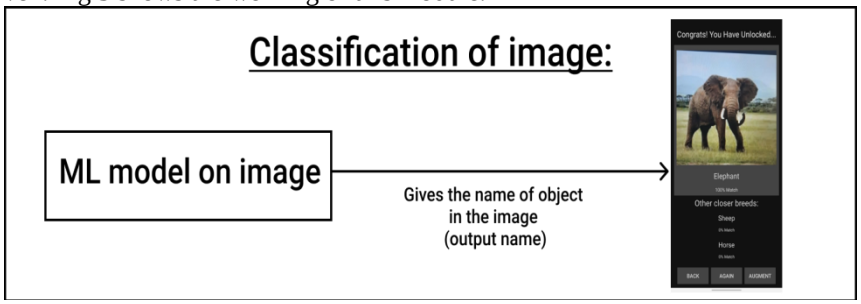

Fig. 3. Classification of the Image

D. **Augmenting the Model:**

Once the class of the animal is predicted by the Machine Learning Model this data will be carried to the AR Core and it will use the device camera to scan the surroundings and once surrounding is scanned the user can just place the 3D model of the object on its surrounding and interact with it. Fig. 4. shows how data are handled within this module.

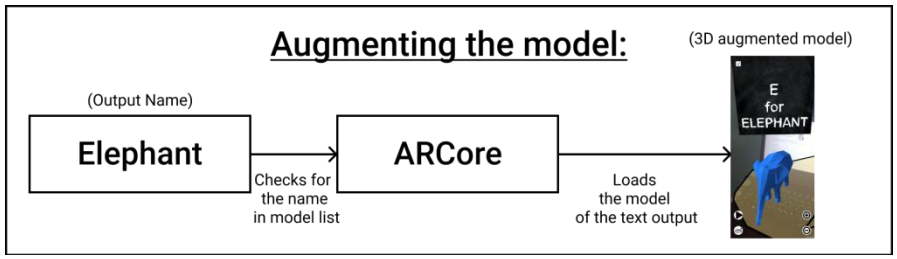

Fig. 4. Augmenting the Model

E. **OCR to Detect the Object:**

If the user doesn't have the image of the object, then the user can just write the name of the animal on a piece of the paper and by scanning it the phone will perform OCR and will identify the object and will augment it as defined in the module "Augmenting the Model". Fig. 5. Shows the working of this module.

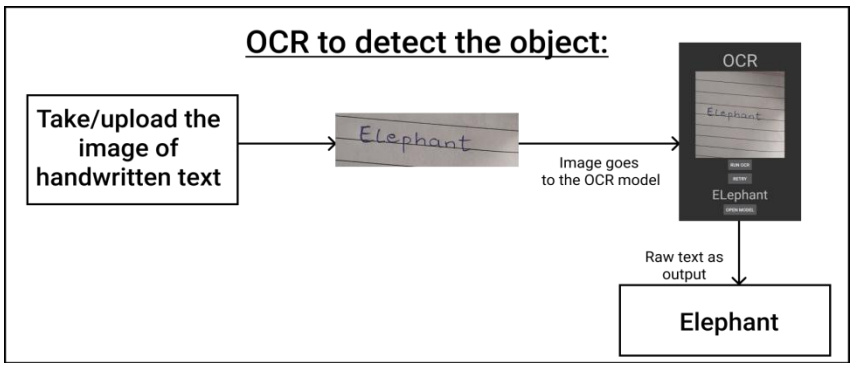

Fig. 5. OCR to Detect the Object

F. **System Architecture:**

Fig. 6 Shows the system architecture of the proposed system. It also shows how the flow of information takes place within the proposed application.

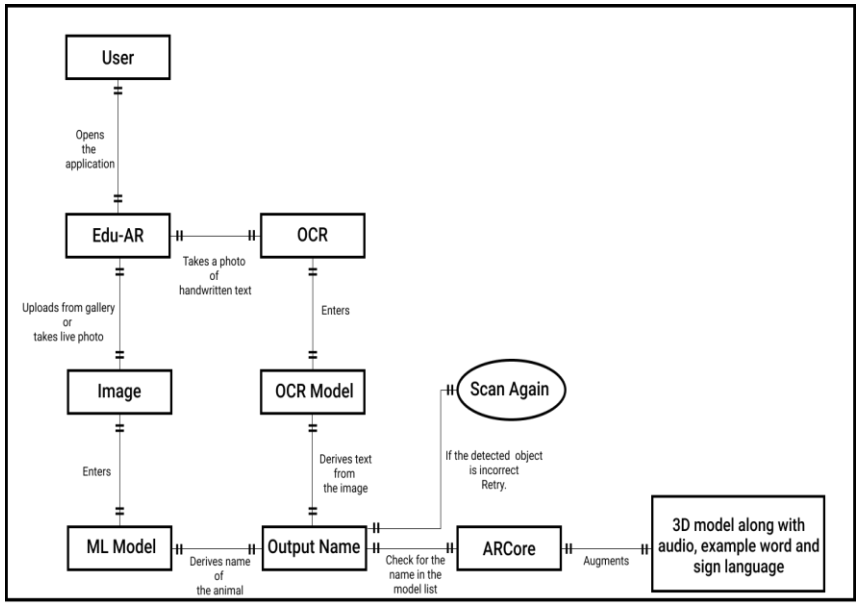

Fig. 6. System Architecture

Software & Algorithm:
The software must be able to sense the surrounding and provide with the real world coordinates, independent from the camera, from the images captured from the camera. This is called Image Registration. It consists of 2 Stages. In the first stage, features are detected from Fiducial Markers, Interest Points or Optical Flow in the images and in the second stage the real world coordinates of those feature points are computed mathematically. Some of the software we have used are Unity3D, AR Core, Android Studio.

Unity3D: Unity3D is one of the most used Cross Platform Game Development Engine. It was released in 2005. It has inbuilt different Physics engine implementation and also supports adding various Animations, Audio, Videos, 3D Models and many more.

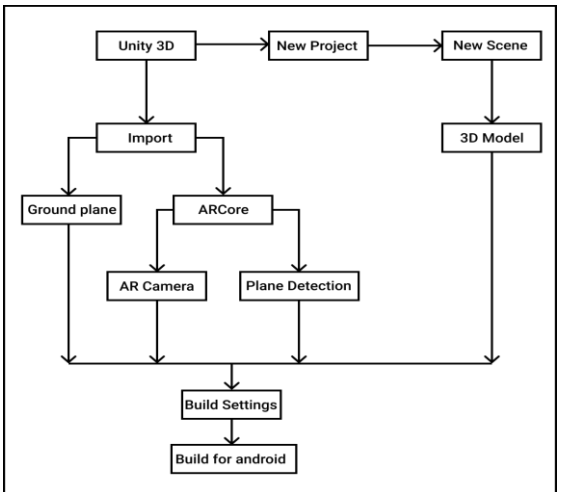

Fig. 7. Unity 3D

Android Studio: Android Studio is widely used for developing Android Application. It can be used to develop various types of Applications for Android. It supports JAVA and Kotlin languages. App Designing and Development can be done in Android Studio.

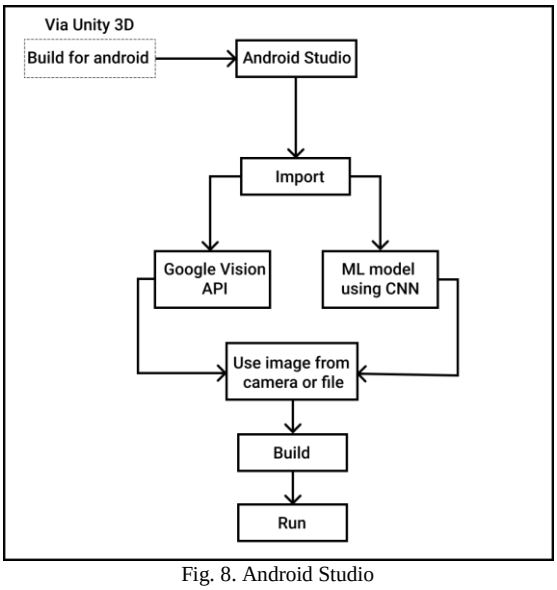

Fig. 8. Android Studio

AR Core: It is also known as Google Play Service for AR. It is a Software Development Kit made by Google. It allows users to create Augmented Reality apps for various devices and is also supported by various engines.
Machine Learning Algorithm: For ML we have implemented CNN. This model is trained and tested using 10 Animals dataset from Kaggle and the accuracy given by the model is 85%. It is trained to detect and classify 10 animals. There are over 28K images for these animals to train.

Handwriting Analysis OCR: For OCR we have used the Google Vision API. It is an open source API from Google which detects texts within Images with Automatic Language Identification. It was added and then was set to detect text in the clicked images or images selected from the file.
Hardware: The app described in this paper only requires an android smartphone with pre- installed Edu-AR

IV. EXPERIMENTAL EVALUATION

#For image classification to be done with the use of CNN algorithm, #. More details are shown in Table 1.

Table 1. dataset

Dataset	Animals-10 (Animal pictures of 10 different categories taken from google images)
Context	This dataset contains over 26K medium quality animal images belonging to 10 categories: dog, cat, horse, spider, butterfly, chicken, sheep, cow, squirrel, elephant.
Content	Raw-Image is the folder containing folders named according to the categories of animal. Each folder contains a large amount of medium quality images which are further divided into test and train categories which are used by CNN to train and test based on images. Translate.py contains all the labels of the categories.
Source	https://www.kaggle.com/alessiocorrado99/animals10

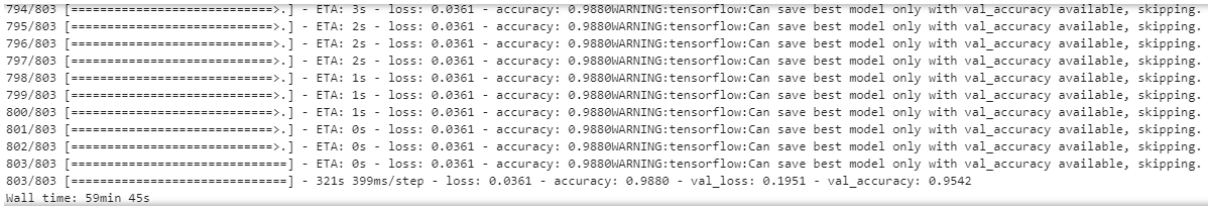

Fig. 9.Accuracy Values of ML Model

The Machine Learning model was trained with the above mentioned dataset and gave accuracy of 98.80% and loss of 3.61% on Training data. The accuracy value and loss value for Validation data is 95.42% and 19.51% respectively.
respectively.

IV. RESULT & DISCUSSION

In existing system here needs to be predefined image targets to render the 3D model on the target and there need to be one distinct target for each 3D model so if the number of 3D models were increased then there should be an increase in the number of physical targets that can be in the form of printouts or book. In Edu-AR we eliminate all those things. The 3D models are preloaded into the app while development and in order to load a specific 3D model user just needs to provide any image or just have to write the name of the object the user wants to augment. Once the image is captured by the user, depending on it the ML model or OCR model will predict the object and will allow the user to Augment the 3D model of the selected object. To Augment the 3D model user needs to scan the environment around it to create a plane for the object to be placed. Once the surroundings are scanned by the camera user can just tap on the plane generated and the 3D model will be placed. Additional features like rotating, scaling and moving are available for better understanding of the object. Users can also access the video, by tapping on the play button. Once the button is pressed. A video will be played which includes the spelling and pronunciation of the object played along with the spelling in sign language so that any user can access it and there's no barrier while learning.

V. FUTURE SCOPE

AR is an enormous field and the scope of implantation of it in the sector of education is gigantic, although when two domains such as AR and ML are fused together, the result is truly astonishing and efficient, although this a topic that is hardly explored, the results are truly promising. The initial challenge in this application was to form a coalition between AR and ML. The future scope of this project is making a cognitive analysis of the students based on the small activities and quiz that will be in the form of a memory game. This will test their memory retention power and keep them engaged and also in touch with learning in an interactive way. The future scope also is to project and add different sections such as math (number system), sanitation and hygiene etc. to it, to cover up the most basic form of learning for pre-school going students.

VI. CONCLUSION

Augmented reality can be used as a new tool in support of the teaching activity. It enhances the perception of students and emphasizes information that is not perceived directly by the use of their own senses, AR education games can express teaching content vividly and make learning more direct and easier to understand. Edu-AR makes use of the following features that distinguishes it:

a. Marker-less target
b. Handwritten object detection
c. Sign language support
d. Spelling the particular word
e. Rendering the 3D model
f. Audio support to help understand the pronunciation.

REFERENCES

[1]. Paul Milgram, Haruo Takemura, Akira Utsumi and Fumio Kishino, "Augmented Reality: A class of displays on the reality-virtuality continuum", Proceedings of Telemanipulator and Telepresence Technologies, SPIE vol. 2351, pp. 282-292, October 1994.

[2]. Paul Milgram and Fumio Kishino, "Taxonomy of Mixed Reality Visual Displays," IEICE Transactions on Information Systems (IECE special issue on networked reality), vol. E77-D, no. 12, pp. 1321-1329, December 1994.

[3]. Tobias H. Hollerer and Steven K. Feiner, "Mobile Augmented Reality", Tele Geoinformatics: Location-Based Computing and Services, H. Karimi and A. Hammad (eds.), Taylor & Francis Books Ltd., 2004.

[4]. Tobias Sielhorst, Marco Feuerstein, Nassir Navab, " Advanced Medical Displays: A Literature Review of Augmented Reality", Journal of Display Technology, vol. 4, pp. 451-467, December 2008. Yoshitaka Masutani, TakeyoshiDohi, Fumitaka Yamane, Hiroshi Iseki and Kintomo Takakura, "Augmented Reality Visualization System for Intravascular Neurosurgery", Journal of Computer Aided Surgery, vol. 3, pp. 239-247, October 1998.

[5]. Alexander Bornik, Reinhard Beichel, Bernhard Reitinger, Georg Gotschuli, Erich Sorantin, Franz W. Leberl and Milan Sonka, "Computer-aided liver surgery planning:an augmented reality approach", Proceedings SPIE 5029, Medical Imaging:Visualization, Image-Guided Procedures and Display, May 2003.

[6]. X. Zhang, N. Navab, S.– P. Liou, "E-commerce direct marketing using augmented reality", IEEE International Conference on Multimedia and Expo- ICME 2000, Proceedings, Latest Advances in the Fast Changing World of Multimedia, vol.3, 30 July-2 August 2000.

[7]. FadiChehimi, Paul Coulton and Reuben Edwards, "Augmented Reality 3D Interactive Advertisements on Smartphones", IEEE Sixth International Conference on the Management of Mobile Business, 9-11 July 2007.

[8]. H. Regenbrecht, G. Baratoff and W. Wilke, "Augmented reality projects in the automotive and aerospace industries", IEEE Computer Graphics and Applications, vol. 25, pp. 48-56, Nov.-Dec. 2005.

[9]. U. Neumann and A. Majoros, "Cognitive, performance and systems issues for augmented reality applications in manufacturing and maintenance", Virtual Reality International Symposium, IEEE, 14-18 March 1998.

[10]. Bruce Thomas, Wayne Piekarski and Bernard Gunther, "Using Augmented Reality to Visualise Architecture Designs in an Outdoor Environment", In DCNET 1999- Design Computing on the Net, November 1999.

[11]. B. Thomes, V.Demczuk, W. Piekarski, D. Hepworth and B. Gunther, "A wearable computer system with augmented reality to support terrestrial navigation", Second International Symposium on Wearable Computers, IEEE, 19-20 Oct. 1998.

[12]. JunhoAhn, Richard Han, "RescueMe: An Indoor Augmented-Reality Evacuation System by Personalized Pedometry", Services Computing Conference (APSCC), IEEE Asia-Pacific, 12-15 Dec. 2011.

[13]. Diogo Cordeiro, Nuno Correia and Rui Jesus, "ARZombie: A mobile augmented reality game with multimodal interaction", IEEE, 2015.

[14]. ZhihanLv, Alaa Halawani, Shengzhong Feng, Shafiq ur Rehman and Haibo Li "Touchless interactive augmented reality game on vision based wearable device", Personal and Ubiquitous Computing, vol. 19, pp. 551-567, May 2015.

[15]. Feng Tian, Feifei Xu and Jiacai Fu, "Augmented reality technology overview for tourism app development", IEEE International Conference on Machine Learning and Cybernetics, IEEE, 14-17 July 2013.

[16]. Surabhi Nanda, Shailendra Kumar Jha, 2017, Augmented Reality – an Application for Kid's Education, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) ICCCS – 2017 (Volume 5 – Issue 10),

[17]. Shou-Ming Hou,Yan-Yan Liu, Qi-Bo Tang, Xiao-Guang Guo, (2017), " Conference Paper Mobile Augmented Reality System for Preschool Education", Hou, Shou-Ming & Liu, Yan- Yan & Tang, Qi-Bo

& Guo, Xiao-Guang. (2017). Mobile Augmented Reality System forPreschool Education. 321-323. 10.1109/ICVRV.2017.00074.

[18]. Arnav Nigam, Milan Chandrakar, Kaushal Kumar Bhagat, Pramod Goswami, (2019), "Design and Development of an Augmented Reality Tracing Application for Kindergarten students", A. Nigam, K. K. Bhagat, M. Chandrakar and P. Goswami, "Design and Development of an Augmented Reality Tracing Application for Kindergarten Students," 2019 IEEE Tenth International Conference on Technology for Education (T4E), Goa, India, 2019, pp. 240-241, doi: 10.1109/T4E.2019.00-14..

[19]. Yang Kuang, XiaoMei Bai, (2019), "The Feasibility Study of Augmented Reality Technology in Early Childhood Education", Y. Kuang and X. Bai, "The Feasibility Study of Augmented Reality Technology in Early Childhood Education," 2019 14th International Conference on Computer Science & Education (ICCSE), Toronto, ON, Canada, 2019, pp. 172- 175, doi: 10.1109/ICCSE.2019.8845339.

[20]. Lucas Farias, RummeniggeDantas, AquilesBulamaqui ,(2011), "Educ-AR: A tool for assist the creation of augmented reality content for education", L. Farias, R. Dantas and A. Burlamaqui, "Educ-AR: A tool for assist the creation of augmented reality content for education," 2011 IEEE International Conference on Virtual Environments, Human-Computer Interfaces and Measurement Systems Proceedings, Ottawa, ON, 2011, pp. 1-5, doi: 10.1109/VECIMS.2011.6053850.

[21]. Richard E., Billaudeau V., Richard P., Gaudin G., (2007), "Augmented Reality for Rehabilitation of Cognitive Disabled Children: A Preliminary Study", E. Richard, V. Billaudeau, P. Richard and G. Gaudin, "Augmented Reality for Rehabilitation of Cognitive Disabled Children: A Preliminary Study," 2007 Virtual Rehabilitation, Venice, Italy, 2007, pp. 102-108, doi: 10.1109/ICVR.2007.4362148

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