Augmented Reality (AR) based application to introduce animals for children

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Abstract. The development of technology today is very helpful in the multimedia-based learning process. Children will be more interested in learning if the application can be installed on a Smartphone, because children enjoy playing Smartphones. In teaching children to recognize animals, teachers at school use pictures. With the presence of multimedia based on Augmented Reality (AR), it is helpful for displaying images of animals in 3-dimensional form so it is more interesting. Applications created can help children to classify, explain about animals through information about sounds, habitat, breeding about animals in the form of 3D objects. In making Augmented Reality Animal Recognition, the researcher adopted the SDLC (System Development Life Cycle) method. At the trial stage, the Alpha version of the application was carried out to determine the quality, shortcomings and smoothness of the application that had been made. Application test results could run well. Therefore, through this application, children are more interested in getting to know animals so that it provides a learning experience and is easily accessible on smart phones.

1. Introduction
Technology develops rapidly. It affects the education positively; especially multimedia applications that provide useful information that can be accessed easily by children. Equipping children with enough prior-knowledge is important basis for them to expend their knowledge. Before signing -in elementary school, children must be able to engage in verbal and nonverbal communication. Verbal communication is defined as the form of communication that includes writing and oral speaking. While non-verbal communication is defined as conveying information or messages to others without using words, rather conveying them by using body movements [1]. In teaching and learning practice, most teachers when explaining material used verbal communication with the help of paintings, drawings or posters, and books. Those helping tools were wasting large amount of paper and ink.

Early introduction of the size and the shape of the animal will help Children to develop better understanding about the animals. Based on this idea, it is necessary to develop media that can be used for introducing animals to children at schools. The technology for this specific purpose is Augmented Reality (AR). Augmented Reality Animal Recognition provides children with materials about the shape of the animal, the habitat of the animals, and the original sound of the animals. Learning animals is like learning letters or alphabets in which children must understand the shape of the letters first. During their learning process, children do not only learn from books, posters or pictures hanged on the classroom wall but also from the AR-based learning media which helps children to understand animals easily.
Besides, the AR assisted learning is interesting and fascinating and children love it. AR technology has been used for developing animal-recognition magic book for kindergarten. The magic book is Android-based application using three-dimensional object markers [2]. Reference [3] also developed learning media to introduce theme called curriculum for early preschool children.

AR incorporates two or three-dimensional virtual objects into real objects. The advantage of AR is its extensive implementation. It can be implemented in various media, for example: the introduction of batik motifs using augmented reality [4]. Its advantage makes the AR a good technology for developing interesting learning media. The implementation of AR-based learning Media is not expensive because the learning media is developed with open source applications. The application only requires computer or smartphone. The purpose of developing AR-based learning media is to give children different learning experience utilizing existing technology. The learning will be more interesting and realistic for children.

2. Method

2.1. Data Collection
The research method was a scientific method to obtain data which had specific purposes and usage [11]. The research was conducted at kindergarten in Gerokgak District. The research starts from November 2018 to June 2019. Data collection was conducted for 3 months that included searching for information, data, or information that aimed achieving the objectives of the application or system made. In developing the AR-based Animal Recognition application, literature review method was also. The Literature Review Method is a list of references from various types of books, journals or the internet and others sources that are subsequently quoted and written in the proposal. In this research, the process of finding data or information was done through books and the internet. Another method used was direct interviews with kindergarten teachers to get input for the development of this project.

2.2. Application development
The method used in developing software was SDLC. The System Development Life Cycle (SDLC) method was a classic method to develop, maintain, and implement it on the system or application [10]. This method had an important role in developing systems and applications to ensure strong management and maximize productivity. The general stages of the development are Planning, Analysis, Designing, Implementation, Testing, and Maintaining. The SDLC method can be seen on Figure 1.

![Figure 1. SDLC Method.](image-url)
Figure 2. Flowchart of operate the application

- Planning
  This was initial development process of AR-based Animal Recognition application. Currently learning media for introducing animals was still laid upon the use of posters and flash card. The AR-based application Animal recognition was made based on the needs of the user therefore the application was motivating and interesting. Users can observe 3D objects, listen to information, or observe information that had been provided and can also listen to animal sounds. There were 6 animals displayed. This application retrieved data about animals from internet sources, books, and also magazines that were used as a support for the application of AR-based animal recognition application.

- Analysis
  Analysis was a stage for collecting data to get information about the shape of animal, clear information about the animal and coding preparation. The workflow of this application was displayed on the flowchart diagram explaining the features of the AR-based animal recognition application. See Figure 2.

- Design (modeling)
  The modeling phase was done by creating the interface design based on the pre-designed model. Photoshop Cs6 software was used to design background in the main interface, 3D Blender was used to create 3D objects that would be displayed on the AR-based Animal Recognition application.
  The process of designing the application included interface design process. This design was necessary to make the application interesting and attractive for the user and also provided an overview of the application regarding the implementation and interface of the developed application such as the main menu and buttons used in applications such as start, guide, and exit buttons. The content design was done by creating storyboards. Storyboard was used as an overview of the stages and processes that occurred in the AR-based Animal Recognition application.
• **Implementation (Evaluation)**

  This stage focused on implementing the design concepts that had been made previously into applications that were ready to be used by users. The application can be used by users to find out bugs in the menu and also find errors in coding.

• **Testing**

  At this stage, the AR-based Animal Recognition application was tested after fixing error. Observing the results was also conducted and executing data to be tested in order to ensure deficiencies or bugs that could prevent users from using the application.

• **Publication**

  At this stage, the AR-based Animal Recognition application would be installed and used in several Smartphone with different specifications in order to identify the Smartphone specifications supporting this application and also to find out bugs and identify which application supporting the Smartphone with less specifications. Maintenance must be done to fix the bugs and errors that were not found in the previous stages.

2.3. **Augmented Reality (AR)**

Augmented Reality or known as AR is a technology that combines two-dimensional or three-dimensional virtual objects into a real three-dimensional environment and then launches these virtual objects into real time [5]. Augmented Reality Research aimed at developing technology that allowed real-time integration of digital content created by computers with the real world, Augmented Reality allowed users to see two-dimensional or three-dimensional virtual objects projected on the real world [6].

Virtual objects provide full information for users to develop better understanding of something. The AR technology simplifies the real object by transforming it into virtual objects, so information can be used not only by the direct users but also by each user who are connected with real objects. The AR is principally similar to Virtual Reality which is real-time. Virtual Reality displays object along with its surrounding environment, whereas Augmented Reality combines an object into reality. The animal used in the development of AR-based animal recognition was limited. There were 3 herbivorous animals, 3 carnivorous animals, namely: Zebra, Giraffe, Cows, Bear, Komodo, and Cheetah.

2.4. **Unity**

Unity is a software for developing game which allows developers to create a 3D game easily and quickly. Unity can also be used to develop real-time 3D game. Unity has long been used to develop the following games: (1) First Person Shooting (FPS), (2) Role Playing Game (RPG), and (3) Real Time Strategy (RTS) games. Besides, Unity is also a multiplatform software. Multiplatform software is an application that can be applicant to various file type formats, such as: exe, apk, and others, which allows us to publish like Windows, Mac, Android, IOS, PS3 [7].

Unity is the best game editor as its editor feature developed with simple interface. Unity is suitable for the game developers who cannot buy game engine license or develop their own game engine. Unity helps the developers to create 3D games, 2D games, and even online games. Other valuable features available on the application are creating 2D / 3D games, developing Augmented Reality, and creating online games. The Unity supports the file conversion into: Mobile Android, I phone, Windows, Linux, Flash, Web player, Google Play online publish, Android market that can be sold. Unity also supports various file extension such as 3ds, obj, and fbx. Unity cannot be used to design object or modeling because the software is not equipped with design tool. If developers want to design or modeling multiple objects they can use other software 3dsmax or blender. But there are many interesting feature that make the software worth studying.
2.5. **Vuforia Qualcomm**

Vuforia is an application developed by Qualcomm to support the game development that uses Augmented Reality technology. Vuforia simplifies the game development because the library and its core functions are readily available. The developers only need to explore their imagination and develop appealing application. Vuforia uses Vision Computer technology to recognize and track markers or target images and simple 3D objects such as boxes in real-time [8].

Vuforia is SDK (Software Development Kit) developed by Qualcomm to support the game development that uses Augmented Reality technology. By using Vuforia, developers do not need to worry about the image processing in developing Augmented Reality applications. But Vuforia cannot recognize objects in real time and technically there is no other software that supports Vuforia. Therefore, Vuforia is not free for production but it can be used freely for the development stage which means the developer can use features freely.

The SDK has interesting features such as objects, text scanning, frames recognizer, virtual buttons, object surfaces identification, clouds-based scanning, target images recognizer, cylindrical targets recognizer, and recognizing objects that have already been targeted. The utilization of Vuforia has increased significantly to integrate the capabilities of the Augmented Reality feature.

2.6. **Blender 3D**

Blender is an open source software normally used on 3D graphics computer software to create 3D modeling objects, produce animated films, build visual effects, create interactive 3D applications, and video games. Open source 3D programs and animations can be freely used, developed and redistributed. Blender objects can be published freely and for commercial use. Blender has official support for Microsoft Windows, MacOS X, and Linux [9].

Blender is open source software where users can invest, participate, and help to update powerful collaboration tools. The software was specifically designed to create 3D multimedia content which has numerous advantages, namely: it is open source where users can freely modify 3D objects as long as they do not violate the General Public License, it is multiplatform which means that blender is available in various OS, for example Linux, Mac, and Windows, it is also a free software because its extraordinary features can be updated and developed to become better application.

The use of Blender is widely documented on its site. Support for the users is also available through community tutorials and internet discussion forums. Professional support is also provided by Blender network which contains support and social services for professional blenders.

2.7. **Animal**

Animals are living organisms classified into Animalia or metazoan. Animals are classified based on their respective characteristics, from physical characteristics, food, habitat, and others. Animals include multicellular organism and organized themselves with different functions. From the type of food, animals can be grouped into three different types, namely: Carnivorous Animals, Herbivorous Animals and Omnivorous Animals.

2.7.1. **Herbivorous Animals**. Herbivore animals are plant-eating animals. These plant-eating animals are not dangerous. Herbivore animals have molars to grind green plants soft mold and incisors to cut green plants. Herbivore animals also have canine teeth as protection tools. The herbivore animals are viviparous and mammals animal, land-based animal, quadrupeds, and warm-blooded animals. The herbivorous animals live in groups in order to protect themselves from predators. By living in groups, herbivore animals can protect each group members when predators attack. There are various kinds of herbivore animal. They are normally part of human life.
2.7.2. Carnivore Animals. Carnivore animals are meat-eating animals, both frees meat and carcasses. The meat is from fish, reptiles, birds or others. Carnivore animals refer to vertebrate animals and invertebrate animals. The vertebrate animals are tigers, lions, and dragons. The invertebrate animals are ground snails and squid. In general, carnivorous animals have sharp claws that are used to hunt its prey.

Predominant physical characteristics of the carnivorous animals are having strong jaws and teeth. These allow them kill larger prey. Some of carnivore animals produce poisons to awaken and paralyze their prey. Carnivore animals have sharp eyes and they are also fast runner. The sharp eyes enable them to spot the prey from a long distance. Some of the carnivore animals are marsupials such as Tasmania, predator birds such as eagles and owls, vultures such as crows, vultures, weasels, snakes, seagulls, penguins, pelicans, octopus and squid.

![Figure 3. Main Menu Application.](image)

![Figure 4. User guide.](image)

![Figure 5. Object display when the marker is detected.](image)

3. Result and Discussion

Hardware specifications suitable for the process of application development are the Intel (R) Core (TM) Processor i3-4005U CPU @ 1.70GHz, installed memory (RAM) 2.00 GB and the Windows 10 operating system. The application used for developing the AR was Unity 3D used for combining libraries from Vuforia. Photoshop Cs6 application was for background editing. Blender 3D application was for creating objects as well as creating rigging in the AR-based Animal Recognition application.

Marker card was employed in the usage of the application. The smartphone was brought close to a marker that has been determined so that it could be read on the application. The marker used should be...
a clean image so that the image could be easily detected by the application. If the marker used is not good, the application will fail to detect and 3-dimensional images will not appear.

The application is easy to use. The users turn on the AR camera then an object will automatically appear based on the predetermined marker. Then the 3-dimensional object will appear on the smartphone. The marker identification process is taken from a database that has been created by Vuforia library that contains marker images used to identify images on the marker. The main interface of this application can be seen as Figure 3, instructions on how to use the application on Bahasa Indonesian can be seen on Figure 4. The image of an animal object, description, and sound are presented on Figure 5. The process of how the application works can be seen as in Figure 6. Applications that have been produced can be used to introduce animals based on animal types, namely carnivores and herbivores. In addition, children can listen directly to the sound of animals, as well as other information for example related to the animal's habitat. This research has similarities with AR-based applications that have been developed that take the theme of animals. The difference is in the classification of animals, while there are other studies that make AR in the form of Magic Book [2] and some even specifically make AR for animals in Indonesia that are difficult to start extinct [12].

The next stage was to test the applications. The testing consists of two stages, namely application testing and device testing. Application testing was done by testing the parts such as marker size, angle, menu features, and lighting. Device testing was done by applying the application scenario on different types of smartphone, presented on Table 1.

![Figure 6. How the application works.](image)

Table 1. Device Testing.

| No. | Testing                                                | Result                       |
|-----|--------------------------------------------------------|------------------------------|
| 1.  | Marker Size (Large 100 % - 50 %)                       | 3D-object Appear             |
|     | Marker Size Testing (Medium 50% - 25%)                 | 3D-object Appear             |
|     | Marker Testing (Small 25% - 0%)                        | 3D-object disappear          |
| 2.  | Angle Testing (0º - 30º)                              | 3D-object disappear          |
|     | Angle Testing (30º - 60º)                             | 3D-object Appear but inappropriate position |
|     | Angle Testing (60º - 90º)                             | 3D-object Appear             |
| 3.  | Menu Feature (Opening Main menu)                       | Running smoothly without error |
|     | Menu Feature (Opening User Guide)                      | Running smoothly without error |
|     | Menu Feature (Select play button sound on the AR Camera) | Running smoothly without error |
| 4.  | Lighting (outdoor at noon)                            | 3D-object Appear             |
|     | Lighting (indoor with turned on lamp)                  | 3D-object Appear             |
5. **Android Smartphone Brand**  
(XIAOMI Note 5A Prime  
Qualcomm MSM8940 Snapdragon 435, RAM 3 GB)  
Running smoothly

Android Smartphone Brand  
(OPPO F1Plus, Eight Core, RAM 4 GB)  
Running smoothly

Android Smartphone Brand  
(VIVO V5, MediaTek MT6750, RAM 4 GB)  
Running smoothly

Android Smartphone Brand  
(OPPO A37, Snapdragon 410 Soc, RAM 2 GB)  
Running smoothly

### 4. Conclusion

The AR-based Animal Recognition application designed using the SDLC method has been successfully developed. The development of AR-based Animal Recognition application also used Unity 3D application, libraries from Vuforia, Blender 3D, and Photoshop CS6. The main components of the application are menus on the main page such as Start, Guide and Exit. If the user clicks the start menu then the application will directly point to the AR Camera. If the user chooses the guide menu, the application will direct the user to the instruction of using the application. If the users want to end the application, they can click the exit menu. The application interesting features of the application includes 3D models display, animation, and oral description of the animals on Augmented Reality. The application has been tasted and the result was promising. The application could run well matching the interface and storyboard design. This application can be used to introduce animals in a fascinating and interesting way because it offers moving animals with their actual sound. Th 3D models and animations on the application were herbivore and carnivore animals such as Zebra, Cow, Bear, Komodo, Cheetah, and Giraffe.

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