Design and Development an Augmented Reality Pop-Up Earth Application Using the Design Thinking Method

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Abstract

The importance of providing information about planet earth to users is one of the reasons for conducting this research, because humans are living beings who play an important role in protecting the earth so that various information and knowledge about planet earth are needed. To get this information, *the smartphone* is one of the tools used as a medium of information. Through the use of this technology, researchers convey information using an interactive pop-up application in the form of three dimensions. To realize the interactive application, researchers use *markerless*-based *augmented reality technology*, so that users can use it without any limitations of space and time.

The development method used in this research is the design thinking method consisting of 5 stages, namely *empathize*, *define*, *ideate*, *prototype*, and *test*. The testing phase in this study uses *blackbox testing*, validation tests carried out by experts, and a *usability scale* system carried out by potential users to determine the level of satisfaction when using the application. The results of the Pop-Up Earth application test show that the application is in *grade* A or the *excellent category* with an average SUS score of 82.5% and can run well as expected. Experts state that this application is valid for use with an average value of 98.3% for the delivery of application media and 87.5% for the delivery of application information. It is hoped that the Pop-Up Earth application can provide various information about planet earth to users interactively and informatively.

Keywords: *Augmented Reality; Earth; Information Media; Design Thinking; System Usability Scale.*

I. Introduction

The solar system is a system of interaction of celestial bodies bound by the force of gravity consisting of the sun as its center and also the celestial bodies that surround it such as the planets [1]. Earth is one of the planets included in the composition of the solar system and is a planet that is home to humans and various other living things. Knowledge of astronomy, especially on planet earth, is an important thing that can provide correct information on life on earth [2]. Humans are living beings who have an important role in protecting the earth [3]. Therefore, so that humans can protect nature and life on earth, various information and knowledge about the earth are needed.

Through the development of technology, the life of modern society cannot be separated from the use of *mobile devices/smartphones.* Not only as a communication tool, but *smartphones* are also very helpful in everyday life, especially as a medium of information. In general, information media can be obtained from various print media (newspapers or magazines), radio and even internet search engines. Realizing this, encourages researchers to bring innovations in conveying information related to planet Earth by using an interactive pop-up application in the form of three-dimensional images. An interactive three-dimensional image pop-up application is an application that displays three-dimensional images on each page that can be moved so that users will not feel bored [4]. To realize the interactive application, researchers use *Augmented Reality* (AR) technology.

Augmented Reality technology *can* create a new environment by unifying the interaction between the real environment and the virtual environment in real time so that what is felt by the user is real [5]. Unfortunately, there are not many *augmented reality technologies* that discuss planet Earth interactively. Study belongs to Muni [6] and belongs to Muqorrobin, et al. [7] discusses the *augmented reality* of the solar system as a whole based on *markers* by only displaying three-dimensional objects without any interaction with the user. Cahyono, et al. [8] conducting *augmented reality research* on the topography of the earth's surface using a box containing beach sand as a marker. While the research of Iqbal and Rosnelly [9] explained learning material about the layers of the earth using *augmented reality* and books as markers.

In previous studies that have been described previously, it can be concluded that these studies only focus on explaining the solar system as a whole and only discussing one topic regarding planet Earth, also in its application it still uses media or other objects as markers and is less interactive. While in this research will focus on an interactive explanation of the planet Earth based on markerless *augmented reality.* These studies will be used as a reference for developing interactive *augmented reality* in the form of pop-ups that discuss information on the earth.

II. Method

In designing Pop-Up Earth 's *augmented reality,* researcher use method *design thinking.* The design thinking method has 5 stages that is *empathy, define, ideate, prototype,* and *test.*

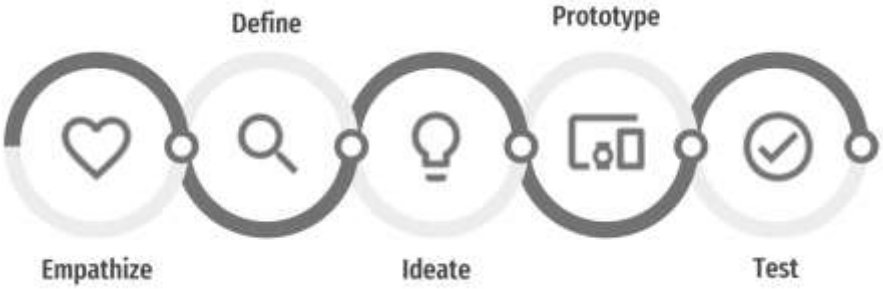

Figure 1. Stages design thinking method

a. Empathize

This stage is done to get an understanding of the problems that are being experienced by the user. Generally, to get this can be done through library research, observation, interviews or other types of activities so as to get accurate data.

b. Define

The define stage is used to collect information that has been obtained in the first stage, namely empathize. The data obtained at the time of the interview are collected and described into an *empathy map* which is useful for identifying user characteristics and validating problems to identify indicators of user problems. [10] . This problem identification stage will be used to generate ideas or solutions that can help solve problems effectively. The ideas or solutions obtained at this stage will be used as the basis for making products or applications.

c. Ideate

At this stage, the collection of ideas is done using *brainstorming* which aims to determine the solution to the problem that is being experienced by the user. Through *brainstorming,* researchers can come up with creative ideas that allow them to be used as solutions to existing problem points. Various solutions that have been collected will be defined into *an affinity diagram* to be used as a reference in making features [10] .

d. Prototype

After finding and determining ideas to be used as solutions to problems, the next step is to implement these ideas into an application/test product. For determine features, use *information architecture* for make it easy composing draft information that will applied to the application / test product [10]. At the prototype stage, the resulting product is designed to overcome the problems experienced by users.

e. Test

prototype that has been made will be tested for users to assess whether the *prototype* has met the user's needs or has not even met the user's needs. At stage the test, researcher using the System Usability Scale (SUS) for 5 users, because with 5 users has fulfill as much as 80% rating about application/product tested. After testing the *prototype,* the researcher received input and suggestions from users to develop a better product.

III. Results and Discussion

Pop-Up Earth is a mobile app with use augmented reality technology used for look for various information around planet earth. Pop-Up Earth made as a medium of information in convey knowledge and insight about planet earth. Following this is results from every stages method research used.

a. Empathize

Based on the predetermined characteristics, there are 20 selected respondents with an age range of 10-15 years who are interested in the planet and actively use smartphones. The collection of problems is done by interviewing respondents to determine and resolve the problems experienced by users. The interview contains 10 questions that focus on the difficulties that are often experienced when looking for information about planet earth.

b. Define

After getting information from the respondents, all data obtained at the time of the interview were collected and described into an *empathy map* and problem validation. In the *empathy map,* user characteristics are identified to find out what they feel, think, and do. The description of the *empathy map* is depicted in Table 1.

Table 1. Empathy Map

Says	**Thinks**
• Difficulty finding various information about the earth (solar system material, layers of the earth and the earth's surface) in the same page/link • Difficulty finding explanations accompanied by supporting animations/images • There is a video about the earth that uses audio other than Indonesian	• Is there an application that provides various information about the earth? • Information about the earth is easier and faster if there is an application provided
does	**Feels**
• Searching for information through many pages/website links • Search videos that use Indonesian or if not, then search on the website page • Ask and discuss with friends or other people	• Confused • Dizzy

Then the things that are felt by the user are described in the *validation problem* as described in Table 2.

Table 2. User validation problems

User Problem	Category
Users need many web pages to get the information they want	Looking for earth information
Too much writing in books or websites to get bored easily	View earth information
The audio presented in the video is too fast, not clear, and mostly in English	
A few illustrations and animations are shown	

c. Ideate

The problems that have been described in the Define phase are used as a reference to collect ideas that will be used as solutions to user problems as shown in Table 3.

Table 3. User validation problems

User Problem	Solution
Users need many web pages to get the information they want	Provide material choices with clear information
Too much writing in books or websites to get bored easily	There is interaction with illustrations or images using AR & show short material
The audio presented in the video is too fast, not clear, and mostly in English	Provide short and clear audio explaining using Indonesian
A few illustrations and animations are shown	Displays interesting illustrations or images based on Augmented Reality

Various solutions that have been collected will be defined into *an affinity diagram* to be used as a reference in making features in the Pop-Up Earth application, which is illustrated in Figure 2.

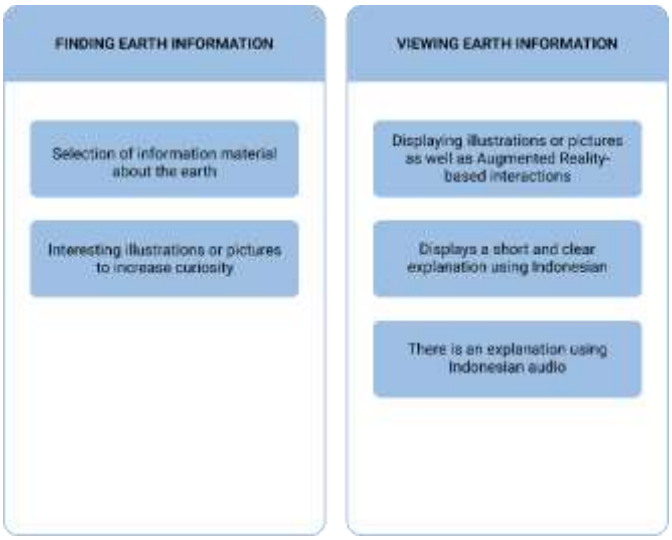

Figure 2. *Affinity Diagram*

d. Prototype

Affinity diagrams that have been determined in the previous stage, are then realized at this prototype stage. To determine its features, the researcher uses *Information Architecture* to facilitate the preparation of information concepts that will be applied to the Pop-Up Earth application based on user needs as shown in Figure 3.

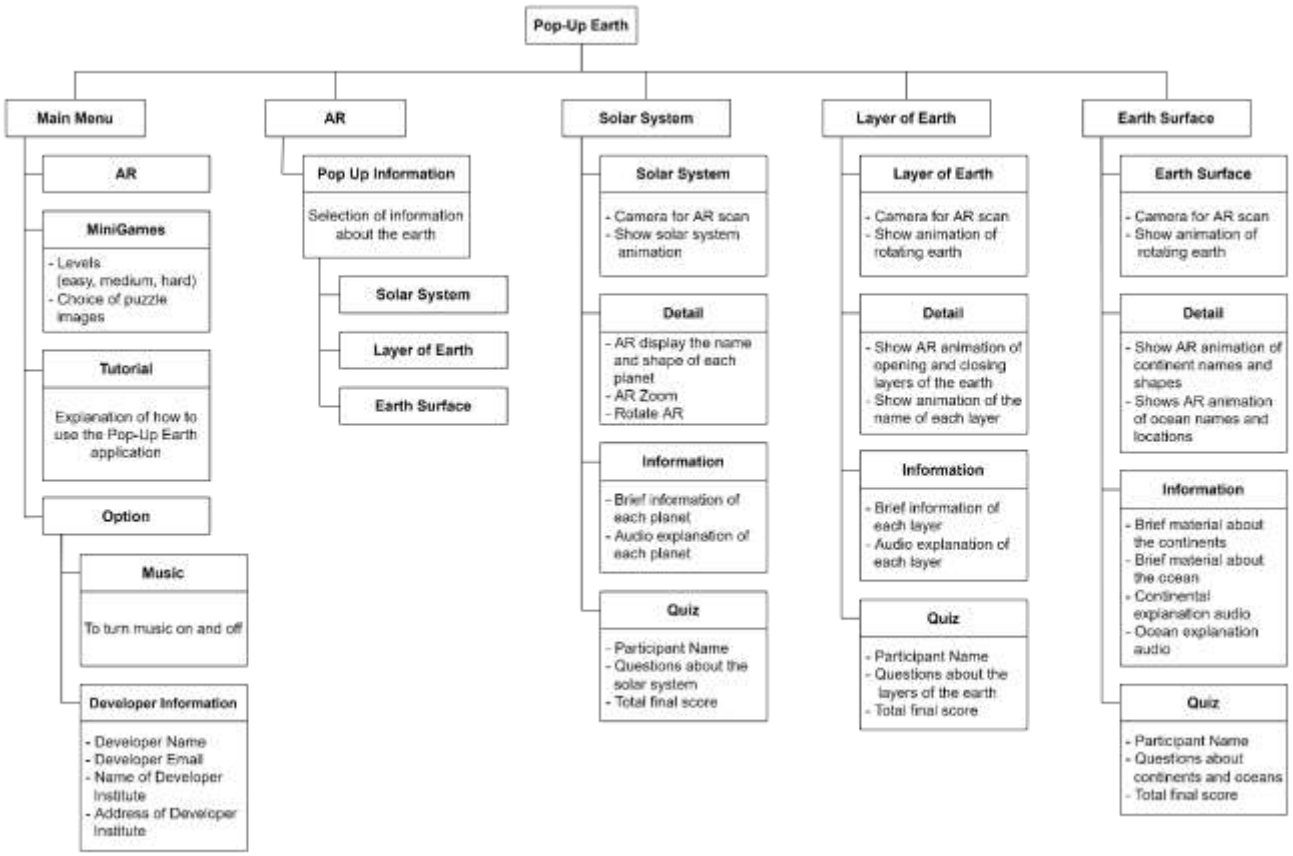

Figure 3. Information Architecture

These features are then implemented into the test application/product. The following is a display of the Pop-Up Earth application which can be seen in Figure 4.

Figure 4. Display of the Earth Pop-Up application prototype

e. Test

Test *prototype* conducted with use *System Usability Scale* (SUS) for measure score satisfaction user to use Pop-Up Earth application. Next is the test data obtained can seen in Table 4.

Table 4. SUS testing data for the Pop-Up Earth application

No	Respondent	Score										Results	
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Amount	Score
1.	R1	3	4	4	3	4	4	3	4	4	3	36	90
2.	R2	3	3	3	1	4	4	3	4	4	4	33	82.5
3.	R3	3	3	4	3	3	3	3	3	3	2	30	75
4.	R4	3	4	4	1	4	4	4	4	0	3	31	77.5
5.	R5	3	4	4	3	3	4	4	3	3	4	35	87.5
Average Result													82.5

The results obtained from user testing get an average SUS score of 82.5, where the value is included in *grade* A with the category of *Excellent* and *acceptable* or acceptable to the user. The following is an illustration of the results of the SUS score, which can be seen in Figure 5.

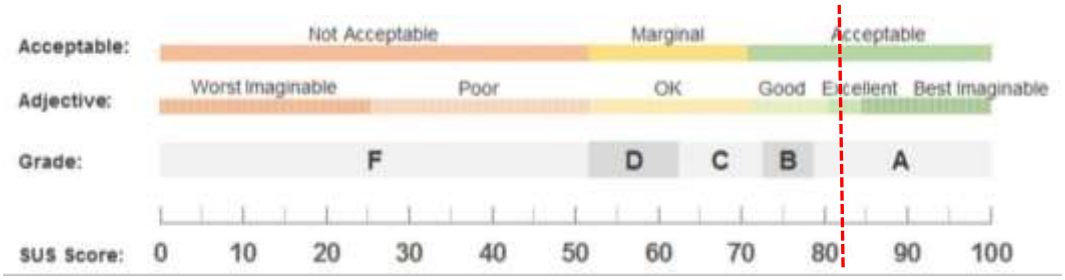

Figure 5. Scale of results SUS score

IV. Conclusion

Pop-Up Earth application based on augmented reality was developed using the *design thinking method* through a number of stages among them collection information (*empathize*), analysis requirements (*define*), formulation of solution ideas (*ideate*), prototype creation (*prototype*), and evaluation *usability* (*test*) so that produce capable app become a medium of information about planet earth for user with apply *markerless* and served by interactive. Test results performed by users by using SUS get an average score of 82.5 and is included in the *excellent category* and can be accepted by users.

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