Augmented Reality based Interactive Text Book
An Assistive Technology for Students with Learning Disability

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Abstract—Statistics based on research reveals that India has approximately ninety million people with varying degrees of Learning Disabilities (LD) and an average class in schools has about five students with learning disabilities. Epidemiological studies of learning disabilities in India are burdened by problems ranging from identification, assessment, to socio-cultural factors unique to India. Therefore, it is believed that number of children with LD may be much larger than five to a class of fifty students. Hence it is necessary for us to develop suitable technologies to assist the education of these learning disabilities children. This paper presents a PROTYPE called Interactive Text book for assisting students with learning disabilty. Here the book will be same as normal text book with out any special markers and identifiers.Once the children focus on a text , the 3D images, audio and videos that explains the text more graphically will be augmented on that page. This enhances the students understanding and makes the learning process easier for them.

Keywords--Augmented Reality; Learning disability;OCR

I. INTRODUCTION

Augmented Reality (AR) is a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called. VE technologies completely immerse a user inside a synthetic environment. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composite with the real world. Therefore, AR supplements reality, rather than completely replacing it. Ideally, it would appear to the user that the virtual and real objects coexisted in the same space. [5]Azuma defines the AR systems' three characteristics:(1) Combines real and virtual (2) Interactive in real time (3) Registered in 3-D.With the help of advanced AR technology (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulative. Artificial information about the environment and its objects can be overlaid on the real world.

Learning disability refers to a neurobiological disorder, which affects a person's brain and interferes with a person's ability to think and remember. It is manifested in disorders of listening, thinking, reading, writing, spelling or arithmetic [1]. These are not attributed to medical, emotional or environmental causes despite having normal intellectual abilities [2]. LD cannot be cured completely by medication. Children suffering from LD are made to go through a remedial study to make them cope up with non-LD children of their age.

This paper explores some of the potentials raised by the use of augmented reality, in the education and training of people with Learning disability.

II. LEARNING DISABILTIY

The concept of Learning Disability (LD) includes: children who could see and hear and who do not have marked intellectual deficits, but who show deviations in behaviour and in psychological development to such an extent that they are unable to adjust in home or to learn by ordinary methods in school. LD refers to a heterogeneous group of disorders manifested by significant difficulties in acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous dysfunction, and may occur across a life span.

LD can be classified into mild, moderate, severe and profound. The definitions of the degrees of disability are usually expressed in terms of IQ, behavioural competence and/or the need for special service. Children with Mild Learning Disability (MLD) typically have verbal and performance IQ scores in the 50-70 range. They often have significant limitations in adaptive behaviour as expressed in conceptual, social and practical adaptive skills. Specific cognitive deficits often exist in such areas as memory, attention or language. One of the most common learning characteristics of children with MLD is that they have difficulty mastering academic content.

Separating and excluding children from their natural school environment did not always have positive consequences. The integration of children with LD into mainstream schools is an important social and educational issue The UNESCO Salamanca Statement (1994) states that: 'Inclusion and participation are essential to human dignity and exercise of human rights' .The fundamental principle of the inclusive school is that all children should learn together, wherever possible, regardless of any difficulties or differences they may have. Inclusion is based on a social model of disability that views disability as a socially created problem and management of problem requires social action in the form of environmental modifications necessary for the full participation of persons with disabilities.

This paper supports inclusive education for students with MLD, by providing assistive techniques based on augmented reality so that their learning process can be much easier.

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III. NEED OF AUGMENTED REALITY FOR EDUCATING MILD LEARNING DISABILITIES

The education of LD students represents a great challenge for their teachers in terms of interaction. The experience of the teachers at the school has shown that when computer tools are used to help in the learning process, the students are encouraged to learn, to participate and to interact with each other and with their teachers. In such educational environments, participation and motivation of the disabled students is crucial, so the use of information technologies in the classrooms is increasing.

AR supports discovery-based ICT learning which refers to a learning technique in which students take control of their own learning process, acquire information, and use that information in order to experience scenarios which may not be feasible to construct in reality given the time and space constraints. The usage of AR in the education could help to capture their attention and encourage more active participation from the students. The usage of multimedia such as animation is able to enhance learning experience in term of: Attractive Learning, Attentive Learning, Effective Learning and Classification.

IV. IMPLIMENTATION OF AR BASED INTERACTIVE TEXT BOOK

The 'Interactive Text Book' introduces an ICT-enabled learning approach that has the following innovative Characteristics:

1) Makes use of advanced visualization technologies (AR) that not only have the potential to enrich the learners' optical view with relevant information but also allow the learners to interact dynamically with the miniature exhibits
2) Easy to operate
3) Promotes an inquiry-based and experiential learning approach
4) Uses desktop AR environments

During the teaching process or learning process a sensing device focuses the topic or text, which needs more explanation, and then the related images, videos or audio are augmented on the page. Refer Fig:1

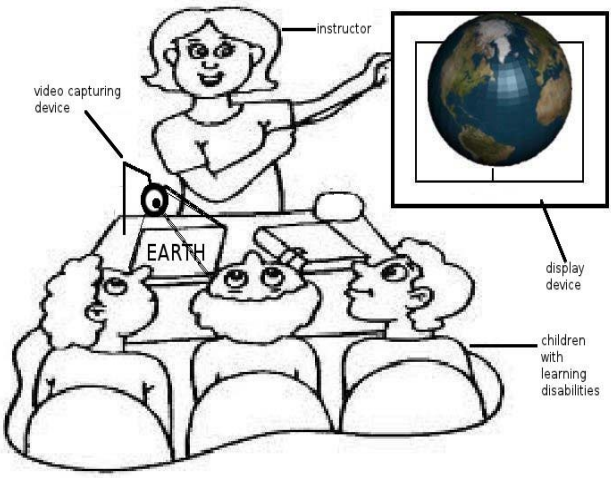

Fig: 1 A teacher explaining to LD students

V. SYSTEM ARCHITECTURE

The client runs with the web camera in video mode. The user can focus the web camera over a document and video frames are captured and recognized. The image frames are formatted and the tiff-formatted image is then OCR-ed to extract the text and some keywords are searched in this text. These keywords are matched with already available keywords in the database. The relevant virtual multimedia, available in the database, is rendered on the display via augmented reality. The database is updated on the database generator and transferred to the client machine. Refer Fig: 2.

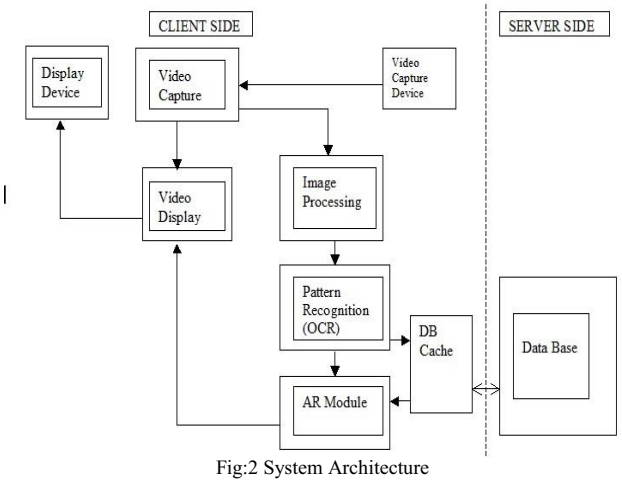

Fig:2 System Architecture

The application works with five modules: Video Capture Video display, Image processing, Character Recognition and AR

A. Video Capture

In this module video is captured using a video-capturing device. The captured video frames are sent to the Image processing module

B. Image Processing

This module is responsible for converting image frames to tiff format. The formatted image is sent to the character recognition module.

C. OCR module

The tiff image is OCR-ed to extract the text and some keywords are searched in this text. These keywords are matched with already available keywords in the database. The relevant virtual multimedia, available in the database, is sent to AR module.

D. AR module

In this module we are using AR toolkit operation to augment virtual multimedia to real video with correct position and orientation. The frame image collected from OCR module is sent to AR module with position of the text. AR module augments virtual media to the frame image at the position of text (Fig 3) and this frame is sent to video display module.

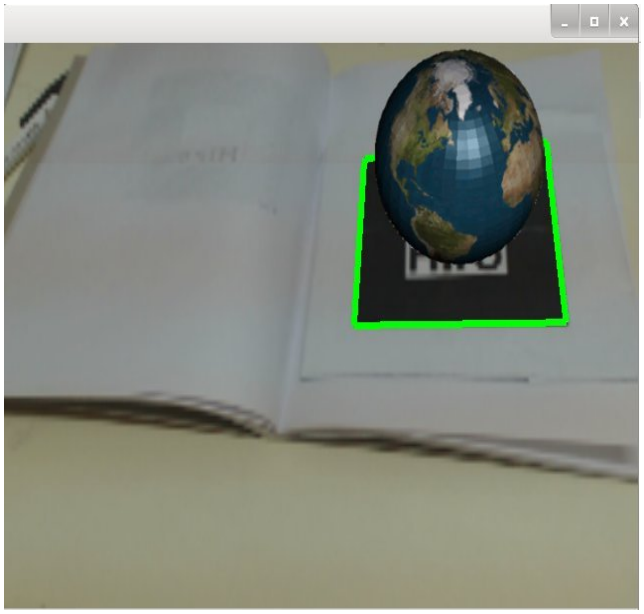

Fig:3 Augmenting virtual media to text

1) Tesseract OCR

Tesseract as provided by Google, takes as input a TIFF image and outputs text. In our case, tesseract runs in a thread that takes up a frame from the currently playing video buffer as a YUV image, recognizes text in it, and returns the output text to database module. The tesseract source consists of a main program, a word level recognizer, a module that organizes (orders) text into lines and words; low-level character classifiers and a dictionary that is used by the classifier.

Tanushyam [11] suggests that tesseract OCR has beeter accuracy than other open source OCR system. . Font based accuracy of tesseract is documented in table 1

2) Architecture of tesseract

Tesseract OCR works in step by step manner as per the block Diagram shown in fig 4. First step is Adaptive thresholding [10], which converts the image into binary images. Next step is connected component analysis [8], which is used to extract character outlines. This method is very useful because it doesthe OCR of image with white text and black background.Tesseract was probably first [8] to provide this kind of processing. Then after, the outlines are converted into Blobs. Blobs are organized into text lines, and the lines and regions are analyzed for some fixed area or equivalent text size [8]. Text is divided into words using definite spaces and fuzzy spaces [8]. Recognition of text is then started as two-pass process as shown in fig 4. In the first pass, an attempt is made to recognize each word from the text. Each word passed satisfactory is passed to an adaptive classifier as training data [8]. The adaptive classifier tries to recognize text in more accurate manner. As adaptive classifier has received some training data it has learnt something new so final phase is used to resolve various issues and to extract text from images.

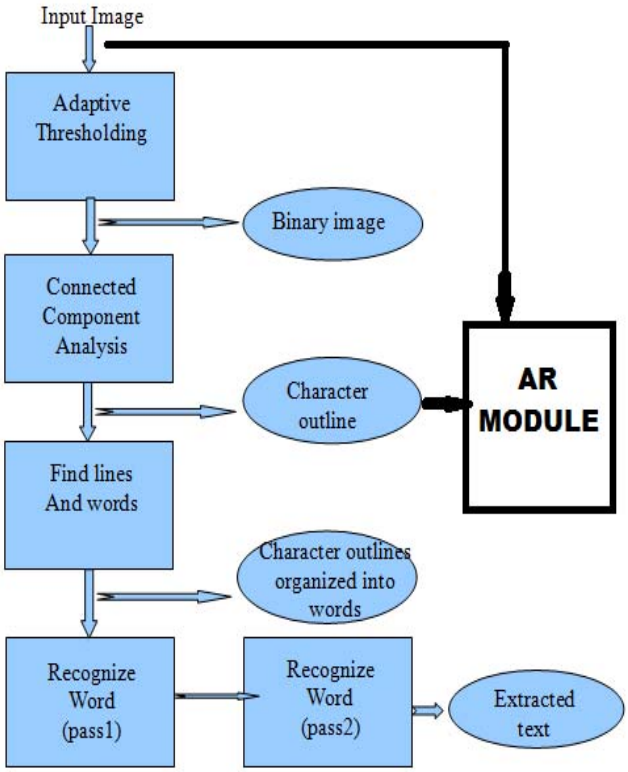

Fig:4 Architecture of Tesseract

TABLE 1. FONT SPECIFIC ACCURACY OF TESSERACT THAT INCLUDES BOTH BOLD AND ITALICS

Font Family	Character level (in %)	Word level (in %)
Times	88.25	28.86
Arial	84.89	22.36
Courier	82.62	0
Verdana	83.33	0
Georgia	83.33	0
Trebuch	84.88	9.3
Bookman	83.33	0
Century	96.51	79.07

VI. CONCLUSION

Educating students with learning disability is a challenge. Due to their limited attention span they get easily distracted. A learning technology that can simulate their interest and catch their attention is needed to ensure an effective learning session.

The assistive technology of teaching aids enables Augmented Reality to combine virtual environment with the real environment to make learning more interesting and interactive for children with learning disabilities

Analytical results demonstrate that children could learn remember and gain knowledge via a simple process and user-friendly interface. This study adopted a user centered approach and applied technology to the learning process of children with learning disabilities, reducing learning barriers and difficulties

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