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Development of Computer Assisted Automotive Technology Training Course through Augmented Reality

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Abstract

Modern science and technology require a high caliber of instruction. Producing new interactive educational systems based on the achievements of information technologies is a challenging subject. Application of augmented reality technology is one of the possible ways to improve the educational process. ESSU Guiuan uses the conventional method of teaching Automotive Technology. Under such learning conditions, students often had difficulty relating theory to practice, which led to poor knowledge retention and a lack of understanding. This paper proposes to design and develop a computer-assisted automotive technology training course using augmented reality. This paper introduces a marker-based mobile AR application for supporting the learning process of assembling and disassembling of vehicle transmission in the context of a vocational education program for car maintenance. Developmental Research will be used. The system guides a student step-by-step through an assembly/disassembly sequence. During the educational process, a student receives a chance to return to any previous instruction if necessary. This makes the educational process more interesting and engaging. End-users and experts also believe that the Computer Assisted Automotive Technology Training Course as usable and acceptable with a rating of 77% using the System Usability Scale (SUS). The application shall guide instructors in the delivery of the subject using AR as an advancement in teaching.

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I. INTRODUCTION

Computer-Assisted Instruction (CAI) offers an interactive presentation of materials through the use of graphics, text, video, and audio enhancements. CAI is often used as a tool to facilitate the training experience; it can enhance the user experience and increases engagement [1].

CAI covers the entire educational system by proving a useful tool in teaching various subjects [2]. Computer-assisted instruction is a new type of educational model that integrates with modern technology and pedagogy [3]. Traynor, as cited by [4], reported that many schools include CAI in their school-wide programs to provide students with opportunities to increase the quality of instruction.

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A combination of CAI and Augmented Reality (AR) would make the teaching and learn much more engaging and interesting. A review of the research conducted in several fields in education shows that AR technology has the potential to be further developed in education [4]. Many surveys have reported a positive impact on Augmented Reality (AR) applications in primary, secondary, and higher education training in terms of the student's motivation, learning gains, collaboration, interaction, learning attitudes, and enjoyment [5]. Yet, very little has been done on the benefits of AR applications in Vocational Education and Training (VET), as well as their impact on addressing a broad variety of student's special educational needs such as learning difficulties [6]. Eastern Samar State University (ESSU) Guiuan Campus formerly trade school is offering different vocational courses, one of which is the Bachelor of Science in Industrial Technology (BSIT) four-year degree program designed to equip students with the basic principles and procedures of shop training and technology repair works. Automotive Technology in ESSU Guiuan, are delivered through didactic teaching of theories, and workshop demonstrations, followed by hands-on practice. Under such learning conditions, students often have difficulty relating theory to practice, since theoretical knowledge was imparted without an authentic context. This led to poor knowledge retention and a lack of understanding of the principles behind how things work [6].

Moreover, it is essential to update TVET teachers' pedagogical skills and to introduce ICT tools for teaching and learning [6]. The Education 2030 Framework for Action, which outlines how to translate the global commitment into practice [7], recognizes the immense potential of ICT in achieving lifelong learning for all. It highlights the need for ICT to 'be harnessed to strengthen education systems' and to assist in increasing knowledge dissemination, expanding access to information, improving the quality and effectiveness of learning, and in providing more effective services' [8]. The Education 2030 vision was affirmed by the Qingdao Declaration [8], articulated at the International Conference on ICT and post-2015 education, which noted that ICT could improve access to education.

The concept of AR was coined in contexts of maintenance tasks when Caudell and Mizell, as cited by [9], proposed the head-mounted display for assisting maintenance in the aircraft industry. Since that moment, AR has been extensively used for assisting maintenance and repairing tasks in a wide variety of fields in the industry [9]. Besides that, many studies have reported experiences about using AR in educational processes at primary and secondary educational levels as well as at university. However, very little has been done in terms of AR in vocational education institutions as a support for the learning process [9]. Academic and Technical Vocational

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institutions are challenged to provide the best training methods and tools that could prepare their students to land the proper intended job in the industry [10].

ESSU Guiuan uses the conventional method of teaching Automotive Technology. Under such learning conditions, students often had difficulty relating theory to practice, which led to poor knowledge retention and a lack of understanding.

The end work is a Computer-Assisted Automotive Technology Training Course through Augmented Reality that would satisfy and engage students in learning.

II. Methodology

For this study, the researcher adopted the Feature Driven Development (FDD). FDD is a development process that, as all agile methodologies, is iterative and incremental to deliver working software. FDD mixes best practices that are all driven by what is important to the client [11]. It develops frequent tangible results and provides progress and status information about the project.

FDD Life Cycle: FDD process consists of five sequential processes that are performed iteratively to build software in increments, as shown in Fig. 1. These processes are Develop an overall model, Build a Features list, Plan by Feature, Design by Feature, and Build by feature [11], [12].

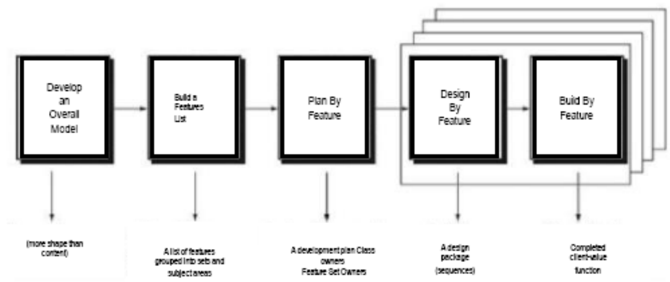

Fig. 1. FDD life cycle

A. Develop an Overall Model

This phase begins by developing an overall model for the project, and it is known as domain object modeling.

The researcher used the Use-case diagram to present the user interaction and relationship between the user and the different use cases. Also, the activity diagram shows the flow from one activity to another activity.

B. Build a Features List

This phase is formed to create the feature list. Once the classes had been identified in the classes' domain object model, design and implementation can now be done. There is a need to understand better the basic scope of the project to develop the feature list.

The researcher documented all the diagrams, the class diagram, and use case diagram, features list, and reports. These documents serve as the basis in identifying the design issues and necessary features that were incorporated into the computer-assisted automotive technology training course through AR.

This project has a very simple feature the video has a written instruction that follows a step by step process with corresponding tools needed to assemble and

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disassemble the engine transmission manually, that would guide the students in the learning process. The student can play the video and rewind the video and learn at their own pace while following the instruction in using the proper tools and assembling and disassembling of the manual transmission.

C. Plan By Feature

In the third phase, it's more or less about planning in which order the features will be implemented, and it's about organizing. While planning, the researcher takes into consideration different aspects, such as risks and difficulty dependencies.

The researcher used a Gantt chart to assign the due dates for the activities and to track the next activities that are needed to be done.

D. Design By Feature

This refers to the construction phase. The construction phase is iterative for feature sets; activities will be performed for each feature. Activities are designed by feature set, where features that are going to be implemented are selected, and sequence diagrams for the features are suitably designed.

The researcher created the design of the proposed computer-assisted automotive technology training course through AR. The researcher made a prototype that shows the graphical user-interface of the system.

E. Build By Feature

This phase is the development of the system. Different educational content was prepared that would be adapted to different learning styles, such as video, audio, and animation. Features are carefully designed and build.

The application was developed using Blippbuilder and Blippar (SDK). Blippbuilder is the one used to create the application, and the Blippar SDK is used to link the augmented reality camera and the image and the image tracker. The start is create and log-in to your Blippbuilder account. Once log-in click on the app project. You will be creating an AR project that works within a mobile app. For this project it started from scratch. Followed by creating the Blipp and uploading a marker image. A marker format should be JPEG, RGB, and between 300-800 pixels in width and in height. The marker image used was a manual transmission. Then giving the Blipp a name and click continue. Followed by creating an overlay a 3D images of assembling and disassembling. A touch action should be embedded in the overlays for it to execute video. Then click preview, test code will be generated, this code will be use to unlock the blipp in your mobile apps. Click continue, then click to publish to test. Download and install blippar in the mobile phone. Open blippar in the phone, click settings, click enter test codes generated by Blippbuilder, then start scanning the marker image. Top the overlays to execute the video.

III. Results And Discussions

This presents the results and findings for designing and developing a computer-assisted automotive training course using augmented reality. As a result, the system guides a student step-by-step through an

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assembly/disassembly process of a manual transmission.

A Use case diagram was created for the respective role of Teacher and Student in using the AR technology, as shown in Fig. 2. The teacher is responsible for creating/editing the course materials that will be uploaded to the studio, create the AR technology, publish, provide the code to the student, as

well as save and test. The student shall be the one to download and installed the Blippar app in their mobile phone, enter the code generated by the program, and interact with the AR technology. Internet connection is necessary for this application to work.

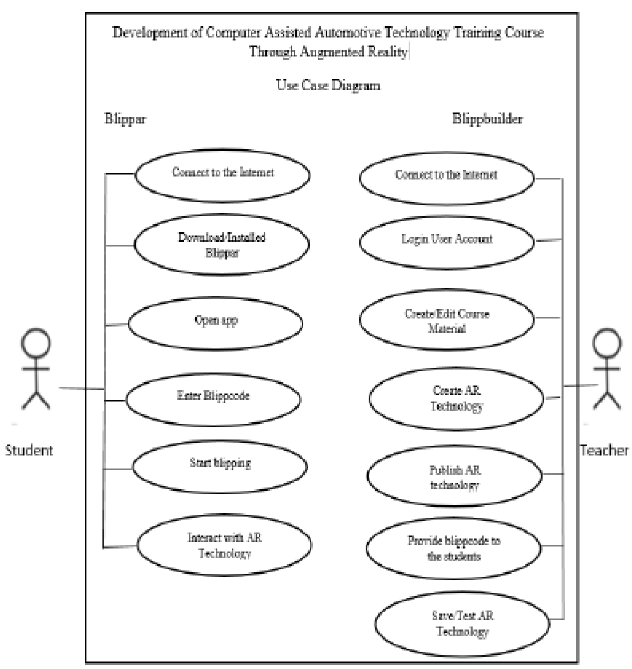

Fig. 2. Use Case Diagram of the AR Technology

The following figures show the activity flow of how the user navigates with the AR technology. Figure 3 shows how the teacher login using the username and password to access the Blippbuilder studio. Every registered user should be provided with a username and password for authentication purposes, and this will also serve as a security measure to the project created.

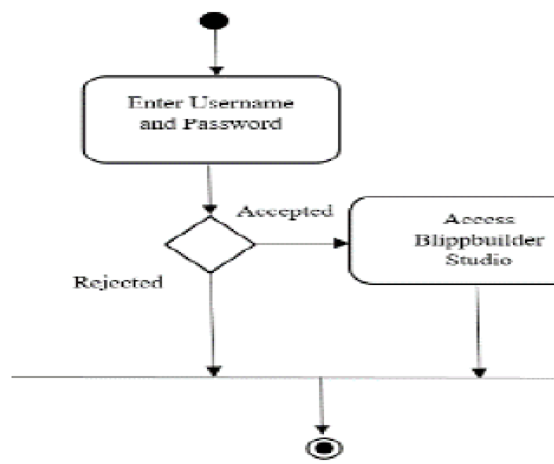

Fig. 3. Activity Diagram of User Log-in

Fig. 4. is the specific activity of the teacher. The teacher is responsible for searching, preparing, creating, editing, deleting, and uploading the course content into the AR tools. Create AR technology by preparing all the materials needed to create the AR. The idea is to develop AR technology using Blippar. Blippar could add the power of augmented reality into your mobile app. The Augmented Reality Software Development Kit (AR SDK) lets you leverage any AR content within your existing app. You can easily create these augmented reality experiences using the AR creating tools – Blippbuilder and Blippbuilder Script.

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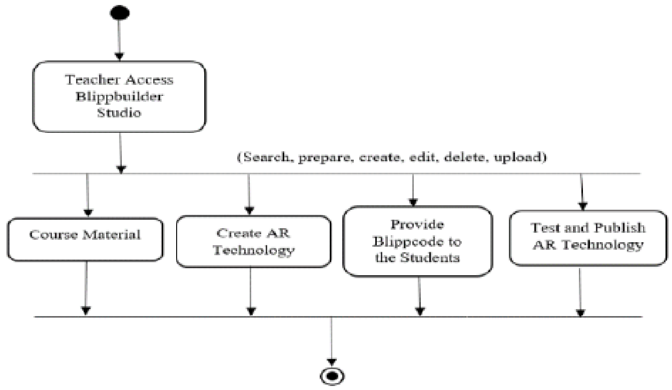

Fig. 4. Activity Diagram of the Teacher

Fig. 5 shows the activity of the student using the Blippar. To start blipping, the student should acquire the blippcode from the teacher, go to the setting menu, and select enter code and enter the blippcode. Next is to tap the mobile screen to start blipping and focus the mobile phone camera to the marker to start scanning. Once the augmented reality overlay is already visible on the screen, you can now remove your camera away from the marker. One thing good about this Blippar is you do not need to keep on focusing it on the marker to see the content of the AR technology. You can interact with the AR content by tapping on the thumbnail on your screen.

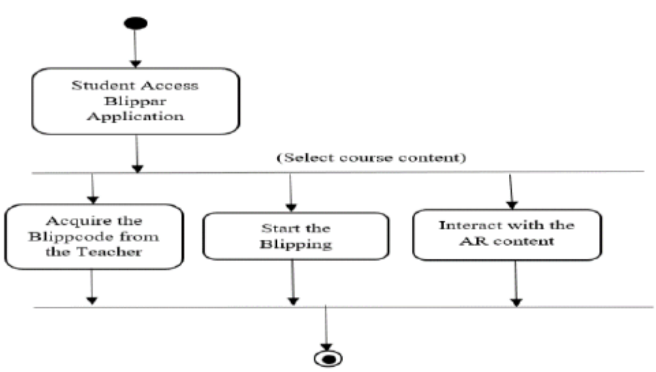

Fig. 5. Activity Diagram of the Student

Blippar is one of the most commonly used AR browsers. The main part of Blippar is a subsystem of pattern recognition, through which students were looking for markers. Markers can be images or real objects. After recognizing the marker, the program adds virtual objects (blipps) to the real image, which can be images, 3D models, animations, interactive dynamic scenes, links, etc. [13].

Using Blippbuilder for educational purposes is free. Teachers have access to all functionalities without limitations. For the student to access the learning blipps, there is a need to enter the code generated by the program. Using this approach, students only need to enter the code once on their device.

Fig. 6 shows the architecture of the system model. The application was developed using Blippbuilder and Blippar (SDK). Blippbuilder is used to make the application, and the Blippar SDK is used to link the augmented reality camera and the image and the image tracker. The tracker is used to detect

the picture which is stored in the database. Assets and scripts were working along with entree to the object database. Open the application using a mobile phone, scan the image. The scanned image is sent to the picture, capturing a model for identification. If the image is detected, it is transported to the processing model. The processing model then finds the marker post and carry it to the tracker model; it then identifies the marker and sent it to the rendering model. Rendering model using picture detection will mark a

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virtual object to the marker, and hence, the augmented video with written instruction will be exhibited.

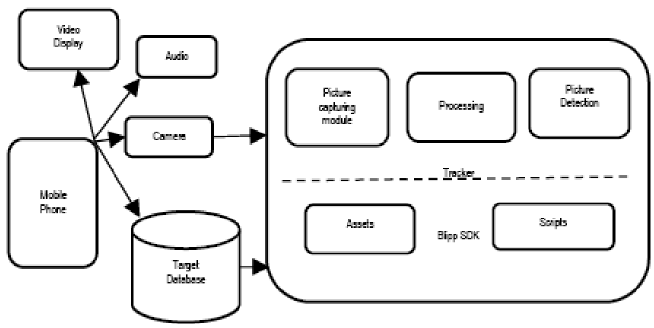

Fig. 6. The architecture of the system model

Figure 7 shows the marker image of the Automotive Technology Training Course. In this project, the marker image is a manual transmission.

Fig. 7. The Marker Image

Figure 8 shows the overlays. In this project, there are two overlays the disassembly and the assembly of the manual transmission.

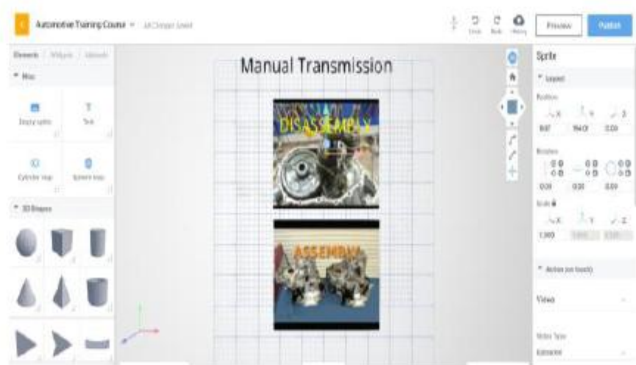

Fig. 8. The Overlays

After implementing the overlays in Blippbuilder, an action was created to activate the video for the automotive training course. Figure 9 shows the marker image is scanned using a mobile phone.

Fig. 9. Scanning the marker image

After scanning the marker image, the 3D image will be shown on the screen. There are two 3D images, which are the overlays representing the disassembly and assembly of the manual transmission. Figure 10 shows the blipp as the graphical user interface of the system of the automotive training course. To show the content of the Blipp there is a need to touch the images to play the video of disassembly and the assembly video of the manual transmission.

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Fig. 10. The Blipp

The following figure 11 shows the prototype output of the automotive training course being executed using the Blippar. A video with written instructions that would surely guide the students.

Fig. 11. Prototype output of the automotive training course

The following figure 13. show a student using the AR application following the written instruction and imitating what is being executed on the video.

Fig. 12. Student trying out the application

Evaluation

The researcher conducted a System Usability Scale survey on a purposive sampling of (11) students and one instructor. To rate the students' and instructors' responses, a five-scale Likert scale (Strongly Agree {5}, Strongly Disagree {1}) was used. Based on the result, it has an average of 77.14, which was converted into a percentile rank of 77%, and with a grade of B, AR technology is assumed to be usable and acceptable as shown in Figure 13.

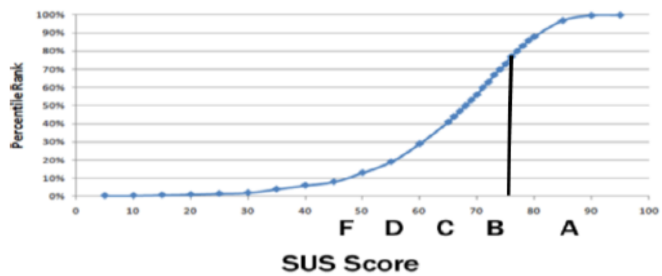

Fig. 13. The SUS score result

IV. CONCLUSION

The identified problem of Automotive Technology at ESSU Guiuan is the use of the old method of teaching that makes students difficult to relate theory to practice, which leads to poor knowledge and lack of understanding. Because of this reason, the researcher developed a computer-assisted automotive technology training course that will improve the quality and effectiveness of learning. During the educational process, a student receives a chance to return to any previous instruction if it is necessary. This makes the educational process more interesting and engaging. End-users and experts also believe that the Computer Assisted Automotive Technology Training Course is

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usable and acceptable, with a rating of 77% using the System Usability Scale (SUS). Automotive technology training course utilization is vital to improve AR-based training delivery in academic and technical vocational institutions. The application shall guide instructors in the delivery of the subject using AR as an advancement in teaching.

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