Design And Development Of Android-Based Interactive 3D Virtual Tours For Campuses

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Abstract.

Virtual Tour has become a popular simulation in virtual reality (VR) technology by combining a series of images to produce 360-degree panoramic photos. By taking objects in the Wijaya Kusuma University Surabaya campus environment, the Virtual Tour can introduce the social and physical environment to new students and the general public. This research aims to enable users to feel like they are in the campus environment through the virtual world. The virtual world environment is created in 3 dimensions, which contains an explanation of the object to be targeted; for software design using programming algorithms in the C# language, a finite state machine (FSM) is created in designing the player control system, 3D Blender in creating three-dimensional objects and using Unity 3D in building applications. The research results show an innovation in the form of a 3D virtual tour of Wijaya Kusuma University Surabaya using the Unity 3D platform, which allows users to interact with the campus environment through smooth movements using a virtual joystick. This virtual tour allows users to explore the university in depth by walking around the campus to find important places at Wijaya Kusuma University Surabaya.

Keywords: *Virtual Tour, Virtual Reality, Android, Interactive and 3 Dimensional.*

I. INTRODUCTION

A virtual tour visually represents a location or environment that can be accessed digitally. It allows users to explore and experience those environments through digital media, often 360-degree or 3D technology [1]. Virtual tours can include various locations, such as interior spaces, buildings, cities, parks, or even planets. This concept has broad applications, but we focus on virtual tours to explore educational institutions, such as universities or schools, in this context. The campus environment plays a crucial role in students' decisions when choosing where to pursue higher education. To increase involvement and expand prospective students' views of the facilities and potential of an institution, the use of an Interactive 3D Virtual Tour [2], which can be accessed via Android devices, is an innovative step [3].By combining the power of Android technology and 3D Virtual Reality experience, this research aims to provide users with an immersive experience in exploring campus virtually [4].

The focus on interactivity will give users the freedom to explore lecture halls, laboratories, libraries, and campus recreation areas, all through an easy-to-use interface on their Android devices [5]–[7]. In terms of scope, the campus environment is divided into two parts: the physical and social environments. The physical environment in question includes learning tools, campus buildings, etc. Meanwhile, the campus social environment consists of lecturers and classmates [8].This research takes a case study of the campus, namely Universitas Wijaya Kususma Surabaya (UWKS). The University of Wijaya Kusuma Surabaya is a campus with the theme of the buildings and environment of Majapahit culture. The campus environment is taken in specific areas such as the main lobby, library, mosque, and sports field areas. For software design, flowcharts and FSM are used for interaction concepts with users, while for graphic creation, 3D image processing is used. The main aim is to introduce the environment of Wijaya Kusuma University Surabaya (UWKS) to the broader community and prospective students so that they can know more clearly about the environment at UWKS.

II. METHODS

The research begins by analyzing user needs so that it can be used as a reference for system needs. After generating user needs, the research method generally has two parts: software engineering design 2D for user interface and 3D for character graphic design. In software engineering, finite state machine (FSM) [9]

algorithms and flow diagrams are used; in graphic design, the 3D blender application is used; and finally, Unity 3D is used in development. For more details, see Figure 1.

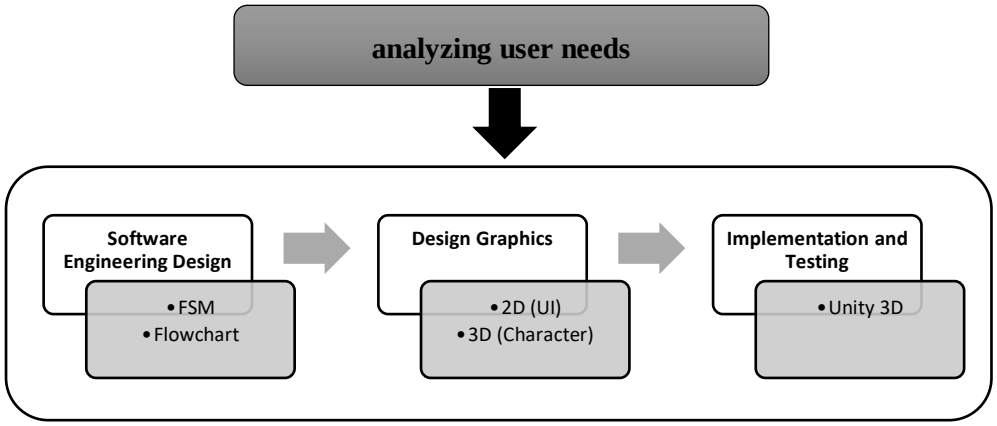

Fig 1. Research flow

User satisfaction is the primary goal of creating an application, so it is necessary to know the needs of users in general [10], including:

- The User Interface is simple and easy to understand.
- Interactive User Interface.
- Building objects displayed in the application exist in the real world.

To design the system, use FSM so that it is visible in the virtual tour, especially in the user interactive concept. In contrast, the flowchart algorithm is used to design software for player movement, the player moving vertically and the player moving horizontally, and display texts when a collision occurs with another object.This UI design with 2D graphics is helpful for user interaction and the virtual tour system. UI design consists of a main menu and information UI. 3D graphic design for the characters and environment around the UWKS campus, which includes the lobby, field, various offices on campus, and also the campus mosque.The Virtual Tour application uses several tools, including Blender3D and SketchUp, which are useful for designing and creating the necessary 3D objects, Adobe Photoshop for editing images or textures in coloring 3D objects, Unity 3D for creating Virtual Reality applications using the C# programming language, and Audacity for creating sound effects.

III. RESULT AND DISCUSSION

1. Analyzing user needs

The main need for users is that they can move around the campus and that objects on campus provide explanations when approached. Apart from that, the shape of the object also resembles the actual situation, so it is necessary to view the object from above so that users can map the location of buildings on campus.

2. Software Engineering Design

For software engineering, FSM (Finite State Machine) describes the movement of a virtual joystick for the user, where the user is considered the player. Starting from State Spawn Player, if the user does not direct the joystick, then the transition value is 0, or the player will freeze. If the user directs the joystick, then the transition will have a value of 1, but if the user does not direct the joystick, then the transition will have a value of 0. In this FSM, there are float x and y, which function to direct the joystick vertically and horizontally, as in Figure 2.It is used to display programming algorithms so that it clearly provides an overview of the course of a program from one process to another. The Movement Flowchart in Figure 3 shows how the user can move, starting from detecting horizontal and vertical input and changing position in real-time. Figure 4 shows a flowchart to display text if the player approaches the target object, also known as a collision.

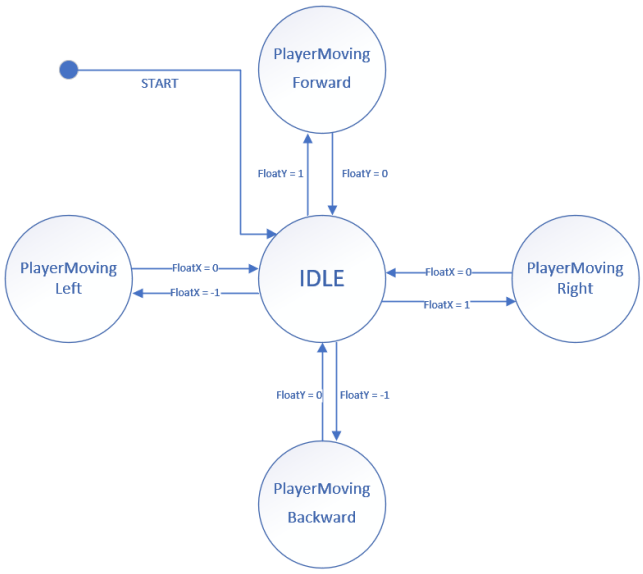

Fig 2. FSM for users/players to access Joystick

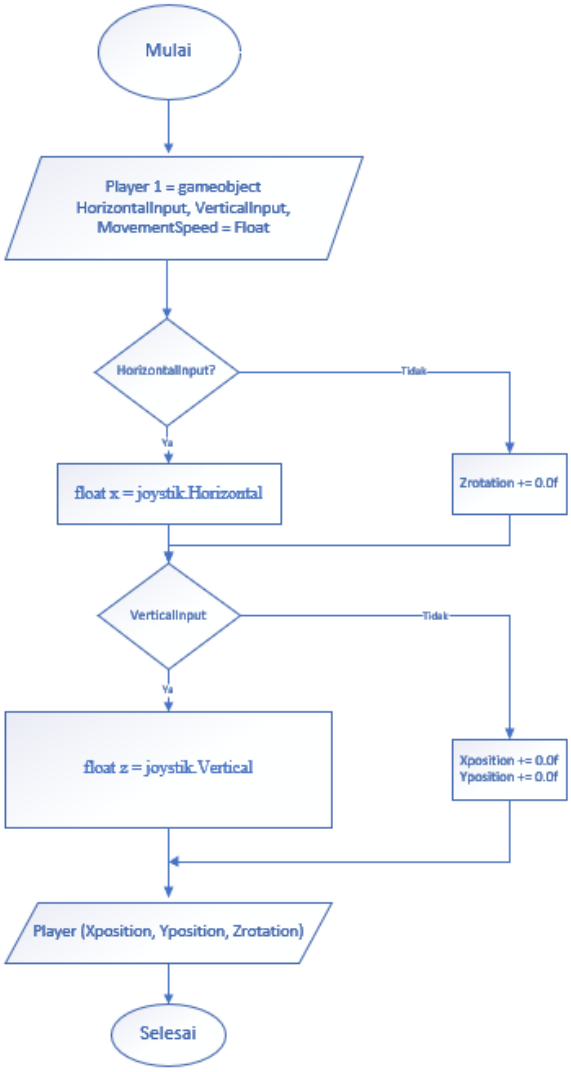

Fig 3. Flowchart for users movement

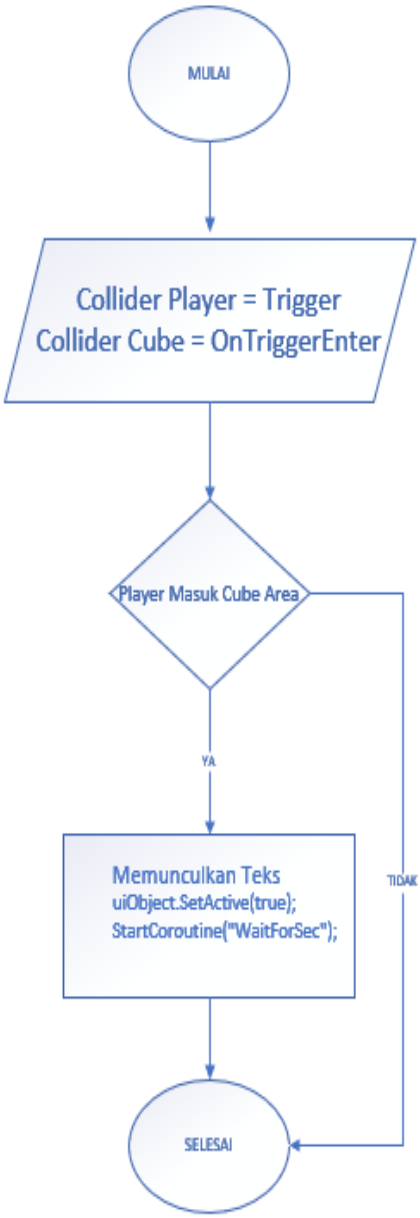

Fig 4. Collision detection Flowchart.

3. Design Graphics

The UI design is 2D so that it becomes a means of interaction between users and the virtual tour. Consists of a menu display design and an info display design when a collision occurs. In Menu Display Design, this is the display that will appear automatically when the application starts running. This display contains three buttons that can be selected by the user, namely Start, Info, and Exit, as in Figure 5. In the information display design, when a collision occurs, as in Figure 6.

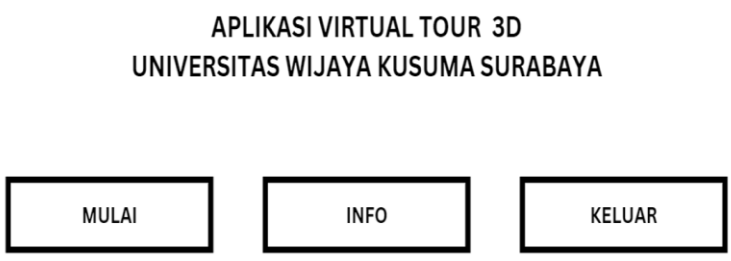

Fig 5. User Interface design for the main menu.

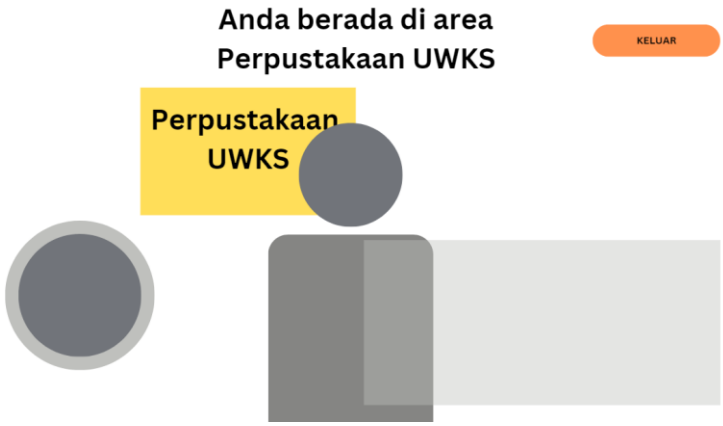

Fig 6. User Interfaces design for text information.

The 3D design includes the character and environment of the space and buildings on the Wijaya Kusuma University campus, Surabaya. The character sketch is a man who will animatedly walk around the campus; then, several parts of the office are sketched in 3D, as in Figure 7.

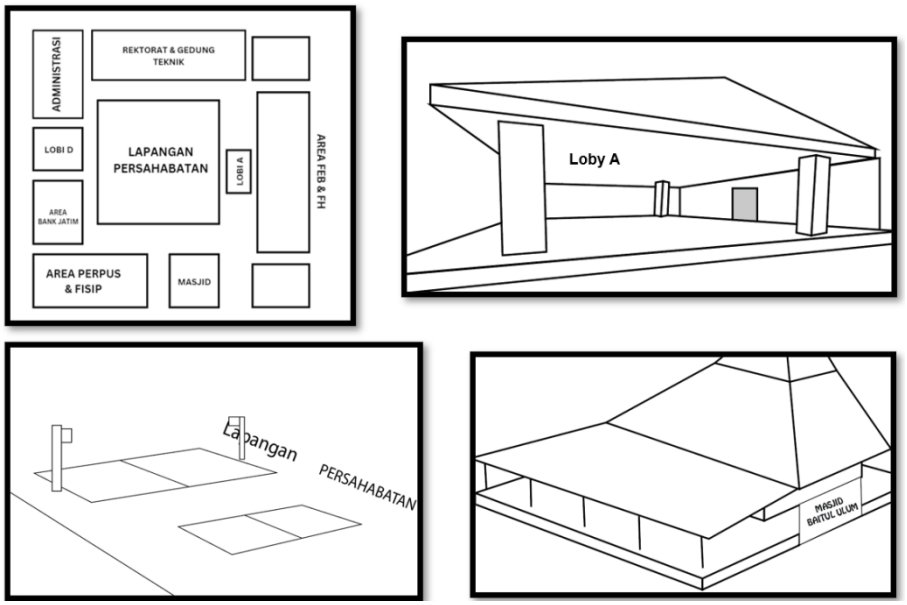

Fig 7. Examples of several 3D designs for around campus.

4. Implementation and Testing

The software implementation takes the form of programming using C# with the Unity game engine, and for graphics, a 2D and 3D image processor is used. The source code for user-driven character movement, in this case, is a player like Figure 8.

```
public float speed = 12f;
    public CharacterController karakter;
    public float gr = -9.81f;
    Vector3 velocity;
    public FixedJoystick joystik;
   void Update()
   {
       //IMPLEMENTASIKAN JOYSTICK
      float x = joystik.Horizontal;
      float z = joystik.Vertical;
     //UNTUK MENNGERAKAN player
      Vector3 move = transform.right * x + transform.forward * z;
      karakter.Move(move * speed * Time.deltaTime);
      //MEMBUAT GRAVITASI
      velocity.y += gr * Time.deltaTime;
      karakter.Move(velocity * Time.deltaTime);
   }
```

Fig 8. Code for users movement

The source code displays information on the area that is passed when a collision occurs, as in Figure 9.

```
public GameObject uiObject;
    void Start()
    {
        uiObject.SetActive(false);
    }
    // Update is called once per frame
    void OnTriggerEnter (Collider player)
    {
        if (player.gameObject.tag == "Player")
        {
            uiObject.SetActive(true);
            StartCoroutine("WaitForSec");
        }
    }
    IEnumerator WaitForSec()
    {
        yield return new WaitForSeconds(12);
        Destroy(uiObject);
        Destroy(gameObject);
    }
```

Fig 9. Code for Collision Detection.

Implementation of the user interface as in Figure 10, and for 3D graphics as in Figure 11.

Fig 10. User interfaces for start application.

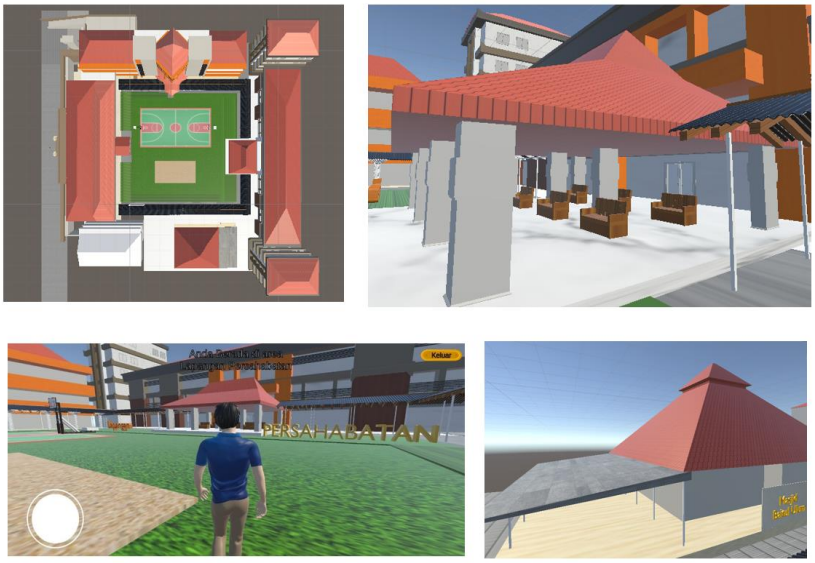

Fig 11. 3D campus enviroment and character.

The sections for the User Accepted Test (UAT) are Joystick testing on the Virtual Tour, Testing the camera direction on the Virtual Tour, and Testing the Animation and Collider on the Virtual Tour. Application testing results are in Table 1.

Table 1. Testing application result

No	Test Scenario	Result	Condition
Joystick Testing			
1	Joystick pointed upwards	The character moves forward	Correct
2	Joystick pointed downwards	The character moves backward	Correct
3	The joystick is pointed to the right.	The character moves to the right	Correct
4	The joystick is pointed to the left	The character moves to the left	Correct
Camera direction testing			
5	Swipe down on the right side of the screen	The character looks up	Correct
6	Swipe up on the right side of the screen	The character looks down	Correct
7	Swipe right on the right side of the screen.	The character looks to the right	Correct
	Swipe left on the right side of the screen.	The character looks to the left	Correct
Animation and Collider Testing			
8	Character walking animation	The character will start a walking animation	Correct
9	Character Idle	The character will start to idle	Correct
10	Collider in Lobby A area	Characters cannot penetrate objects in Lobby A and show the information text.	Correct
	Collider in the mosque area	Characters collide in the mosque area and show the information text.	Correct

IV. CONCLUSION

The software design and graphic design for the interactive 3D virtual tour of Wijaya Kusuma University Surabaya based on Android was successfully implemented, as seen by the appropriate user. The test results were acceptable. The character can be controlled by the user using a virtual joystick, and when a collision occurs with an object on the campus property, information about the object will appear. This application can be used to provide more experience to users and is useful for the campus as an object of promotion and introduction to the wider community.

REFERENCES

[1] J. Song and S. Huang, "Virtual Reality (VR) Technology and Landscape Architecture," *MATEC Web Conf.*, vol. 227, p. 02005, Nov. 2018, doi: 10.1051/MATECCONF/201822702005.

[2] M. B. Garcia, D. M. C. Mansul, E. B. Pempina, M. R. L. Perez, and R. T. Adao, "A Playable 3D Virtual Tour for an Interactive Campus Visit Experience: Showcasing School Facilities to Attract Potential Enrollees," *2023 9th Int. Conf. Virtual Reality, ICVR 2023*, pp. 461–466, 2023, doi: 10.1109/ICVR57957.2023.10169768.

[3] A. P. Ramadhanty, P. W. Handayani, A. A. Pinem, and M. H. Hilman, "Virtual Tour Actual Usage: The Influence of Perceived Benefits and Sacrifices," ***J. Sist. Inf.,*** vol. 17, no. 2, pp. 62–76, Oct. 2021.

[4] A. D. Samala, M. Ricci, C. J. A. Rueda, L. Bojic, F. Ranuharja, and W. Agustiarmi, "Exploring Campus through Web-Based Immersive Adventures Using Virtual Reality Photography: A Low-Cost Virtual Tour Experience," ***Int. J. Online Biomed. Eng.,*** vol. 20, no. 01, pp. 104–127, Jan. 2024, doi: 10.3991/IJOE.V20I01.44339.

[5] S. Ramdhan, R. Tullah, & Oka, and R. Nirlandi, "Promotional Media Application with Android-Based Virtual Tour Technology," ***J. SISFOTEK Glob.,*** vol. 12, no. 2, pp. 131–137, Sep. 2022.

[6] R. Cózar-Gutiérrez and J. M. Sáez-López, "Game-based learning and gamification in initial teacher training in the social sciences: an experiment with MinecraftEdu," ***Int. J. Educ. Technol. High. Educ.***, vol. 13, no. 1, p. 2, Dec. 2016, doi: 10.1186/s41239-016-0003-4.

[7] Y. W. Purnomo and Herwin, "Educational Innovation in Society 5.0 Era: Challenges and Opportunities," Oct. 2021. doi: 10.1201/9781003206019/EDUCATIONAL-INNOVATION-SOCIETY-5-0-ERA-CHALLENGES-OPPORTUNITIES-YOPPY-PURNOMO-HERWIN.

[8] G. T. Hawkins, C. S. Chung, M. F. Hertz, and N. Antolin, "The School Environment and Physical and Social-Emotional Well-Being: Implications for Students and School Employees," ***J. Sch. Health,*** vol. 93, no. 9, pp. 799–812, Sep. 2023, doi: 10.1111/JOSH.13375.

[9] I. Setiawan, "Perancangan Software Embedded System Berbasis FSM," ***J. Tek. Elektro,*** pp. 1–2, 2006.

[10] D. Saputra and R. Kania, "Designing User Interface of a Mobile Learning Application by Using a Design Thinking Approach: A Case Study on UNI Couse," ***J. Mark. Innov.***, vol. 2, pp. 102–1019, 2022.