Manufacturing and Calibration of Augmented Reality Sandbox for Geomorphological Modeling

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Abstract. Technological developments provide an opportunity for innovation and negative impacts if used incorrectly, so to anticipate being misused it is necessary to have a 3D technology innovation that can increase human resources in geomorphology. So this research is a type of R&D (Research and Development) research with the aim of; 1) creating an Ar-Sandbox modeling design; 2) knowing the development of components; 3) knowing the process of system testing; 4) modeling 3D geomorphology with augmented reality sandbox. The Augmented Reality Sandbox (AR–Sandbox) consists of a computer, sensors, a sandbox, and a short-throw projector. The research stages consist of; 1) the preparation stage; 2) the planning stage; 3) the installation stage; 4) the calibration stage; 5) the testing phase of the use of the tool. This research resulted in augmented reality prototype designs and components that were collaborated with a sandbox to carry out real-augmented 3D geomorphological modeling. Geomorphology that can be modeled using Ar-Sandbox is such as structural, fluvial and marine landforms. The modeling also shows color gradations, shapes and density of contour lines as well as real-time simulations of water movement on the earth's surface, such as the example of the Singkarak Lake modeling simulation.

Keywords: R&D (Research and Development), Augmented Reality Sandbox, 3D Model

1 Introduction

Augmented Reality is a technology that can connect the real world and the virtual world, both spatially and cognitively. The use of *Augmented Reality* media can change digital information into information that seems to exist in the real world. With *Augmented Reality*, virtual reality completely replaces the real-world environment with the use of technology in a simulated manner [1].

According to the definition [2] , there are 3 principles of this *Augmented Reality technology*. First, Augmented Reality is an amalgamation of the real and virtual worlds. Second, run interactively in real-time (*real-time*). Third, there is integration between objects in 3 dimensions, namely virtual objects integrated into the real world. The use of Augmented Reality technology has been widely applied in various fields, such as education which aims to assist in the learning process and the delivery of information. An example is the *magic book*, which is a book that provides a high " *user experience* " to its users [3].

The utilization of AR technology can also be applied in geomorphological modeling by collaborating with a *sandbox*. The combination of *Augmented Reality* and *Sandbox* will create real 3D visualizations. *Augmented Real-Time* can be integrated to create a physical topographic model which is then scanned using a computer in *real-time* by forming the sand that has

ICGEO 2022, November 19-20, Padang, Indonesia

DOI 10.4108/eai.19-11-2022.2332173

been provided on *the box*. Users or researchers can see the object from various sides, thus giving the impression and a more interesting learning experience, especially in visualizing geomorphology.

Based on the above problems, the technology *Augmented Reality Sandbox* with the *real augmented real-time system* can be used as learning media based on 3D visualization. Therefore, the researchers took the initiative to design the technology for geomorphological modeling.

2 Methods

The research method used in this research is the *Research and Development* (R&D) method. The object of this research is *singkarak lake*. The place for the *Augmented Reality Sandbox tool* is at the Geography Department Media Laboratories, Faculty of Social Sciences, Padang State University.

2.1 Data Processing Stage

The stages of data processing carried out in this study are as follows:

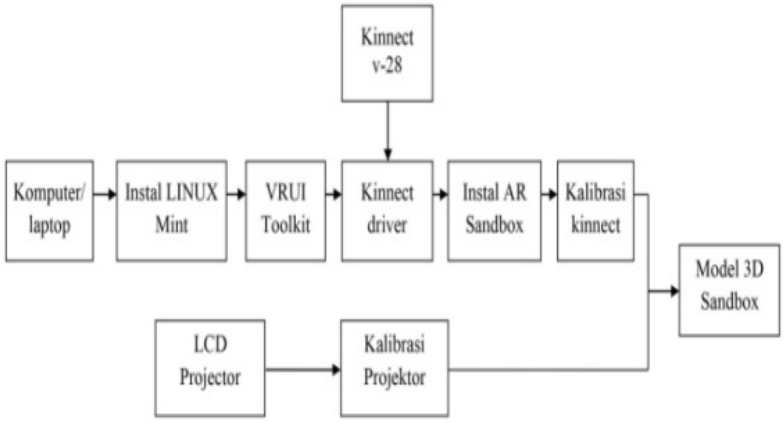


Fig 1. Data Processing Flowchart

The following is an explanation of the data processing flow diagram :

a) Prepare a computer / laptop with the appropriate specifications.
b) Installing the Linux Operating System according to the condition of the computer or laptop
c) Install the Vrui VR Device. Vrui is a C++ software development toolkit for highly interactive virtual reality applications, with a focus on portability between different remote computer/laptop virtual reality environments.
d) Input on the Kinect Sensor Xbox 360 computer, then install the Kinect Driver.
e) Next, install the SARndbox application. Sandbox Augmented Reality is an augmented reality application that scans the sand surface with the Kinect 3D camera and projects a real-time updated terrain map onto the sand surface with a calibrated projector.

f) Collect all the equipment in the finished sandbox frame and finally put the sand in the box
g) The last step is kinect calibration and projector calibration.
h) Sandbox can be used

3 Result and Discussion

3.1 Preparation and planning stages

At this stage, planning and designing the dimensions of the media and instrumentation from Geo-AR is carried out by measuring the dimensions of the classroom/laboratory against the ideal dimensions of the media. This was followed by a market survey regarding the availability of equipment and materials for making Geo-AR available in the local market and digital/marketplace market [4]

The requirements analysis process at this stage is in the form of identifying *software* and *hardware* and all instruments needed by the system. All these stages are related to materials, processes and *outputs* in the activities carried out. The system instruments and materials needed in making the *prototype* are presented in the following table.

Table 1. Instrument Prototype

Hardware	Software	Complementary Media
Computer	Linux operating system	Table Layout
Projector Infocus	Vrui VR	Object Sand
Kinect 360	Kinect Driver	Sandbox
	SARndbox Software	

3.2 Prototype Making

Furthermore, the process of making the *Geo-AR Prototype* begins with making the dimensions of the media for the designs that have been designed in the form of images on *CoelDraw*. In the manufacturing ,process This *prototype manufacturing* team is assisted by people who are experts in their fields. Then proceed with the system installation process which includes the installation process of the Linux operating system on the computer, supporting *software in making Geo-AR such as Kinect Driver software* , *Vrui VR* , and *SARnbox Software* which will be the main system in Geo-AR. Furthermore, the *prototype* that has been made will be calibrated for the sensor to the media box that has been made and proceedsoceed with testing the system function and responsiveness of the sensor to the resulting visualization.

3.3 AR Sandbox development process

To apply the Geo-ARsandbox Prototype, you must go through the following steps. Making a Sketch Drawing of a table shape as a sandbox media

a. GeoAR Sand Media Shape Sketch

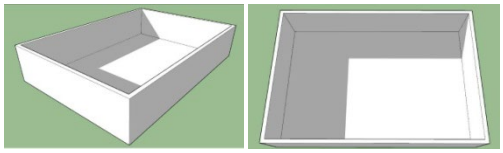
Fig. 2. Sketch of the shape of the wood sand media

This process occurs because of the need for GeoAR media mobility which is designed and tries to minimize production costs and increase the strength and resilience of the media.
Raw Materials used:

1) 3x4 . Galvanized Hollow Iron
2) Triplex 9mm

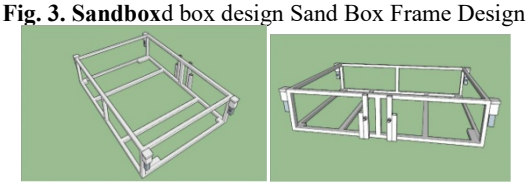
b. Manufacturing Design

Sand Box Design



(Length 1,02 m x 81 cm)

Fig. 3. Sandboxd box design Sand Box Frame Design



(1,07 mx 87 cm)

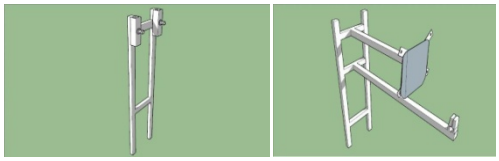
Fig. 4. Sandbox frame design

Leg Frame Design

(Foot Height : 87 cm), Middle Length (1.08 m) Right/Left (80 cm)

Fig. 5. Design of the leg frame

Sensor And Projector Hanging Frame Design



(Length 40 cm x Width 25 cm)
Fig. 6 . Hanging frame design

c. Stages in Running the Augmented Reality Sandbox Technology Program.

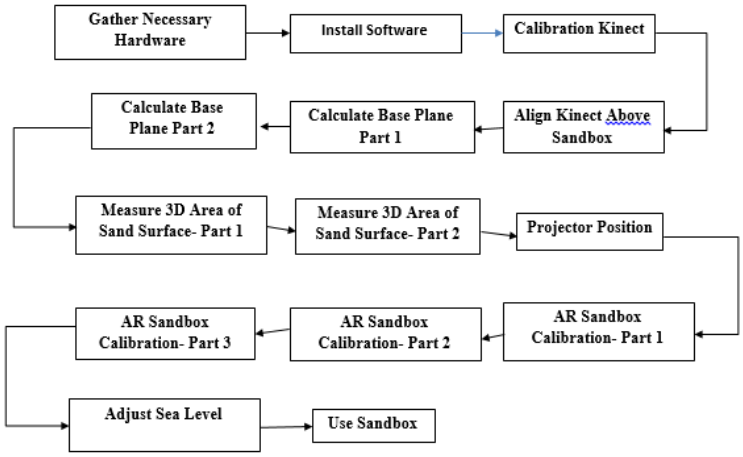


Fig. 7. *AR-Sandbox* Stages

3.4 AR Sandbox system trial

3.4.1 Ubuntu OS Installation

Ubuntu OS is a Linux-based operating system that is used as cloud computing and is the reference operating system for Openstack. This study uses the Ubuntu OS because of the free-dom to install compared to software that must be paid in advance to get it. In addition, users of the Ubuntu OS software have the right to modify it until the software can work as desired

3.4.2 Software Installation with Terminal

Software installation with the terminal function to call the program. Stages of Software Installation with a terminal continuation of the prototype, then a calling script is made like the following program:

```
sudo add-apt-depositor pays ppa:system76-dev/weekend-project
sudo apt-get update
sudo apt-get insandboxandbox
whoami
sudo adduser USERNAME(geoar) vrui-grpSTEP : KINECT CALIBRATION
KinectUtil getCalib 0
```

STEP: Align Kinect Above Sandbox
RawKinectViewer -compress 0
STEP:Calculate Base Plane – Part 1
RawKinectViewer -compress 0
RawKinectViewer
STEP : Calculate Base Plane – Part 2
gedit /etc/SARndbox-1.6/BoxLayout.txt
Step : Measure 3D Extents of Sand Surface - Part 1
RawKinectViewer -compress 0
Step : Measure 3D Extents of Sand Surface - Part 2
gedit /etc/SARndboc-1.6/BoxLayout.txt
Step : Position the Projector
Xbackground
Step : Calibrate AR Sandbox - Part 1
CalibrateProjector -s 1920 1080 (adjusts to resolution)
Step : Adjust the "Sea Level"
gedit /etc/SARndbox-1.6/BoxLayout.txt
Step : Sandbox ready to use

This modeling is done by the user by doing the modeling directly by hand. The results of the formation of the sand will be recorded by the Kinect sensor and emitted by the projector to display altitude information in the form of color calibrated with *software* . Sandbox modeling is acceptable if the results reach a natural state. The results of the *sandbox* modeling are shown in Figure 8. From the *sandbox* modeling , it can be seen the topography is shown by satellite imagery whereasre the *sandbox cross section* shows similar results. Furthermore, for the modeling of geomorphological and geological structures, no suitability has been found. This happens because it is complex in the formation process.

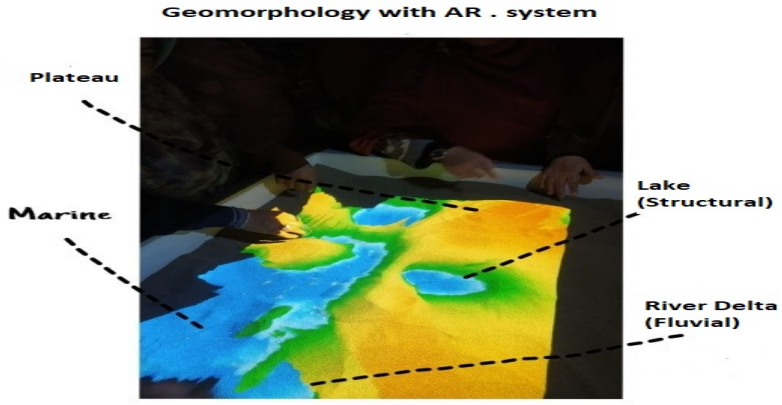


Fig. 8. AR-Sandbox Visualization

Based on the image, there are also several color contrasts that emerge from the results of the augmented reality sandbox, namely light blue, green, yellow and orange. The color also shows meaning, for example the blue color shows the appearance of water, the green, yellow and orange colors indicate lowlands, mediumlands, and highlands.

The difference in color displayed from the image above also has another meaning, namely, in the form of a difference in height or depth. Point 0 in the image above is when the ap-

pearance of the lowlands. The higher the shape of the sand, the brighter the color shown (land), as well as the depth, the deeper the sand, the darker the color (water). The appearance of the contours in the image above is clearly visible.

Simulation of water with this technology can also be done, which is done by moving the sand by forming a lake-like shape with the conditions before and after the lake.

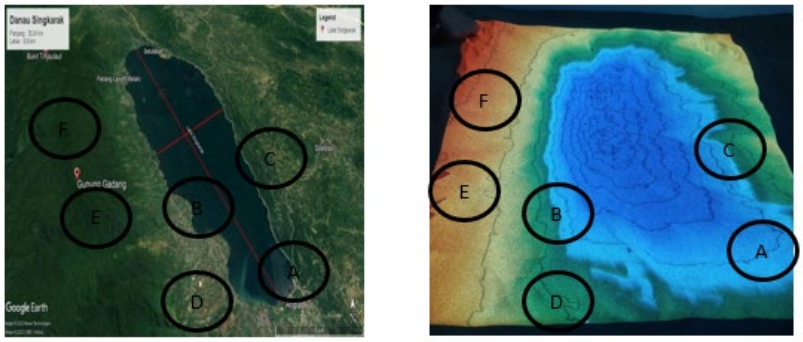


Fig. 9. 3D Modeling Comparison

The similarity between the comparison between the images (GE: Left) and (AR: Right) lies in the existing features such as low, medium and highland areas. In addition to the plains of particular concern is the appearance of the existing lake. Interpretively, Lake GE and AR do not experience a perfect resemblance. GE Lake is structurally narrowed, while in AR the lake is expanding or widening. In interpretation between Lake GE and augmented reality do not experience a perfect resemblance. There are several parts of the lake area that are not suitable, indicated by letters A, B, and C in Figure 24, while areas that are suitable are indicated by letters D, E, and F.

4 Conclusion

a. The stages in the geographic design of augmented reality sandbox include the preparation of tools and materials, design planning, and prototyping .
b. sandbox development process in this study was carried out with the initial step of making a sketch using Corel Draw software using wood as a base material, and developing a sandbox made of iron/aluminum with the planned size.
c. The trial process for using augmented reality sandbox technology consists of installing the Ubuntu OS and installing which consists of, namely Kinect calibration , calculating the base plane, measuring the 3D area, calibrating sensors and projectors, and sandboxing can be used.
d. Geomorphological features contained in the Ar system, namely in the form of land and water forms based on calibrated heights. The appearance of the land according to color is in the form of lowland areas in green, medium plains in yellow, and highlands in orange. While the water areas such as rivers, lakes, and seas, are based on color, namely, shallow waters with light blue, and deep waters with dark blue. Singkarak Lake modeling can be done with Augmented Reality sandbox technology , lake identification is easier to do, by simulating the formation of lakes.

Acknowledgement

Thank you to the Supervisor, research team, Geography lecturer, and ICGEO^{2nd} committee, as well as students involved in assisting the paper.

References

[1] R. T. Azuma, "A Survey of Augmented Reality, Hughes Research Laboratories, Malibu.," 1997.

[2] Mark Bilinghurst, "Augmented Reality in Education," *(http://it.civil.aau.dk/it/education/reports/ar_edu.pdf)*., 2002.

[3] V. Geroimenko, *Augmented Reality Games II*. Springer International Publishing, 2019.

[4] A. Yulfa *et al.*, "Pembangunan Geo-Augmented Reality untuk Pengembangan Pembelajaran Geografi Berbasis Project Based Learning," *Abdi J. Pengabdi. dan Pemberdaya. Masy.*, vol. 4, no. 1, pp. 199–204, 2022, doi: 10.24036/abdi.v4i1.243.