Understanding Electronic Circuits through Augmented Reality

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Abstract - *It undeniable that today's technological developments can enhance the productivity and quality of many fields, including education. The integration of technology in education helps to convey knowledge more effectively. Augmented Reality (AR) is a technology with the concept of incorporating real-world and virtual dimensions that has the potential to improve pedagogical quality both inside and outside the classroom. Collaborative and student-centered learning strategies can be considered using AR modules. This study focuses on the teaching approach in the field of TVET that requires the skill of visualizing three-dimensional objects in a concept to reinforce a particular understanding of basic circuit learning. This application module (AR Electronic Circuit) is designed for students as a stepping stone and a tool to understand a field more thoroughly and in depth. The use of blank breadboards and step-by-step instructions helps student put the component in place. This really creates a more interactive, creative, safe learning environment and saves time and cost. The development of this application uses Blender, Unity 3D, Vuforia software and is aided by Java and C# programming.*

Key Words: Augmented Reality, Electronic Circuits, Blender, Unity 3D, Vuforia, C# Programming

1.INTRODUCTION

Recent developments in technology and communication have brought about changes in the fields of education and intellect. Teaching methods that only involve oral learning are becoming less effective and also less popular because students consider this an old and boring way of learning.

Students who only learn by listening and reading have more difficulty remembering what they have learned and are unable to solve problems related to the learning. This is because the younger generation is now not known for bookworms who are diligent in reading and gaining more knowledge but known as 'digital natives' are born with simple technology and exposed to technology in their daily lives. Therefore, the use of technology is seen as a necessity to improve the quality of student learning in the 21st century.

The use of technology as a medium of instruction can also help shift the pattern of education that was previously teacher -centered to student -centered learning. Students play an active role while the teacher as a facilitator with the help of learning media. Students will tend to learn cooperatively, that is, help each other, share ideas, interact, communicate and collaborate in understanding what is learned. It also increases students 'motivation and provides reinforcement of understanding through the learning experiences they go through. Therefore, the use of technology such as augmented reality (AR) can be a medium in promoting student -centered learning. In addition to being a facilitator in the classroom, teachers also have the responsibility of providing appropriate equipment before starting the class. For classes involving basic electronics courses in particular. Sometimes teachers face problems for example, not enough components, missing components, bulbs that do not light, expired batteries, faulty components and short circuits. This will be a waste of time and the continuous purchase process of replacement components will increase the cost of teaching and learning management.

Therefore, augmented reality (AR) technology is seen to be used in the teaching and learning of AR by using breadboards to help students learn to assemble circuits more easily and solve problems. Augmented Reality or simply AR is a technology that combines a virtual object or environment as generated by a computer on top of a real object or environment. It does not replace the real environment but adds a virtual object on top of the real environment.

2. PROBLEM STATEMENT

In the 21st century there are too many things that can be obtained with just the use of fingers but students in institutions of higher learning are less in-depth about the facilities available today. This causes the students to not understand how to install the circuit properly so that the work given cannot be completed perfectly, the students also do not know the name and appearance of the components causing the students to consider installing the circuit a difficult thing. Several ways have also been done by the lecturers to help students to understand something but to no avail. Therefore, students can use gadgets and even facilities available in the 21st century creatively, because that is the emergence of AUGMENTED REALITY (AR) which helps people a lot in daily life. The students had trouble reading the color on the resistor resulting in errors in calculating the value of the resistor. Also, another component that is difficult to understand is the IC, this is because this component has many legs and students find it difficult to recognize the legs of this component.

3. OBJECTIVE

AUGMENTED REALITY (ELECTRONIC CURCUIT) can help students who do not understand how to install the circuit properly and make it easier for students to understand

something easily. This AR can also facilitate the work of students in terms of cost and time because this AR is able to save the cost of students to buy components in the event of damage. In terms of time, AR saves students time from busy looking for components and other things. Therefore, AUGMENTED REALITY (ELECTRONIC CURCUIT) is able to create a way of learning that is easier and understood for students.

4. SCOPE OF PROJECT

is known among us as "hashtag" but in the field of Augmented Reality this is a language known as C# (C sharp). This is a language used in the field of AR. This language is used in Visual Studio to program the animations found in Unity 3D to do something you want, such as inserting a song. Before it can work it needs to be programmed to make it work. C# is one of the programming languages designed for a computer or application to read and produce the desired results. Applications that use this language are Visual Studio.

The target image is uploaded to Vuforia to be used as a database to be uploaded to Unity 3D to see the dots used to detect an object and this object is rated by star, the higher the star the easier it is for the camera to detect. These electronic components are downloaded via Grabcad software.

The blender application is used to draw 3D animations to be used in unity to make the project a success.

5. LITERATURE REVIEW

In general, there are two types of AR, namely marker-based AR and markerless AR with markers requiring a marker that has been formatted to embody a virtual object on the marker. While AR without markers tracks position and location data using GPS system then displays virtual objects. This study focuses on the use of marker -based AR because its use is more suitable for electronic circuit learning applications. There are several studies in marker -based AR that are used as references to help develop this study.

AR can help improve students' understanding by giving a true picture of an object. For example, in a study in India involving the subject of Engineering Design where students feel more comfortable if they can see 3 -dimensional objects even virtually than just hearing and imagining the object. The study also showed students were able to interact and research virtual objects to understand the design drawings they built to adapt to the actual landscape environment.

Researchers have used .Net Framework 4.0 software, Visual studio 2010 and developed 3D models for some object input taken using a camera. According to a study from a university in Spain, AR can make reference materials more interesting, increase student motivation and students can learn independently with more interactive information especially in the field of engineering education. This study has adapted AR in a textbook (Augmented book). This L-ELIRA (Learning industrial elements) book can provide an overview of 3-dimensional objects along with information on industrial products if viewed using AR applications. This study has used BuildAR software to create a 3 -dimensional virtual element that can be moved at the X, Y and Z coordinates on the recorded markers.

AR can also be used to aid teaching in practical sessions. This study in Russia shows how the guidelines for the use of laboratory equipment can be summarized using AR. Students only need to scan the object on the panel in the workshop and follow the step by step equipment connection guidelines shown by the virtual object above. This study used Unity and Vuforia software in building AR applications.

Studies on human organ learning in medical education in Indonesia also used Unity and Vuforia software to build AR applications. It uses human statues as markers to AR. This study focuses on the internal systems of the digestive organs and the response processes of those digestive organs. Students are able to understand processes that cannot be seen with the naked eye easily when there is a virtual response aid demonstrated by the AR software. Based on the studies conducted, the project conducted in this study is to use paper sections as target images to replace real electronic components such as capacitors, resistors, transformers and cables. This piece of paper will look like the actual components inside the android app provided to the user. Users can see the connection steps of a complete circuit and understand easily and can also try to install the circuit themselves without having to worry about component damage factors and short circuits.

Based on past studies, the project chose Vuforia and Unity 3D software because it is among the software that is often the choice for building AR as it is suitable for use for iOS and Android devices. Vuforia Software Development Kit (SDK) is a software for developing AR applications initiated by Qualcomm. It operates on recognizing the target image and displaying objects in 2D, 3D, video as well as text stored in a database. There are 2 types of databases used by Vuforia, namely device database and cloud database. The database device is suitable to be used if the developed application uses only a few image targets. But for applications that involve long programs, cloud databases are more suitable to use because of the large memory and processor capacity.

It typically uses the Unity plugin to combine images and coding to simulate an AR. Based on the findings shared from previous studies, it is found that the use of AR is very helpful in terms of teaching and learning. Therefore, this project is expected to meet the existing research gap and can provide added value in improving the quality of student learning, especially in the field of electronic engineering.

6. METHODOLOGY

This project uses AR Electronic Circuit, i.e. a breadboard as a marked image to be detected by the application. The project uses 1 marker detection and can also combine interactions if more than 1 marker is used. For that the process involved is to generate markers using pixelLab

software that has node points that have high contrast readings for object detection on the Vuforia platform, then the objects and animations that will appear for each marker are built using Blender 3D software. Vuforia software, Unity 3D and Visual Studio are needed as platforms for interaction, data storage and incorporating the C# programming language for animation.

6.1 Unity 2019

Unity is a cross-platform game creation system developed by Unity Technologies, along with a game engine and integrated development environment (IDE). It is used to develop games for websites, desktop platforms, consoles, and mobile devices. It was first announced only for Mac OS, at Apple's World Developer Conference in 2005, it was extended to target more than fifteen platforms. [2] [3] It is now the default software development kit (SDK) for the Nintendo Wii U. This app was done in this project to help my project to create and move target images.

6.2 Vuforia

Vuforia is a web used to upload images to be the target image and to evaluate the image, it is evaluated through stars, the higher the star the easier the image is to be detected and more suitable to be the target image in a project.

6.3 Blender

This Blender application is used in this project to draw 3D objects that will be used in unity so that the picture will show it more clearly. This application can draw anything you want and can be used for all kinds of related projects.

6.4 Visual Studio

Visual Studio is an application used to create coding to be uploaded into Unity so that a program can move anywhere or pound rotate and so on. Anything you want to do whether it is removing objects, moving objects and much more can be done in this application by using coding. This application uses its own language which is C ++.

7. RESULTS FINDING

This process shows the output of the project after pressing the path button. Each component will move and be arranged according to the type of circuit type and form a complete circuit. If you press the repeat button, each component will be disassembled and re -arranged in its place.

In addition, each circuit also has a little description regarding the circuit. The description of each circuit can be seen in the description to identify information about a circuit.

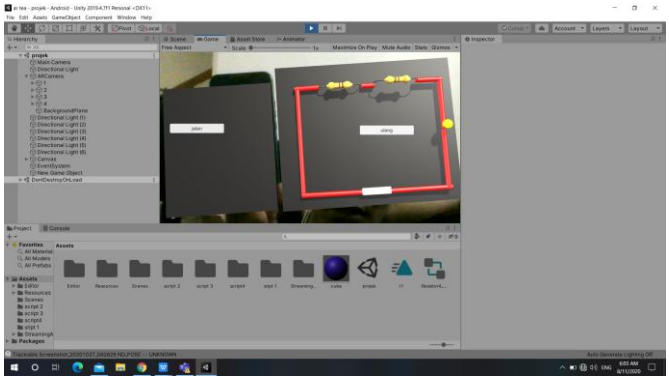

Fig -1: Series Circuit

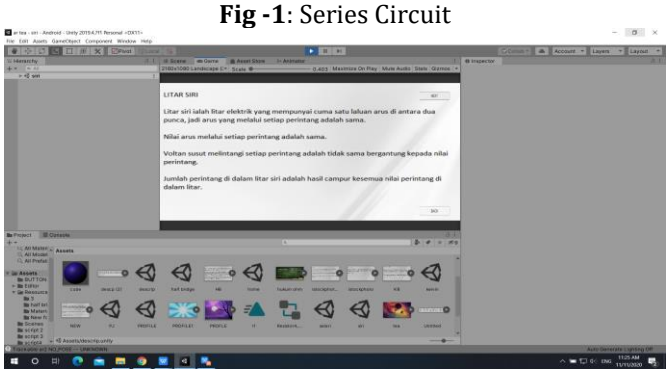

Fig -2: Series Circuit Description

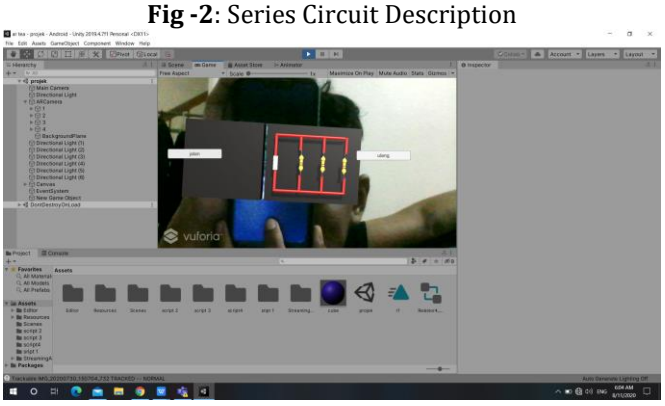

Fig -3: Parallel Circuit

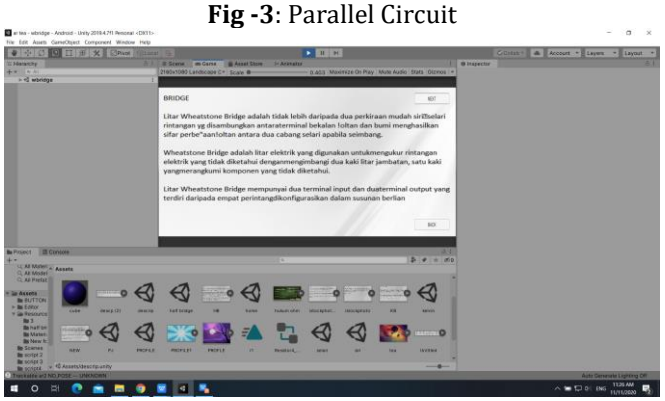

Fig -4: Parallel Circuit Description

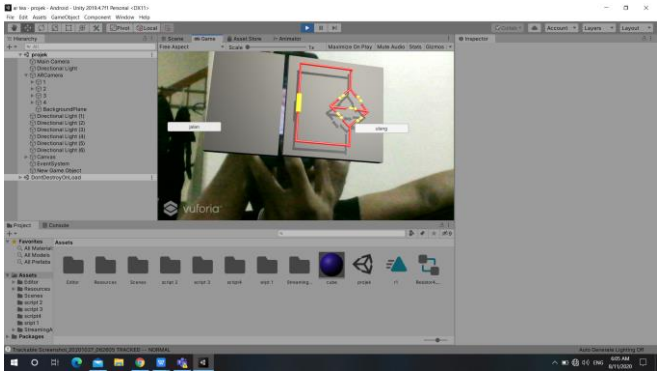

Fig -5: Wheatstone Bridge Circuit

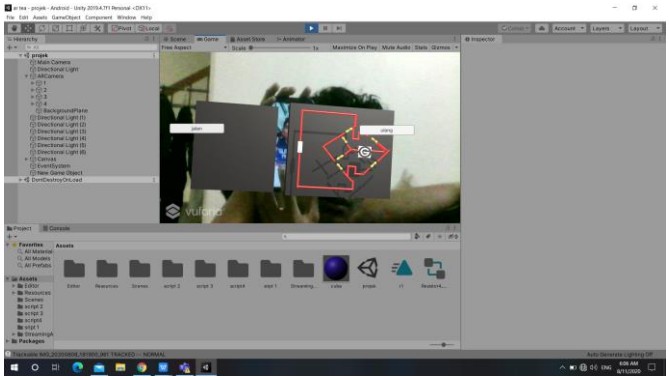

Fig -9: Kelvin Double Bridge Circuit

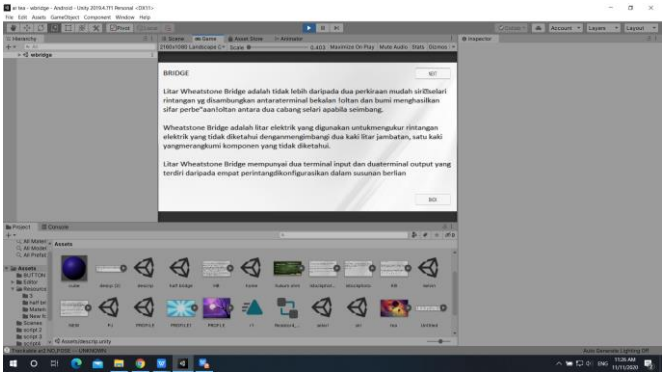

Fig -6: Wheatstone Bridge Description

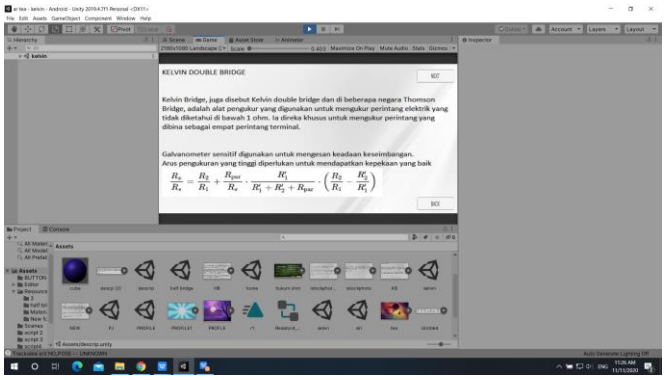

Fig -10: Kelvin Double Bridge Description

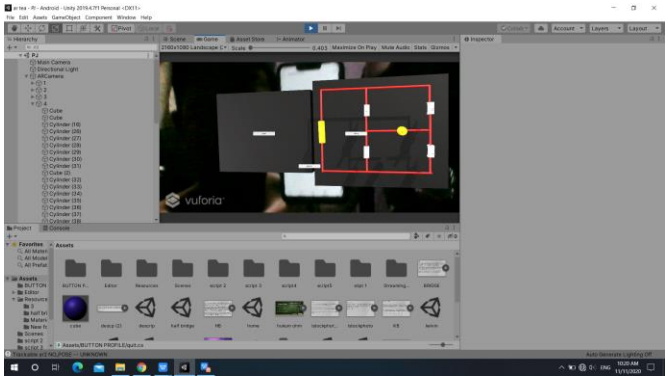

Fig -7: Half-Wave Circuit

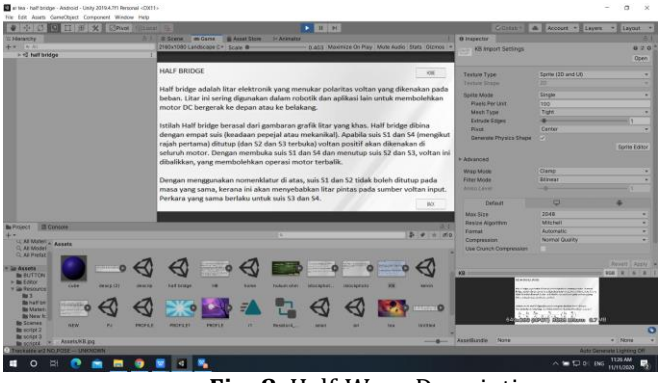

Fig -8: Half-Wave Description

8. CONCLUSIONS

Learning in the 21st century is always in need of innovation to suit the state of students who are immersed in technology and smartphones. The AR ELECTRONIC CURCUIT app can replace learning that requires real components that are always faulty and not environmentally friendly. Students can use this application independently to understand the basics of electronic circuit assembly and become proficient in the components used in circuit connection. Apart from that, it can save the preparation time for teachers to teach because there is a teaching kit that is easier and can be used at any time. The app also offers a more interactive way of learning. A study conducted on 20 students has shown that students are motivated to learn on their own and learn more about circuit connection with the help of this application. They no longer have to imagine how the circuit needs to be fitted and entrusted to the legs of the components that need to be connected because this app gives a clear picture of the function of a component and step by step is shown in the circuit. Anyone with an Android smartphone can run lab tests virtually and cheaper. This research paper concludes that this AR ELECTRONIC CURCUIT project can be used to improve the quality of teaching and learning of teachers and students.

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