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# Augmented Reality as a Medium for Learning Measurements and Quantities

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**Abstract.** This study aims to provide students with a special understanding of material magnitude and measurement by utilizing augmented reality. The method in this research utilizes natural feature tracking-Multi Marker Target, as well as system development model namely ADDIE model consisting of Analysis, Design, Develop, Implementation, Evaluate. As well as using the Fast Corner algorithm. The research resulted in an application in the form of displaying 3D objects of layer magnitude and measurement. The designed UI is as attractive as possible for use in students. The application can run well on android operating system. The results of this study obtained the response of students got an average score of 81.87% with the category "Excellent", so this media deserves to be used as a learning medium based on augmented *reality* in the field of Material Physics Magnitude and Measurement.

## 1. Introduction

The teaching of physics not only teaches concepts, but more importantly the interrelationship of concepts with reality in students' daily lives[1][2]. Because until now every study of physics, in the minds of students will surely imagine difficult formulas and calculations. This is a scary thing and always haunts every student at the time of physics learning. Finally, it has an impact on students' learning interest in physics subjects. The development of education requires teachers to always innovate in learning[3]. A guru needs to find or design innovative and interesting learning media in order to generate students' interest and motivation[4]. With structured, directed, and innovative learning will certainly produce the quality of learning as expected. In this case the teacher is obliged to provide learning media.

Learning media in general is a tool of the teaching and learning process[5][6]. Everything is used to stimulate thoughts, feelings, attention and learning abilities or skills to encourage the occurrence of the learning process. With the media, teachers can explain about the material that will be delivered easily, as well as students, it will be easy to understand the material. The factor that supports the achievement of learning objectives is the selection of the right learning media[7][8]. The right learning medium is how to make the learning in accordance with the characteristics of students and learning materials for the achievement of learning objectives[9]. Therefore, teachers should be able to

choose the right learning media to support the learning process.

To solve the problem, the author took the initiative to implement learning media that can display both two-dimensional and three-dimensional animations. This can be done using augmented reality-based learning media[10][11][12]. Augmented Reality is very useful in improving the teaching and learning process because augmented *reality* technology has visualization aspects that can inspire learners to understand concretely the material delivered through three-dimensional visual representation by involving user interaction in augmented reality *frames*[13]. In this study the focus of the problem is 1. What is the feasibility level of learning media based on Augmented Reality with Material Quantity and Measurement for High School Students? 2. How is the student's response after implementing Augmented Reality-based learning media with material quantities and measurements for high school students?

## 2. Research Methodology

Methodology used in the development of material education media and measurement using augmented reality technology consisting of 4 main sessions are:( 1) The initial session is a planning session, where in this session is done preparation, literature research and problem formulation. (2) The second session is a data collection session through observation, interview, questionnaire, and documentation and carry out the processing of data that has been obtained. (3) The third session is an analysis and review session, in this session will be tried system analysis, system design and design, coding, implementation and testing and assessment of the system applied. (4) The fourth session is the documentation stage of the research results[14][15][16].

## 3. Result and Discussion

The results of the search for information sourced in observations, questionnaire interviews and documentation tried against students and teachers to support media teaching and learning activities show the need for media supporting teaching and learning activities that can be presented in a new form through ICT that can share the ease in teaching and learning for students or teachers, especially the media can be used wherever they are, without any difficulty to be able to access and use it. The results of the information collection that serves as the basis for improving a learning media that is certainly unique, creative, and innovative to support teaching and learning activities for both students and teachers. There is also such media in the form of educational media development using Augmented Reality technology based on mobile can be used using Android smartphones. The use of Android smartphone media is also sourced on the observation of citizens if Android users become increasing, both from the type of operating system level ranging from Android froyo version to jellybean type or users sourced on the type and brand of smartphone used.

The selection of the module of magnitude and measurement as the object raised, namely with an alibi if in pursuing the material requires learning media. By using Augmented reality media makes it easier to learn the material and of course can be done not only in class but can be anywhere.

### 3.1 Analysis System

Analysis of the need for soft features (applications) aims to identify exactly what software features are needed to implement the system to be formed. The application of developing educational media understands the magnitude and measurement using augmented reality technology is formed by using Vuforia and Unity 3D Engine.

Vuforia is one of the applications raised to support the creation of Augmented Reality. Made in the form of an SDK, Vuforia has the expertise to carry out image recognition in image recognition. There are 2 types of workflows with basic databases that can be selected by developers, namely Cloud Database and Device Database. Unity Game Engine is an application used to create 3D video games or other interactive content such as, visual architecture as well as real-time 3D animation. Unity Game Engine is not only an engine game, but also an editor. With the SDK raised by Vuforia for Unity, unity 3D application allows to be used as an engine to create Augmented Reality.

Hardware needs analysis aims to properly identify what hardware features are needed to build and implement the system to be formed. There is also recommended hardware for building and

implementing this application that is :( 1) Pc, with minimum specifications is an Intel dual core Processor 3 GHz, Memory RAM 1 GB, Hard disk 120 GB, monitor 14", Stereo Speakers, connected to the internet, to be able to access cloud server. (2) Android-based smartphone with minimum specifications is a Processor 600 MHz, Display 256K colors; 480 x 320 pixels, Internal Memory 512 MB ROM; 512 MB RAM, Memory External microSD up to 32GB, Audio MP3/ AAC+/ WAV/ WMA player, Video MP4/ H. 264 player, Connectivity HSDPA; 3G; GPRS; Wi-Fi, Operating System Android OS – type 2. 2 Froyo, HTML Browser, CMOS Camera; 5. 0 Megapixel, connected to the internet or using information packages from certain telephone providers, to be able to implement applications and access the Cloud Server.
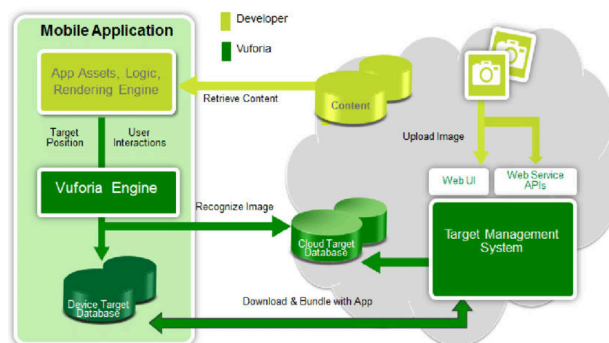


**Figure 1.** Diagram Vuforia (Dohan 2010)

### 3.2 System architecture

The system architecture was formed using the Vuforia SDK (Photo 2). The Vuforia SDK requires some meaningful components to work properly. These components include: Camera, it is necessary to determine if each frame is captured as well as passed effectively to the tracker. Image Converter, convert

camera format (e.g., YUV12) into a format that can be detected by OpenGL (e.g., RGB565) and make tracking (e.g., luminance). Tracker contains computer vision algorithms that can find and track real-world objects contained in the camera video.

Sourced on photos from the camera, different algorithms are tasked with detecting new trackable, as well as evaluating virtual buttons. The result will be placed in the state object to be used by the video background renderer and can be accessed from the application code. Video Background Renderer renders photos from the camera stored inside the state object. The performance of the video background renderer largely depends on the device used. Application Code, initialize all these components and perform 3 meaningful stages in application code such as Query state object on a new target found or marker, Update the application logic of each new input entered, Graphic rendering added Target Resources, made using on-line Target. Management System. Downloaded assets contain an xml-config configuration. xml– which allows developers to configure some features in trackable as well as binary files containing trackable databases.
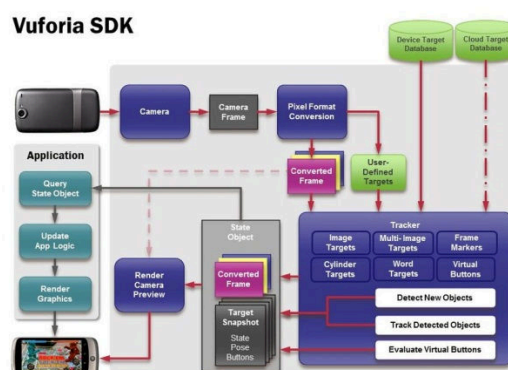


**Figure 2.** Architecture of Vuforia (Dohan 2010)

### 3.3. System Design and Implementation

The system formed based on Android, in its implementation is made of an indicator media in which there are some markers with a pattern that has been set where each marker wants to be identified coordinates and want to cause 3D objects. There are also objects that want to stick out is an object of Measurement and the magnitude of each marker is about to give rise to an object of magnitude and measurement. The target image is made of Magnitude and measurement photos. In Vuforia, photos that are to be used as markers or indicators must be converted first on the Vuforia database so that it has extension*. Unity packages and contains an xml-config configuration. xml–which allows developers to     configure some features in trackable and binary files containing trackable databases using the on-line Target Management System that contains web Vuforia.
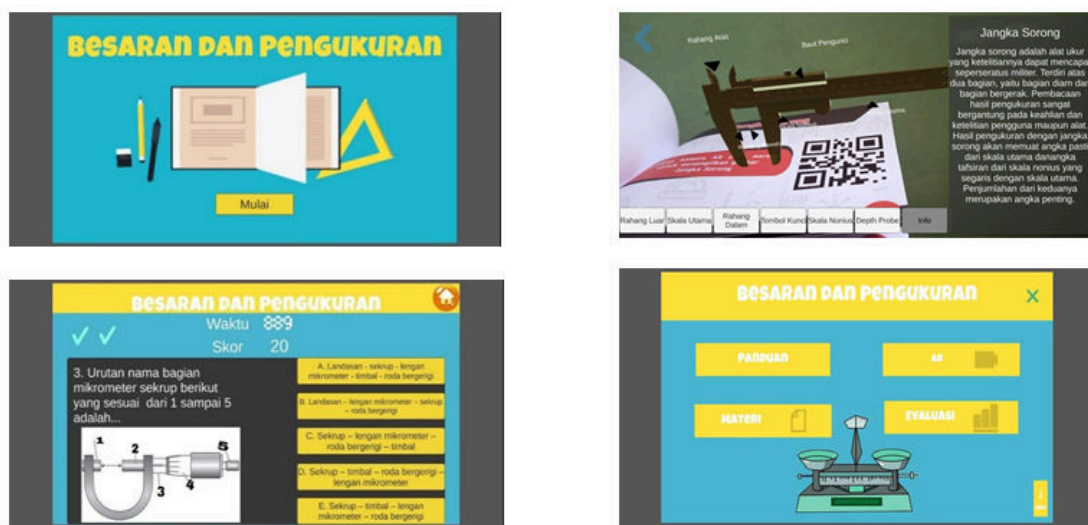


**Figure 3.** System Design and Implementation

The next stage of composing the target image is adjusted to the 3D Object magnitude and measurements that have been made before. In this process what is done is: (1) adding are camera and target image to the scene. (2) Placing 3-dimensional objects on top of markers, 3-dimensional objects that have been created are placed in each marker so that later when the tracking process is done using the android mobile camera on each marker will be displayed 3-dimensional objects that are on each marker. Directional light position against a three-dimensional object.

### 3.4. Student Response

The results of learning using Augmented reality by measuring   the overall response of students fall into the category of "Excellent". For motivation get 79.1%, the aspect of attractiveness gets a score of 85.32%, the aspect of ease of getting a score of 79.43%, and the aspect of ease of getting a score of 83.65%.

**Table 1.** Students' Response to Augmented Reality-Based Learning Media

| № | Aspects Assessment | Amount Grain | Score Maximum | Score Acquisition | Score % | Category |
|---|---|---|---|---|---|---|
| 1 | Motivation | 6 | 30 | 23.73 | 79,1 | Good |
| 2 | Attractiveness | 5 | 25 | 21.33 | 85,32 | Excellent |
| 3 | Ease | 6 | 30 | 23.83 | 79,43 | Good |
| 4 | Benefits | 4 | 20 | 16.73 | 83,65 | Excellent |
|  | Total | 21 | 105 | 75,94 |  |  |
|  | Conversion Results |  |  |  | 81,87 | Excellent |

## 4. Conclusion

Based on the results of the study, it can be concluded at the analysis stage shows that augmented reality-based learning media applications can be applied. Respondents Agree that the learning media Physics material magnitude and measurement developed in this development is an application that supports learning in the classroom and self-learning, by utilizing android *smartphones* Augmented reality-based learning media in subjects Physics material Magnitude and Measurement has been tested feasibility So that overall, it can be concluded that the learning media developed is worth using.

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