Virtual Pet Simulator Game Using Augmented Reality on Android Platform

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Abstract. Augmented reality is one of the interactive technologies that can be used to help the user to easily interact with the system. The game application called AR Virtual Pet Simulator is a simulator game which uses Augmented Reality technology to display a virtual pet, for the purpose of enhancing the users’ experience. Users can also interact by using application to understand the daily behaviours of pets. Application development methods are carried out starting from gathering requirements, design, implementation, to testing and evaluation. Results from the end evaluation shows that the application was well-liked by users and it could help users in knowing how to take care of pets, but the experience of using the application is not the same as having a pet in the real world. Conclusion gathered from the research is that applications with virtual pets are not able to entirely replace real pets but are able to provide knowledge on taking care of pets. Where users cannot interact directly with pets.

1. Introduction
Technology has developed rapidly and plays a role in everyday human life. The development of technology in various fields, including entertainment. One of the most common applications of technology in this field is game development. Currently the use of game consoles has begun to decrease, the direction of game development at this time is to target mobile communication device users such as smartphones [1].

The development of smartphone technology can be divided based on different operating systems. Most operating systems used on smartphones are controlled by two operating systems, namely Android OS and iOS. According to Statista (2018), which is an online statistics portal, market research, and business intelligence that provides market data for world institutions and business organizations, the global mobile operating system market is dominated by Android OS. With a total market of 88%, smartphone users with Android operating systems are at the top, followed by iOS operating systems at 12% [2].

Currently, the development game made more attractive by the Augmented Reality (AR). Augmented Reality is a technology that allows people to visualize cyberspace as part of the real world that make the real world as if you can connect to the virtual world and can occur an interaction [3].

Augmented Reality seeks to present experience because AR gives freedom to users to be able to manipulate and interact with digital information / objects as they interact with real objects [4]. The use of Augmented Reality technology in games allows users to get a more interactive experience, and the technology can be implemented in various types of game genres.
Genres, as discussed for games, are identity information that explains the game style of a game, and until now there have been many combinations of the genre of the game itself to label a game [5]. The game genre can be divided into several categories, namely action, adventure, card, casual, idle, puzzle, rhythm, role-playing, simulation, sports, strategy, and so on.

Based on these genres, simulation is one genre that is quite liked by users. According to WePC (2018), 15 PC games with the most sales in the world have 6 games with the simulation genre, with one of them reaching the largest sales of 7.95 million units, namely The Sims 3 [6]. Simulation game is a genre of game where users can imitate or try fictional or non-fictional realities for simulating events or situations. One example of a simulation game is a virtual pet simulator, a game that allows users to mimic activities such as caring for a virtual pet.

Maintaining a pet can have a positive impact on its owner, such as teaching responsibility and discipline, fostering affection for living creatures, reducing stress levels, and others. However, several factors can cause a person to be unable to have a pet. According to the American Humane Association, several reasons for not having a pet are due to expenses, allergies, and lifestyle (do not have time to take care of pets or travel frequently) [7].

The experience of an owner plays a role in raising pets. Pet owners for the first time report higher prevalence in problematic behavior such as fear, excessive excitement, and owner-directed aggression [8]. This indicates a lack of experience with owners who have never owned a pet.

The existence of a virtual pet simulator game can act as a substitute for pets. However, a study conducted found that virtual pets do indeed create a sense of friendship, but less than actual pets. User interaction design is the key to increasing the emotional involvement of users [9]. The virtual pet make users enjoys games that exist in the application [14]. With the addition of the use of Augmented Reality technology, virtual pet simulator games can enhance the user's playing experience.

2. Literature Review
2.1. Waterfall Model
The waterfall model presents the software development process as a number of stages. Because it cascades from one phase to another, this model is known as the waterfall model or software life cycle. Waterfall model is an example of a plan-driven process, where you plan and schedule all process activities before starting software development [10].

![Waterfall Model](image)

**Figure 1.** Waterfall Model

Waterfall model can be divided into stages as follows:
1. Requirements Analysis and Definition
   Services, limits, and system goals are determined by consulting with system users, who are then defined in detail and become system specifications.
2. System and Software Design
   The system design process allocates requirements between hardware or software, which builds the overall system architecture. Software design involves identifying and describing the basis of software system abstractions and their relationships.
3. Implementation and Unit Testing
   At this stage, software design is realized as a series of programs or program units. Unit testing involves verifying that each unit meets its specifications.

4. Integration and System Testing
   Individual program units or programs are integrated and tested as a complete system to ensure that software requirements are met. After testing, the software system is sent to the customer.

5. Operation and Maintenance
   In general, this is the longest life cycle phase. The system is installed and used in practice. Maintenance includes correcting errors that are not found in the early stages of the life cycle, improving the implementation of system units, and improving system services as new needs are discovered.

2.2. Game
   Game is a kind of play activities, carried out in the context of the reality of pretense, where participants try to achieve at least one goal that is random and non-trivial to act in accordance with the rules [11].

2.2.1. Gameplay
   Gameplay consists of challenges that must be faced by players to get to the goals of the game and actions that are allowed to be done by players to overcome these challenges [11]. An explanation of the challenges and actions is as follows:
   1. Challenges
      A challenge is any task assigned to a significant player to be completed. Overcoming challenges must require a mental or physical effort. Challenges can be unique, repetitive, or ongoing. Challenges in the game are determined by the rules, even though the rules don't always specify exactly. In some cases, players must find out what the challenges are by thinking logically about the rules or playing the game several times.
   2. Actions
      The rules specify what actions players can take to overcome obstacles and reach the game's goals. The rules not only define what actions are allowed, but also what is prohibited and what is needed and under what conditions. Many conventional games that allow any action that is not prohibited by regulations.

2.3. Virtual Pet Game
   Virtual pet games are an alternative where users can interact with pets. Examples of virtual pet games such as The Petz and Tamagotchi series, where users can adopt, raise, nurture, and breed virtual pet themselves, function as substitute or additional pets where users can build emotional connections. Games offer a meaningful affective interaction region to realize affective loop, namely a digital social interaction system capable of acquiring, detecting, and responding to user emotion [9]. However, attachment and emotional involvement with virtual pets is less compared to having a real dog or cat.
   There are two motivations for playing pet games, namely using a virtual pet as a substitute for real pets or using a virtual pet as emotional support. Based on the research motivation is explained as follows:
   1. Replacement Pets
      Most users who are interested in playing pet games say that they like or love animals but cannot have them. For example, a person may not be able to have a pet because they (or others who live with him) cannot be around animals; or where someone lives does not allow pets. Some users say that pet games help them learn how to interact with real pets before they can get a physical pet.
   2. Emotional Support
      Specific emotional support desired from having a virtual pet includes relaxation, excitement, friendship, and therapy. One user said that pet games helped him to regulate his emotions when he did not get access to animals in his life. The user said that he had anxiety, was always in a panic, and playing a pet game made him relax and calm.
2.4. Augmented Reality

Augmented Reality is a technology that provides information on real environments by coating virtual objects generated by computers. Virtual objects created by computers can be two or three dimensional objects. Augmented reality works by analyzing real objects captured by the camera as input and then creating additional virtual objects that are combined with real objects and displayed as output [12].

Augmented Reality (AR) provides a new way to interact with the physical (or original) world. AR makes a modified version of reality, supplemented by digital (or virtual) information, on a computer screen or mobile device. Combining the virtual with the original can lead to a range of new user experiences, exceeding the ability of applications in general [13].

2.5. Vuforia

Vuforia is an Augmented Reality library distributed by Qualcomm Inc. The library can be used free of charge in non-commercial and commercial projects. The library supports frame markers and target detection for natural features and also multi-targets, i.e. a combination of several targets. The library is available for iOS and Android platforms, and performance is better on mobile devices that have Qualcomm chipsets [13].

3. Methodology

The following is a development of the waterfall model in this study:

1. Analysis requirements definition
   The needs analysis phase is carried out by distributing questionnaires to respondents to collect data. The purpose of this stage is to determine the user's needs.

2. System and software design
   After getting the user's needs, the next stage is designing the system using the data that has been obtained, including the creation of storyboards. The design created will be used for application development. Storyboard is used as a rough idea of the appearance of the application.

3. Implementation
   At the implementation stage, the design that was previously created will be implemented into an application. Activities at this stage include creating 3D models and animations using Blender and application programming using Unity3D with Vuforia for Augmented Reality.

4. Testing
   After the application is complete, the application needs to be tested to ensure that the system works as needed. A series of testing is done with various scenarios to ensure that the application has no bugs.

5. Evaluation
   The last stage is the evaluation, where the test has been completed. The application is complete and is ready for use by users.
4. Result

The results of this study produce a virtual pet simulator game application using Augmented Reality technology. Here are some interface views of the game application:

In figure 3, user can select a pet dog or cat by pressing the button with a picture of the desired pet image. After selecting, the guide screen will be displayed and user must point the camera to a flat surface and press the screen to active the Augmented Reality feature, it’s shows at figure 4. After activating the Augmented Reality feature, pets will be displayed and the user interface in the form of images and buttons will be displayed on the screen. At figure 5, users can choose the food, water, or love button located at the bottom of the screen and to add the status of hunger, thirst, and heart located at the top left of the screen. Hunger is related to food thirst is related to water, and heart is related to love. Status will decrease over time, and user need to regularly check and take care of pets. There are coins located at the top right of the screen that are used when selecting of the food and water buttons, or to buy colours in shop. Coins can increase if one status reaches full. There is a shop button located below the coin. When user pressed the pop-up shop will be displayed. At the shop user can use coin to buy and change pet colour. If one of the statues is used up, the pet will feel abandoned and run away. This indicates game over, and neglected pet screen will be displayed when user select the start button on the main menu screen.
Figure 7. Application helps the user to understand how to care pets.

This study has been distributed to 42 of random respondents to get an evaluation in terms of users through a questionnaire. Based on the questionnaire figure 7, the authors get positive feedback about the application and get suggestions and recommendations for development. Overall, the AR virtual pet simulator game application helps users according to the goals and expectations of the author, although there are still flaws in the flow of features and the user's input for application development.

5. Conclusion
In this study, the virtual pet simulator created using augmented reality technology. After carrying out the process of analysis, development, testing, and evaluation, the author can conclude that:
1. Applications can replace pets, as evidenced by the results of the evaluation questionnaire, which amounted to 66.7% who answered that the application can replace pets.
2. Applications can help respondents better understand how to raise pets, as evidenced by the results of the evaluation questionnaire, which is equal to 80.9% who answered that the application can help in better understanding how to raise pets.
3. The Augmented Reality feature helps improve the application usage experience, as evidenced by the results of the evaluation questionnaire, which is 92.9% who respond that the Augmented Reality feature helps improve application usage.

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