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TANGIBLE AUGMENTED REALITY INTERFACE AS AN ASSISTIVE-LEARNING TOOL IN CLASSROOMS

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Abstract: Tangible Technologies have been investigated since decades; proposed to interact with the digital information through the physical objects in an intuitive manner. These technologies are proficient of tiling the new-fangled prospects for forming pioneering customs of interaction which are associated with the gestures, frame arrangements and the way the actual objects are organized tending to a sophisticated level of engagement in the learning process. Tangible augmented reality interfaces as an assistive technology can turn out to be a significant tool in the education system by enabling the students to interact with the virtual objects in a real-time environment. However, greater cost, colossal and fragile setups turn out to be the major drawbacks limiting the usage of the augmented reality interface in the day to day lives. This paper discusses the reasons to use tangible augmented-reality interface as an assistive technology for education exploring various possibilities of Augmented reality which could uplift the knowledge with impulsive ardor. Blending up the studies a model has been proposed that outlines when the augmented interface could be implemented in a classroom to shape active learning among students.

Keywords: Tangible augmented reality interface, learning environment, educational technologies.

1. INTRODUCTION

The rapid evolution of technology has transformed the modes of learning and education. The traditional education system followed the face-to-face collaboration where the learning activities were all organized and carried out by the teacher. In addition, the learning was based on static materials such as pen and papers and lacked the dynamic mode that included motion or continuous movement. In the past few years' technology has swamped the static methods of learning which has influenced and revolutionized the way we teach and learn. There are numerous technologies that have been integrated in the educational arena such as computer, hypermedia, internet and more recently mobile devices and immersive environments such as games, virtual environments and augmented reality.

Augmented Reality (AR) is one of the emerging technologies bearing the potential to play an imperative role in the field of learning and education. Further, interest in advantages of the mobile learning and AR applications has appeared due to the widespread usage of the mobile devices. In the recent years, the developments are rapidly increasing in the area of AR on mobile devices which has resulted in creating a subclass of AR called the tangible AR. As per the studies, the educational research regarding mobile augmented reality learning system is in its embryonic stage and is yet to be explored. This article is intended to provide an overview on information about Tangible Augmented Reality (TAR) and its potential uses in education.

According to Chang et. al., (2010) [1], some researchers have proposed that the students could reinforce their learning and boost their educational realism-based practices with tangible augmented reality. Adopting augmented reality in learning and education is still quite challenging in spite of a great amount of research carried out during the last decades because of its issues with integration with traditional learning methods and the cost of development, maintenance and

resistance to latest technologies. Presently however, the AR promises to fascinate and stimulate students with exploration and controlling the materials from varied perspectives that have not been taken into account in real life. AR in education and training is thus believed to have a more modernized approach with wider user acceptance than ever before, due to the developments in computer and information technology.

In this paper examples of research which tend to lay down the benefits of using tangible augmented reality interface into the education system have been outlined. We aim to identify whether the augmented reality interface could be collaborated with the traditional mode of teaching followed by the mentors so that the teaching-learning methods in the classroom environment could be made interactive in a playful manner. Anticipating that the tangible augmented reality interface could turn out to be beneficial for the students, a model has been proposed which describes how and when the augmented interface could be incorporated during the classroom education.

2. LITERATURE SURVEY

A. History of Augmented reality

Augmented Reality (AR) came into existence in the 1950s when Morton Heilig, alleged that the cinema had the capability to attract the viewers on an onscreen bustle in an effective manner. In 1962, Heilig came up with a prototype, which he defined in 1955 in "The Cinema of the Future," naming it as Sensorama, which antedated the digital-computing [8]. Sutherland (1968) created the first augmented reality system interface using a pictorial see-through head-mounted display [7]. In 1975, Myron Krueger developed Videoplace, a room in which the users could interact with the virtual objects. Tom Caudell and David Mizell coined the term Augmented Reality while they were helping the workers in assembling the wires/cable for an aircraft [9]. They also stated the benefits of Augmented Reality versus Virtual Reality (VR).

L.B Rosenberg established one of the first operational AR systems, called Virtual Fixtures and demonstrated its advantages on the human consummation while Steven Feiner et. al., came up with the first major paper on an augmented reality system which explained the prototype KARMA designed by him [22]. In 1997, the first survey report on AR was presented by Ronald Azuma which classified the hitching of the real and virtual worlds [11]. The first outdoor mobile augmented reality game, ARQuake, was created by Bruce Thomas in 2000.

In 2005, the Horizon Report [10] envisioned that AR interfaces will be the emerging technologies the upcoming years; and, as to that divination, camera-systems capable of investigating the corporeal surroundings in real-time and efficient in narrating the positions between the objects were established in the same year which became the foundation for integrating the virtual-objects with the augmented reality systems. In the subsequent years, numerous augmented reality applications emerged specifically with the mobile applications, such as the Wikitude augmented reality Travel Guide launched in 2008. Now a days, as the technologies are attaining pace in expansions, various systems with the AR applications have come into being remarkably with MIT 6th sense taster and the publication of the iPad 2 and its inheritors and opponents, particularly the Eee Pad, and iPhone 4, which promises to transfigure the mobile augmented reality.

B. Augmented Reality applications in Education

The CONNECT project used the AR technology based systems which were developed to inspire the students willing to learn science both in official and unceremonious environments. The students were required to put on the head mounted display and relate to the computer-mediated learning platform in order to envision and interrelate physically and logically with the learning environment. This project had the potential to expand the scenery of education particularly for disabled students.

Squire and Klopfer in 2007 [2] collaborated with the environmental science faculty at MIT by establishing an AR simulation which were named as Environmental Detectives. The developed game required the students to act as environmental engineers

and to give individuals an experience in carrying out the environmental examination in the real world. Dunleavy, Dede and Mitchell in 2009 [3] designed an augmented game Alien Contact! that focused on teaching math's, scientific literacy skills etc. This game was designed on the basis of Massachusetts state standards and cultivates high order thinking skills. In 2009, Ardito et. al., [4] presented a mobile augmented reality game called Explore! which supported explorations of the middle school students to the archaeological sites in Italy. A group of 3-5 middle school students played this game in which each group was provided with 2 cell phones and the site's map on paper. The game also required the students to discover significant places which was supported by some hints described on the cell phone by the game application.

Recently, Tang and Ou in 2012, [5] carried out an experiment using augmented reality and mobile technologies as an assistive tool for learning the subject named butterfly ecology. By integrating augmented reality in this project, students on the host plants could breed their own virtual caterpillars using their smart phones, and become acquainted with butterfly's life cycle by perceiving their growth.

History is generally considered as one of the toughest subjects for the students, Martín, Díaz, et. al., 2012 [6] created an application for teaching students which was named as Enreda Madrid to cope with this complexity. The objective of Enreda Madrid is to teach the history of cities in 17th century to the students through online training and physical technological gymkhana. This application was built using mobile device based on geolocalisation and augmented reality technology.

As per the research studies carried out so far, it could be interpreted that the augmented technologies have the probability for providing pioneering ways for children to play and learn, and bring the liveliness back into the teaching-learning. Although various publications have described the strong points of the tangible augmented reality environments in the field of education, there is still a dearth of knowledge on using augmented reality interface for education on regular basis. However, this study has tried to cover the strengths and weakness of the AR which could be used for future research and also the proposed model emphasizes on when the tangible AR interface could be blended with the educational environments.

3. REASONS TO USE TANGIBLE AUGMENTED REALITY

Education could be lead to new elevations of exploration by the Tangible Augmented reality thereby kindling and reassuring knowledge among the students along with high attention levels. The reasons specifying the benefits of using the tangible augmented environment in the educational field have been listed below:

- Tangible augmented environment, enables numerous users to interact with each other.
- An intriguing learning experience is provided which is not restricted to the regular classrooms.
- The augmented reality interface has the potential to bring down the language barricades, empowering the disabled to be a part of the classroom environment in a thought-provoking manner.
- Novel methods are quantified by the Tangible augmented environment for envisaging the educational environment, strengthening the visual depictions of the contents.
- Augmented reality interface could be learnt glibly and hence the students could spend more time on performing the task rather than learning the systems.

4. PROPOSED MODEL: WHEN TO USE AUGMENTED-REALITY INTERFACE IN CLASSROOMS

The learning and teaching process followed by the teachers requires various instructional succors so that the lectures could be delivered in a more erudite way. Augmented reality could fulfill some of these objectives, which could make the learning process more fascinating for the children. Specified below are the steps of the model proposed specifying how the Tangible augmented reality interface could be

engrossed into the education system developing a playful environment for the learning:

1. Select the course structure.
2. Tangible augmented reality interface is incorporated into the learning process of the course selected. Benefits and drawbacks of using the augmented interface are well-thought-out during the selection process.
3. The level and type of collaboration required is also determined for learning.
4. As per Step 3 suitable software's and hardware's (such as the internet) are selected.
5. The tangible augmented reality environment is then designed and modeled by the students, teachers or both together.
6. The Tangible augmented interface developed is assessed on an experimental group of target students.
7. The outcome of the assessment is then used to amend the augmented interface. Steps 5 and 6 are carried out in a recursive manner till the augmented interface tends to show success in attaining the desired objective.
8. The proposed model is further assessed and altered up to the time the tangible augmented interface is executed with the target group of students.

A. Experiment

The proposed system was tested using an experimental setup comprising of a smartphone grounded augmented reality system. The volunteers for the experiment were twelve students of B.Tech 2nd year of NIT Agartala. "Arduino structure" was the experimental topic selected relating to the field of Human Computer Interaction. The student volunteers were categorized into two groups i.e. the control group 1 and the target group 2 by the method of random matching [13] [15] as per the prior understanding the students had of the selected topic on the foundation of the pre-tests conducted. Each of the groups had equal number of students which were assigned by selecting the best two scoring students and allotting them to the control group 1 and the target group 2 respectively. Then similarly the next two students were assigned the groups. The similar process was carried out in a repetitive manner until all the students were covered.

B. Procedure

The control group 1 was subjected to the traditional teaching-learning methods followed in the classrooms over the decades involving the delivery of lectures by the teacher whereas for the treatment group 2, along with the traditional method of teaching-learning the students were also exposed to the tangible augmented system developed which depicted the related contents in a 3-dimensional perspective. Further, the experiment was carried out in the similar way as quantified in the model proposed above. The smartphones were brought by the students (with installed android application). However, the google cardboard setup was made available in the lab whenever the contents were required to be studied.

C. Data Analysis

For both the groups a primary and a secondary test was conducted. Primary test was conducted before the beginning of the experimental session and quantified the students' knowledge on the respective topic before the commencement of the session. On the other hand, secondary test results gathered after the commencement of the experimental session quantified the knowledge gain among the students as compared to the primary session. The variation between the primary and the secondary test was calculated to give the performance gain. The experiment was continued for twenty-two days, having the primary and the secondary sessions each and had 11 sessions all together. Table 1 lists the average results of the performance-gain for each group for each session. The Average Performance-gain was calculated for each session for each group using the formula specified below:

Average Performance-gain (for each group) = (Performance-gain of student 1 + performance-gain of student 2 + Performance-gain of student 3 … + Performance-gain of student 12) /12

Table 1
Average performance-gain among the two groups

Session	*Average Performance-Gain*	
	Group 1	*Group 2*
1	5.67	5.0
2	6.15	5.75
3	5.95	5.05
4	5.25	5.0
5	4.75	6.0
6	6..02	6.05
7	6.75	7.05
8	5.85	6.05
9	6.70	8.25
10	6.25	7.0
11	5.05	6.25

The final stage of the experiment included feedback from the students of the treatment group 2 which modeled the following questions:

Table 2
Average response of the students to the questionaire

Question number	*Questions*	*Group 2 average response*
1	Did the experimental session turned out to be fascinating?	7.2
2	Was the augmented reality platform efficient enough to be used in classrooms?	6.4
3	Could the experimental setup of the augmented reality interface easily function?	6.8

The response of the students from the feedback was analyzed and found to be positive in respect to using the tangible augmented interface in the classes. Hence it was concluded that the tangible augmented-reality interface could act as a boon for the students which could make the educational learning to be interesting, interactive and more fascinating as compared to the traditional methods of education that are being followed in the schools.

D. Result Analysis

The performance-gain results of the control group 1 and the treatment group 2 were analyzed and it was observed that the control group students were ahead to the students of the treatment in the starting experimental sessions but as the sessions ensued, significant improvement in group 2 was observed.

Once the experimental duration was terminated it was concluded by analyzing the results that the overall performance of the group 2 turned out to better as compared to the group 1. The conclusion could be henceforth drawn that the performance of the group 2 was better as they were subjected to the tangible augmented reality environment instigated as per the model proposed and the students were found to be more attentive and focused during the learning process

The bar chart comparing the performance-gain between the control group 1 and the treatment group 2 is pictured below and it could be clearly seen in the first four sessions the performance of the group 1 students was comparatively better as compared to the group 2 but from the fifth session onwards group 2 students started performing better which drew the conclusion that incorporating the tangible augmented reality interface in the learning process made the students to understand the topics in a better way.

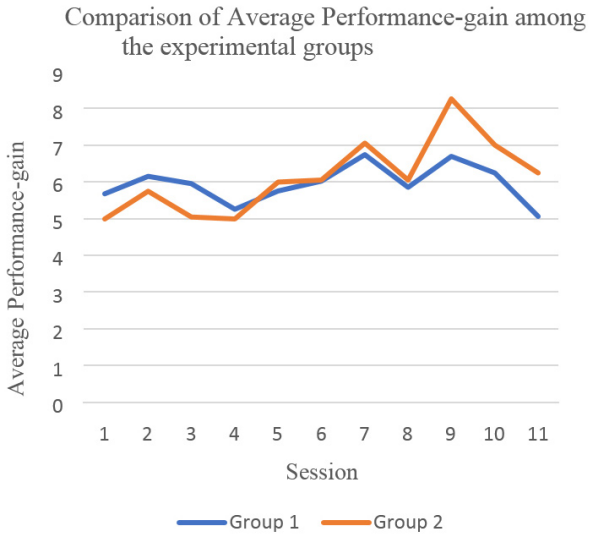

Figure 1: Comparison of performance gain among the two groups (traditional learning (group 1) vs learning with Tangible augmented reality (group 2)).

5. CONCLUSION

Studies on the application of the tangible augmented-reality interface into the education system were carried out which proved to be quite substantial. Further,

areas of augmented reality relating to the teaching-learning in the regular traditional classrooms were sightseen and it was perceived that a sturdy research is obligatory for further implementations of the tangible augmented interface into the education system. It was also observed that one of the most important reason of implementing augmented reality in the classrooms is that the tedious lessons could be made fascinating thereby refining the learning upshots of the students.

The proposed model would serve as a ground for effective enactment of the augmented interface in the learning process. The teacher initially has to however specify the course and the topic for which these interfaces could be casted. The type of the tangible augmented interface to be implemented is chosen as per the model proposed which could be blended with the traditional learning making the studious environment to be a playful one. Positive results were drawn from the experiments conducted to test the accuracy, efficiency and effectiveness of the model presented.

The projected work on the tangible augmented reality could serve as a salvation for future research for the augmented reality implementation in the teaching-learning process, online courses, distance education and many more with exclusive emphasis on providing education for the special abled people making them to be the part of the education system which they are usually deprived off.

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