Mobile Augmented Reality in Education : Recognition of Electronic Component

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ABSTRACT

Keywords
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The introduction of components in the control system practicum utilizes Augmented Reality using cellular so that students know the types of PLC components that are displayed on cellular screens (smartphones). In this case a combination of real world objects such as PLC (Programable Logic Control) components and virtual objects in the form of text, animation, 3D models or computer-generated videos that will be displayed on smartphone screens so that students feel virtual objects in the practicum room. The test results from the detection of the electronic component objects tested included testing the distance, light intensity and covering some objects, the results of the analysis were almost entirely successful in detecting the object. Except in the dark light detection condition, the intensity cannot be determined. This is because, in a marker-based tracking method, identifying the marker pattern is the most important point. In dark conditions, the pattern obtained will be less than optimal so that in the matching process there will be marker errors, or even objects not identified as in the current experiment.

1. Introduction

Digital technology has become a part of human life, digital technology is expected to serve human needs better. Digital technology has made many breakthroughs in various fields, one of which is in the field of Education[1][2]. One example of the development of digital technology in the field of education, namely the digital class, is a real manifestation of the current trend. Digital technology in the classroom is very useful in conveying education to a wider scope, expanding the scope of interaction between teachers and students. With digital technology, students are expected to be able to be more responsive in class, thereby turning the class into a more interactive class[3][4].

The transformation of learning accompanied by technology certainly provides an interesting opportunity to design a learning environment that is realistic, authentic, interesting and very enjoyable. In addition, researchers also found that technology always holds promise for increasing student engagement in understanding learning concepts which leads to better academic outcomes. As mentioned[5][6]. Augmented Reality (AR) is one of the new technologies that may have potential and impact on learning and education. Augmented Reality is a combination of real world objects and virtual objects in the form of text, animation, 3D models or videos that are made by a computer and can be combined with the actual environment so that users feel virtual objects in their environment. Augmented Reality also provides a new touch and experience in its use and is a complement to the real world display, AR technology also has the advantage of being effective and easy to use and relatively inexpensive to develop[7][8]. In addition, the widespread ownership of mobile devices has led to increased interest in integrating the benefits of mobile learning and AR applications[9].

Learning methods using digital technology are currently showing a significant increase, as the use of mobile phones or smartphones among students and teachers as learning media has become a necessity in the teaching and learning process [9][10]. Practicum learning in lectures is learning that is carried out by students when conducting experiments based on the theories they have learned so that students get real experience, the practicum learning process is usually carried out in the laboratory[11]. The practicum learning process requires solutions to encourage students to have learning motivation and interest in technology. One example of practicum learning carried out by students at the beginning of the learning meeting is the introduction of components in learning control systems or electrical devices. The introduction of components is very important in the early stages of the practicum, students must understand the name of each component, the specifications and how these components work. PLC (Programmable Logic Control) is one of the control system devices or components used by students in practical learning, in this lecture students must be able to know the types of each PLC component[12][13].

The introduction of components in the control system practicum utilizes Augmented Reality using cellular so that students know the types of PLC components that are displayed on cellular screens (smartphones). In this case it is a combination of real world objects such as PLC (Programable Logic Control) components and virtual objects in the form of text, animation, 3D models or videos made by computers which will be displayed on smartphone screens so that students feel virtual objects in the practicum room[14]. This study refers to practical learning to introduce PLC (Programmable Logic Control) control system components using Augmented Reality technology, namely displaying text, animation, or 3D models.

2.   The Proposed Method

2.1. Flow Chart of Research Methods

This research refers to research using the Tracking Based Marker Augmented Reality method starting from the early stages of research, namely the potential and problems that occur where the development of technology-based education that is currently happening must switch to the digital era, studies and research related to Augmented Reality-based learning are carried out. facilitating and attracting the attention of students or students in conducting practicum and learning processes in class digitally. In this case the study of literature or previous research becomes a reference where research can be carried out related to detection by having different objects and testing processes.

Research related to Augmented Reality as a learning medium that has been carried out is displaying text, animation, or 3D models using Android as in research where applications use smartphone cameras as input to track and read markers (markers) that have been made on stationery media using tracking system, after the marker is read or tracked later traditional musical instruments in 3D form will appear and virtual buttons will appear so that users can recognize these traditional musical instruments based on their 3D shape[15].

This research develops an Augmented Reality application as an introduction to Electronic Components by using several tools such as: MDLC, Unity, ARToolkit, and Blender to better recognize students about Electronic Components. The application of Augmented Reality in this study uses the Marker Based and Monitor Based System methods and uses a smartphone camera as input to track and read markers (markers). This research aims to create an application modeling the physical transformation process of an object through 3D shapes and animation. The augmented reality method used is the Tracking Marker Based Augmented Reality Physics Learning Transformation Model which can be used to model various types of physical transformation of an object into 3D and animation.

Creating Visual Augmented Reality (AR) elements for Programmable Logic Controller (PLC) components using Vuforia software involves a series of steps. First, 3D modeling of the PLC components is carried out using modeling tools such as Blender or AutoCAD. Next, the 3D model is imported into the Vuforia development environment. In Vuforia, marker creation is done by determining an encodeable pattern that will later be recognized by the device's camera. The marker is then connected to the 3D PLC model, placing it in space. After that, using scripts and functions in Vuforia, interactivity between the 3D model and the physical world is implemented. When highlighting a marker with a device the user can see Visual AR elements appear over the

corresponding physical component. This creates an immersive and informative user experience, enabling better monitoring and understanding of the PLC system.
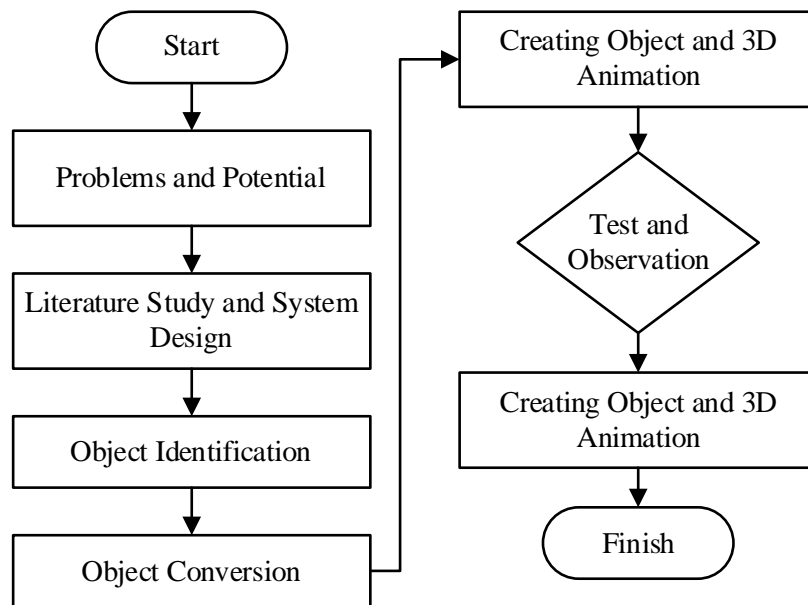

Fig 1. Flowchart of Research Methods

Fig 2. Making Markers Connected to 3D PLC Models

In practice, implementation will be in accordance with the system design stage. The hardware involved in the simulation includes a PLC (Programmable Logic Controller) with Type CMP 1A and PCM 2A. This PLC functions as a digital electronic device that utilizes programmable memory to store processes and carry out special functions such as programming logic, sequences, timers, counters, and arithmetic operations to control electronic machines and technical processes. Meanwhile, the software used to introduce augmented reality-based electronic components will use a 3D unified platform with the C# programming language and the Vuforia Database. Vuforia is an object scanning software that will support the creation of augmented reality experiences that combine the physical and virtual worlds.

3.   Method

After conducting a literature study, information search is carried out from the literature obtained, the initial process is to collect data in the form of information from the components of the control system learning practicum or electrical devices that will be used as objects of the research carried out, the object data obtained is then carried out system design. After the object has been determined, the next step is to use the camera assistance with the Marker Based Tracking method, which is to use markers. The Marker Based Tracking method will distinguish between existing markers and objects that are outside the marker, namely objects in the other real world. In markers position and orientation are highly considered, multiple positions and orientations will also result in multiple markers. The implementation of these markers is very visible when capturing marker data on 3D objects. The marker will be divided into a black border and a white background as an illustration during the implementation stage. Next, this illustration is imported into the Vuforia

SDK. Vuforia will give points how well an object enters vuforia. Assessment is done using ratings, the score of the image to be targeted ranges from 0 to 5. The more stars.

Fig 3. Marker Data Retrieval Process

In this study, researchers used hardware component objects, namely PLC devices/components, with a file capacity of 7.7 MB and 165 points. From all parts of the surface of the object, marker data is collected. After retrieving data for all markers, the data will be stored in the vuforia database. The vuforia database will be imported into the application for object recognition, once an object has been recognized, a 3D object and text will be displayed in response to the detected object.

The marker used is a marker from the practical learning component in the form of a PLC device, using the Marker Based Tracking method the camera will search for markers. The marker obtained will be converted into a binary number, the camera finds the 3D marker method and calculates it with the real world. The next step is to test the compatibility of the markers found by the camera with the marker patterns stored in Vuforia. The final step is to create a 3D object and text over the detected marker as the detected output.

4. Results and Discussion

The above test is useful to determine the suitability of the proposed functions. Black box testing is done by testing every activity that occurs in the application. From the results of the black box test it can be seen in Table 1 below that all the factors used in this study where the distance will be divided into three, namely from a distance of ± 10 cm, ± 20 cm ± 25 cm from the camera, then the angle will be divided into 7°, 70° and 80°, and covers part of the object by recognizing the object well, while in terms of light intensity it is determined by the darkness and brightness of the room around the object. Detection by closing some objects with closures of 30%, 40% and 50% will be set on the cellphone screen to display text written on the name of the component that has been detected.

Fig 4. Image of Component Detection Testing Using Two Mobile Phones

The hardware component recognition application is carried out by taking into account several factors, including light intensity will be divided into three parts: light, rather dark, and dark. Furthermore, the testing phase is carried out using the black box method.
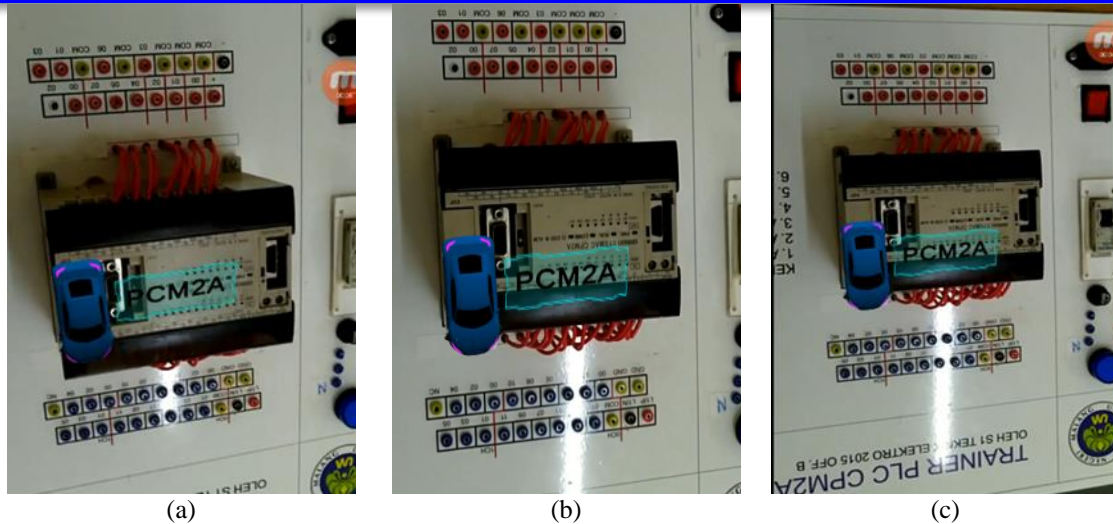
| (a) | (b) | (c) |

Fig 5. Testing Distance a) 10 ±, b) 20 ±, c) 25 ±
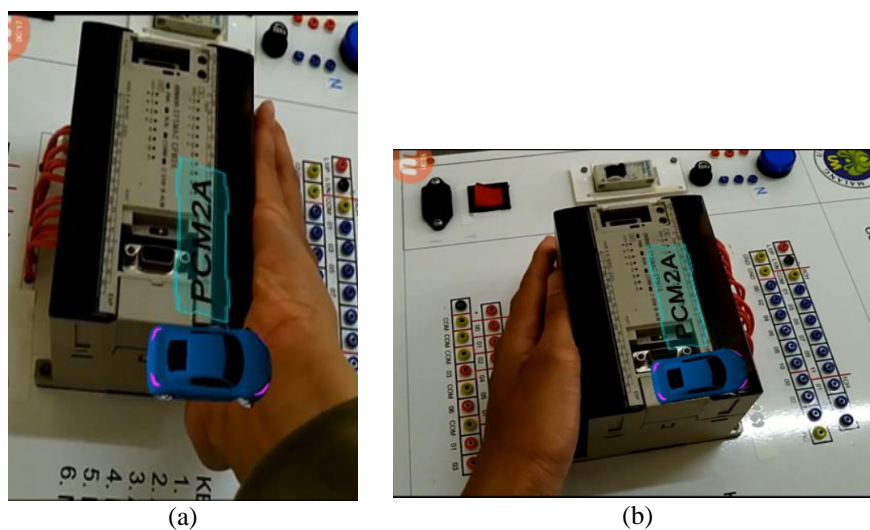

| (a) | (b) |

Fig 6. a) Close Right b) Close Left

If the test results show that all Augmented Reality (AR) elements are detected except light, there may be some issue related to the light sensor on the device. First of all, check whether the hardware used supports light sensors or not. If so, make sure that the sensor is working properly and is properly connected to the system. Additionally, pay attention to whether there are certain configurations or parameters that need to be set to detect light. If all equipment is set up correctly and light is still not detected, it is possible that there is a problem with the software used for AR testing. Ensure that the software has sufficient access to access the light sensor and that there are no conflicts or errors at the software level. Finally, ensure that the test environment has sufficient light conditions for the sensor to detect. If the environment is too dark, the light sensor may not be able to provide an adequate response. Evaluating these factors can help identify and solve problems that may occur in AR testing.

Table 1. AR Overall Parameter Testing

No.	Parameter	Information	Factor
1	Light intensity	160 Lux	detected
2	Light intensity	110 Lux	detected
3	Light intensity	10 Luxs	Not detected
4	Distance	± 10 cm	detected
5	Distance	± 20cm	detected
6	Distance	± 25cm	detected

No.	Parameter	Information	Factor
7	Corner	7 °	detected
8	Corner	70°	detected
9	Corner	80°	detected
10	Close Some Objects	Right	detected
11	Close Some Objects	Left	detected

From data the table above is the result of testing the detection of electronic component objects that were tested including distance testing, light intensity and partial closure of objects. The results of the analysis were almost entirely successful in detecting objects. Except in the dark light detection condition, the intensity cannot be determined. This is because, in marker-based tracking methods, identifying marker patterns is the most important point. In dark conditions, the pattern obtained will be less than optimal so that in the matching process there will be marker errors, or even objects not identified as in the current experiment. Analysis of light intensity parameters shows that the system can detect two of the three intensity levels, except for the low intensity condition (10 Lux) which is not detected. In the distance test, the system successfully detected all three distance levels tested, demonstrating the ability to detect objects at various distances. The angle test shows that the system can recognize objects at the three angles tested, including the extreme angle (80°). Testing the presence of nearby objects shows that the system is responsive to objects on the right and left. Overall, the system shows good capabilities in detecting various parameters in the surrounding environment. Recommendations include optimization for low light intensity conditions and further evaluation to understand system performance in specific situations.

5.   Conclusion

Digital learning technology is currently showing a significant increase, as the use of cellular or smartphones among students and teachers as learning media has become a necessity in the teaching and learning process. In this study, augmented reality detection was developed for electronic component equipment by applying a marker-based tracking method, in testing using several parameters such as distance, angle, light intensity and cover some of the detected objects. The results of research that has been done are almost the same in the detection process. The light intensity parameter greatly influences the process of detecting significant components where object detection is difficult in dark conditions. Detection success is obtained as much as 95%. To learn more.

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