

Development of Web-based Metaverse Platform

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Abstract—Most of the metaverses need to install programs or buy some equipment for entering the world. These processes reduce the accessibility of metaverse. To improve accessibility, this work develops a metaverse for service on the web environment using Unity and web development. The developed web-based metaverse has two advantages. The first advantage is increasing accessibility, when the metaverse is servicing on a web environment, users can connect to the world by typing the specific Uniform Resource Locator (URL) in an address bar. The second advantage is to mix the advantages of Unity and web development. Unity has many methods and assets for generating and controlling the metaverse, and web development has the good ability for communicating between browser and server, controlling information in the database, etc. To interact between Unity and the web, React was used in this work. React provides an Application Programming Interface (API) for interacting between Unity and the web. API makes the metaverse can use functions of the web in Unity. In summary, the goal of this paper is to build a web-based metaverse platform for improving the accessibility of metaverse. To achieve this goal, this work used Unity, Photon, Socket.IO, React, Node.js, MongoDB, and Express for building a more accessible metaverse. For accessing this work built metaverse, the URL is provided as <https://busanmayor.org/>.

Index Terms—metaverse, Unity, web development

I. INTRODUCTION

Metaverse, the word was first used in the novel "Snow Crash" written by Neal Stephenson. [1] It is the combination of meta which means transcending and the word "Universe". In the novel, the author described the metaverse as the virtual world which paralleled the real space in that users can interact through characters projected by self.

Because of the worldwide spread of COVID-19 and the progression of technology like Virtual Reality (VR) and Augmented Reality (AR), the metaverse is attracting the world's attention.

COVID-19 has made people avoid direct contact with each other and has naturally increased interest in using the digital space. [2]

Along with this trend, the recent development of technologies such as VR, AR, and Extended Reality (XR) has led companies or individuals to try to apply metaverse to various fields. But, accessing the metaverse needs some types of equipment or installation programs. These reduce the accessibility of the metaverse.

Our main contribution is to develop web-based metaverse platforms for increasing accessibility. In this paper, the metaverse development consists of two parts. The first one is Unity,

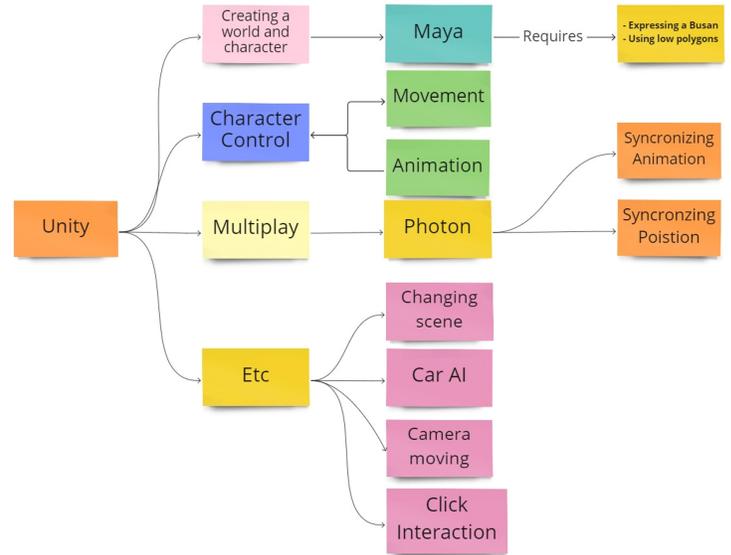


Fig. 1. Unity overall tasks

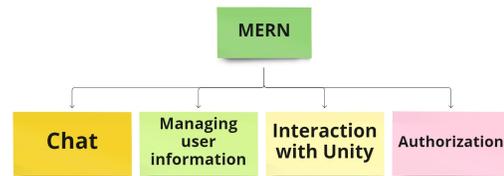


Fig. 2. MERN overall tasks

its roles are creating and controlling the world and characters, and implementing the multiplayer function.

The second one is web development. We used MongoDB, Express, Node.js, and React (MERN) in the web part. MERN is used to manage the information of the users, interact with Unity and external website, authorization, and implement the chatting function. Fig. 1 and Fig. 2 show the overall tasks of Unity and MERN

II. UNITY

Unity is a development engine for 2D, and 3D games originally. But recently, it is used for AR, VR, Animation, 3D construction modeling. This engine can be used on various platforms like Windows, macOS, Linux, and WebGL. Also, it provides developers with a variety of development methods



Fig. 3. Characters

[3]. These are the reasons why using Unity for generating metaverse in this work.

In Unity, objects, components and script are used for implementing to function. Objects mean everything that exists in game, such as the world, character, and building. However, objects can not do anything alone. To control the object, it needs to add the component to the object. The component makes the object has properties such as coordinate, and scale. The script means the code using C# programming language. In code, users can get objects and modify the values of properties in components.

A. Character

In this work, the number of characters are four, an old man, a young man, and a woman and a girl. To reduce the burden of the network, characters are generated to have a low number of polygons through Maya that 3D graphic program.

Fig. 3 shows characters on the metaverse platform.

1) *Implementing physics:* The physical actions of the character is implemented through rigidbody and collider, which are components provided from Unity.

Rigidbody gives character properties that mass, gravity, and drag. It allows the character to have physical effects.

Collider makes the character collide with other objects. There are six kinds of 3D colliders in Unity, box collider, mesh collider, sphere collider, terrain collider, and wheel collider. Character's collider is used capsule collider among these colliders

2) *Character animation:* The character has the four animations such as standing, walking, running, and greeting. These animations are controlled using animator controller in Unity.

The animator controller is a component that gives an animation a condition and allows the animation to run when the condition is satisfied. Each of the four characters used was assigned to execute an animation suitable for each activity under the condition of the input into the script. Fig. 4 is the animator controller used to implement the animation of the character

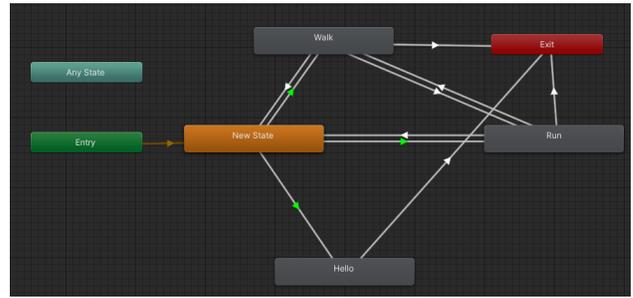


Fig. 4. Animator Controller

B. World

World was created by taking the shape of Busan in Korea. Rather than expressing Busan through a realistic description, It is generated with a focus on expressing landmarks in Busan. it was made in the direction of reducing the load on the computer by reducing the polygon. Instead of a capsule collider, the world used a mesh collider that adds a collider to all polygons.

The world includes the ocean. To prevent the character from falling into the ocean, Transparent walls equipped with a collider were placed on the boundary between the land and the sea.



Fig. 5. Photon

C. Multiplaying

Photon¹ is used to implement multi-playing in this paper. Photon offers a server and components and scripts for multi-playing. It provides an app id for connecting a Photon server. By adding it in unity project settings, The project can access the Photon's server. This work used three components from Photon The first component is the Photon view. It serves to distinguish one's character from the other characters. By using its property, the script can find each own character among all characters and deliver input.

The second component is the Photon transform view. The photon transform view provides information about the positions of characters. Position information is used for synchronizing coordinates of characters and it makes people they are in the same space.

The third component is the Photon animator view. Photon animator view sends each animation state of each character. Information of state allows users to see each other's animations and it helps users to interact with each other.

¹<https://www.photonengine.com/>

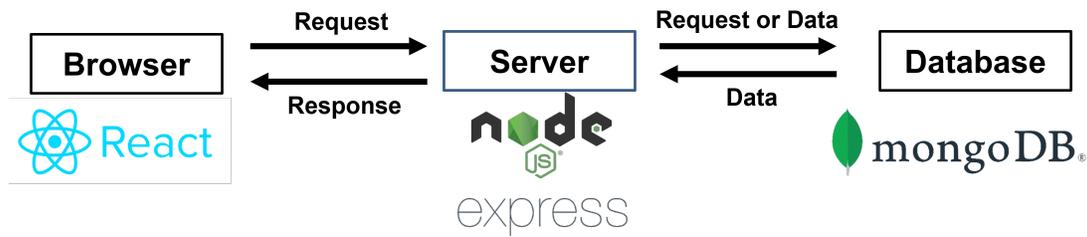


Fig. 6. Roles of MERN in web development



Fig. 7. World

D. Car AI

In this work, there are three kinds of vehicles and two kinds of Non-Player Characters(NPC). They keep moving on the set path automatically avoiding each other. This function used the Nav Mesh Agent component.

Nav Mesh Agent determines the moveable space and the unmoveable space by choosing specific polygons. In the moveable space, it can make a path by setting points to move. When the paths overlapped and can bump into each other, they change their path on the moveable space.

III. MERN

Full-stack web development has two parts, front-end, back-end. Front-end means the part that users can see. Three programming languages including HTML, CSS, and JavaScript are used in the front-end. HTML is used to make the structure of the website, and CSS generates the design and style by controlling elements of HTML. JavaScript makes the website interact with the server and make functions. In this paper, React² is used to manage the front-end. React is a JavaScript library for helping developers to make complex websites.

The back-end is the part that manages the server and database. The front-end sends a request for data to the back-end, and the back-end transfer data to the front-end from the server or database. In the back-end part, this work used

²<https://reactjs.org/>



Fig. 8. Socket.IO

Node.js³, Express⁴, and MongoDB⁵. Node.js is an open-source, cross-platform, back-end JavaScript runtime environment that runs on the V8 engine and executes JavaScript code outside a web browser, which was designed to build scalable network applications. Express is a web framework for Node.js based on HTTP and Connect components. MongoDB is used to store data from websites in JSON format. In the web-development, The combination of MongoDB, Express, React, and Node.js is called MERN. [4] Fig. 6 is showing how MERN is used in web development.

A. Managing user information

In this work, when accessing the website, the user receives the nickname to be used through the input window on browser and selects the character, the nickname and character information are delivered to the server and stored in the database. This information is used to display the user name of the chat window and to use the selected character in the metaverse world.

B. Authorization

Since there is no login function, a separate web page was created to identify the administrator. On this webpage, if users type input window the password that is stored in database, users be administrator. The administrator is given the right to block the chat, ban the user, and deliver announcements.

C. Interaction with Unity

In order to use the metaverse world on the webpage, React-Unity-WebGL⁶ is used. React-Unity-WebGL is API available in React. This API has two functions including uploading the unity project on the webpage and interacting between the web

³<https://nodejs.org/>

⁴<https://expressjs.com/>

⁵<https://www.mongodb.com/>

⁶<https://www.npmjs.com/package/react-unity-webgl>

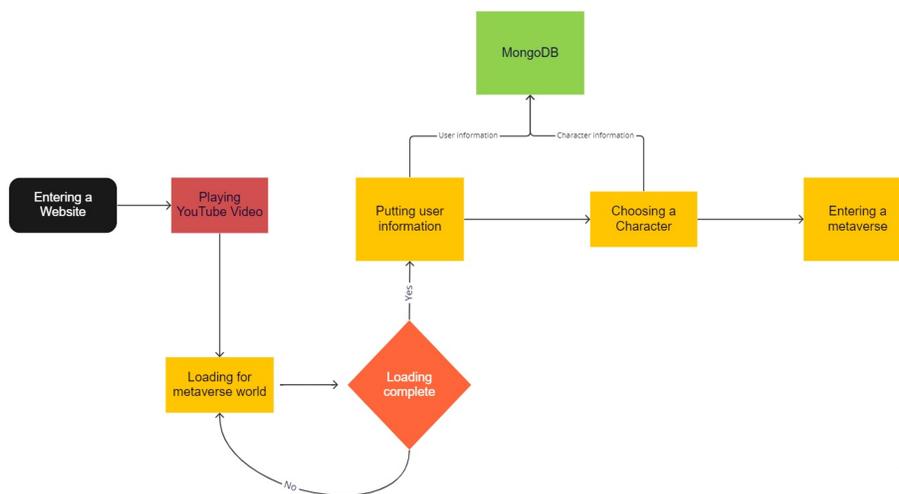


Fig. 9. Metaverse flow chart

and Unity. Uploading the unity project on the webpage is implemented by a Unity project file built in WebGL format. Because of the file consist of JavaScript, React can get and display it on the webpage. The location and scale of the Unity project on the webpage can be adjusted by using HTML and CSS. Interacting between the Unity and web is used for implementing to display user name on the world that gets from the input window on the webpage, and opening the new webpage when clicking specific objects in Unity, etc.

D. Chatting

In Express and Node.js, Protocol is HTTP protocol. In the HTTP protocol, the Connection between the browser and server is only connected when the browser sends the request to the backend, and after the response of the backend, the connection is disconnected. This feature makes the chat function hard to implement in HTTP protocol.

But in the WebSockets protocol, the connection between the browser and server is always connecting. This feature means the server can send data without the browser's request and also makes real-time communication function can be implemented in the WebSockets protocol. To add a WebSocket protocol to this work, Socket.IO⁷ was used.

Socket.IO is a server-side library for Node.js and also it makes web-application can use real-time bidirectional communication between the browser and the server. The chat function was implemented as follows in this work. When users type messages on the input window, the message is stored in the database, and at this time Socket.IO makes the server send all messages to all users to display the chat contents on the chat window.

IV. RESULT

The overall flow of the metaverse is shown in Fig. 9. When users access the website, a YouTube video through MERN

is displayed on the webpage, and in the meantime, load the built metaverse world on the website. When the world is loaded, the camera is controlled through the script to be moved for users can look around the world. The browser receives nickname information from the pop-up input window, and the information is stored in the database of MongoDB via the back-end. After typing the nickname, the world is changed to the character selection scene. In this scene, users can choose the character among the old man, young man, young woman, or girl. After finishing selecting a character, users enter the world as the selected character and interact with other users. Fig. 7 is the world used.

V. CONCLUSION

Implementing metaverse through a website has the advantage of being accessible by simply entering a domain address in URL, so it can be used immediately without a complicated process. In addition, it is possible to access external websites and utilize user information using various APIs provided by the web.

ACKNOWLEDGEMENT

This results was supported by "Regional Innovation Strategy (RIS)" through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(MOE)(2021RIS-003)

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⁷<https://socket.io/>