A Study on the Development of Urban Internal Waters Flooding Visualization System Using Unreal Engine

Yu-Yeon LEE, Hye-Ji PARK and Sung-Chan OH

Abstract: Natural disasters continue to rise due to global warming, and domestically damage due to flooding is the heaviest of all disasters. To minimize these damages, accurate information delivery and speedy countering are required. This study thus aimed to develop the Unreal Engine-based virtual monitoring system designed to ensure an intuitive identification of internal waters flooding occurrences and rapid decision making. The research targeted the Gwanghwamun area in Seoul that has a heavy cluster of facilities and that is likely to suffer heavy flooding. A base map was created, using free 3D object model files including Unreal Marketplace. On the constructed 3D base map, the leveling function designed for the intuitive identification of flooding occurrences was developed and the flooding status was implemented, and Shader designed for expressing the water surface like actual images was developed and applied to the system. Further, buoyancy was applied to 3D objects so as to implement the effects of buoyancy and flooding. The development of such 3D urban internal waters flooding visualization system can predict the situation of the affected area where power outage and communication facilities paralysis occur due to internal waters flooding, making it impossible to identify the damage situation. The resultant data can be used for reference for decision making, thus effectively preventing damage.

Keywords: Internal Waters Flooding, Unreal Engine, Intuitively, 3D, System

1. Introduction

Global warming heavily affects the survival of humans all over the world. Thus, average temperatures rise, creating abnormal climate and sudden climate change and bringing on sudden natural disasters frequently. The recent flooding type is characterized by a fast growing amount of local heavy rain-causing urban flooding damage rather than river flooding-causing flooding. According to historical data, for a typical example, the Gwanghwamun Plaza and areas adjacent to Gangnam Station have thus far suffered flooding damage due to heavy rain. Since urban areas are densely clustered by residential, business, and other facilities and have a high population density, in the case of disaster occurrences, huge human and property damage occurs, thus requiring thorough preventive measures. However, local governments have yet to bolster countering measures. In order to reduce damage so as to prepare measures aimed at effectively preventing and managing urban internal waters flooding damage, special agencies or companies continue to conduct research on the selection and analysis of frequently flooding-hit areas to prevent the damage. This study

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targeted areas that had suffered damage due to heavy rain in the past, and a virtual space was created using Unreal Engine that enables the crafting of intuitive and three-dimensional space. This study aimed to create a visualization system to simulate the same situations as those created by actual internal waters flooding in actual areas, to predict flooding levels, to identify the situation intuitively and to serve as a decision making tool for countering the situation.

2. Configuration of Internal Flooding Prediction Visualization System

In this study, Unreal Engine was used because it enables the use of high-quality 3D graphics compared to other engines. Unreal Engine is a powerful game production engine, boasting high reliability and good optimization, and it has the advantage of being able to use the visual scripting function of blueprint so as to ensure an easy development. Further, the development cost can be reduced using free open resources such as Github. However, Unreal Engine requires high-specification hardware since it can implement high quality features. The computer used for the system development requires a production environment of CPU (Intel® Core™ i7-6700K CPU @ 4.00GHz), graphic card (NVIDIA GeForce GTX 1060 6GB), and RAM (32GB).

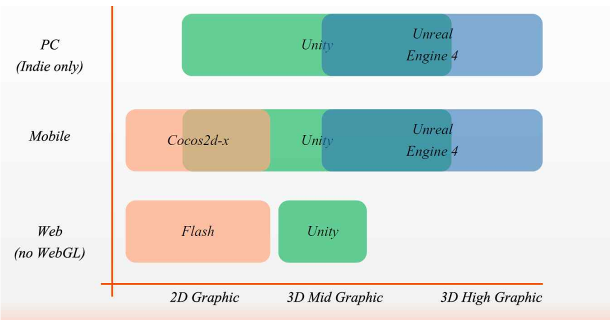

Figure 1. Positioning by graphic platform

2.1. Construction of Gwanghwamun Plaza, Seoul Base Map

In the target Gwanghwamun area in Seoul, a map was constructed from the viewpoint of the user facing the Yi Sun-sin bronze statue. 3D object model files used for the construction thereof were secured from the free resources deemed similar to the actual space facilities. Unreal Engine MarketPlace-providing PolygonCityMaps where urban topography is available was used. The space to be used as an urban background was designated, and the existing deployed objects were removed, and a topography was deployed where facilities on the Gwanghwamun Plaza were due to be placed. And, deployed on each location were 3D model files similar to facilities on the actual space.

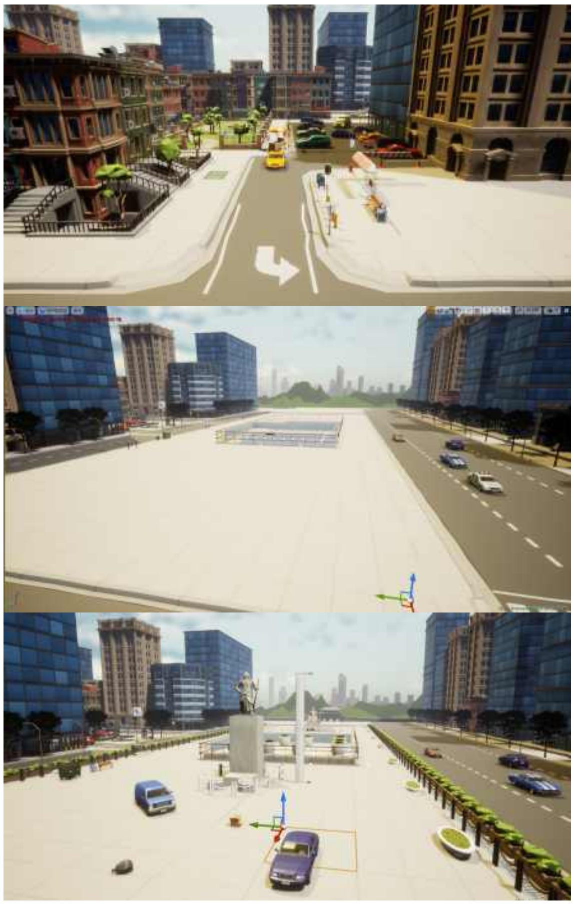

Figure 2. Construction of Gwanghwamun base map

2.2. Flooding Damage Confirmation Leveling Function

Using Widget Blueprint, the UMG button was created. The main functions of the system were produced in the Level Print event graph which can treat all object motions occurring in the system. The function was implemented to click the UMG button, raising the objects that express as much designated water level value of 0. Three values have been specified as samples to confirm situations by stage, so the function is referred to as Leveling. The function of buoying the objects from above stage 2 of 3.5m was added in Leveling. The 3D model Fbx files to be used in the level blueprint was imported to the contents browser so that several objects designed for simulating the submersing situations during flooding were designated and then nodes for importing the actor position and rotation value state were configured. Figure 4 shows the blueprint node designed for creating the effects of buoyancy during flooding situation occurrences. A change was made to the current location of the actor, imported when the level rose to above a certain value, and to the rotation value, and a configuration was created to create the real-time buoyancy effects using the Timeline function. Further, to make it similar to the actual flooding effect, the free-provided Texture Shader to be applied to the level surface was reprocessed and used.

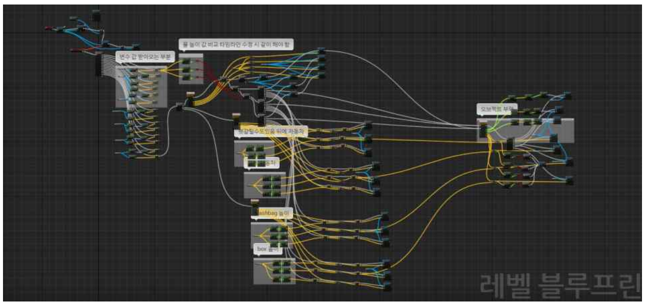

Figure 3. Full node diagram

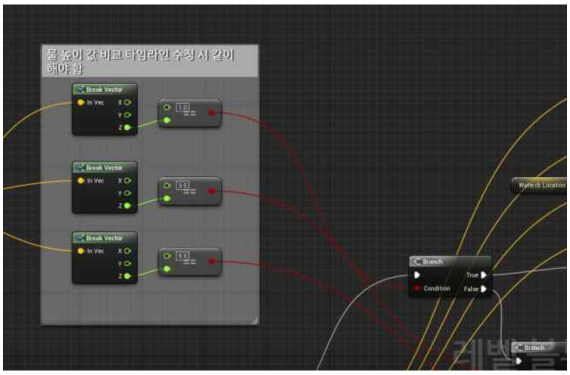

Figure 4. Adjustment of leveling stages

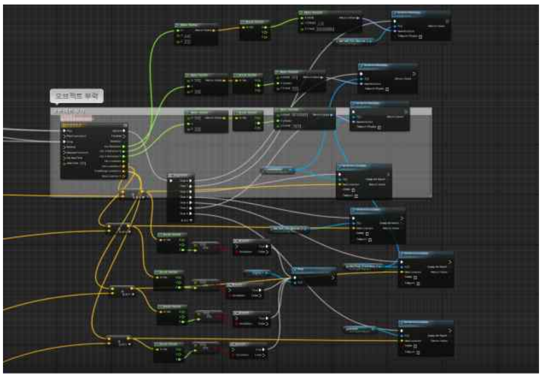

Figure 5. Real-time value change node for buoyancy effect

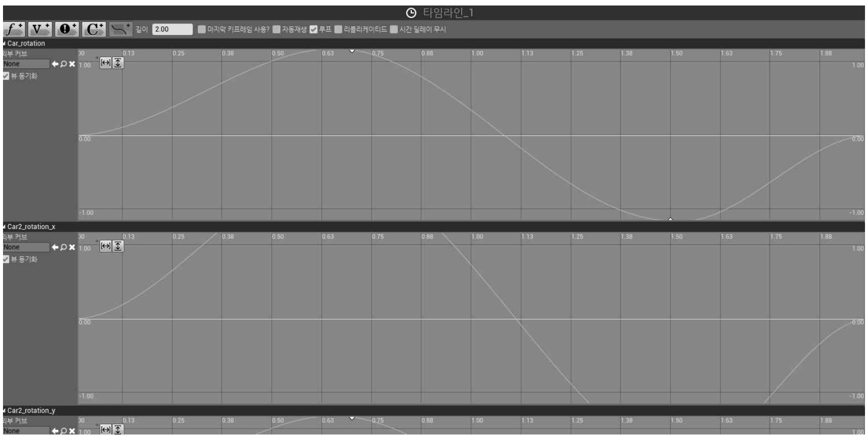

Figure 6. Timeline applied

Figure 7. Result

3. Conclusion

This study selected areas that had frequently been hit by flooding damage, constructed a 3D-based topography, and produced a system designed to predict the internal flooding occurrence situations. Through the leveling function designed to confirm level changes by stage through the current levels of samples, a flooding situation close to the reality can be confirmed. If applying numbers closer to actual numerical value by being linked to the expected levels based on the future actual observed rainfall or to or facility height and the like, the leveling function is deemed to be able to be used more efficiently. Real graphics and effects can be created using Unreal Engine with excellent graphic effects compared to other 3D engines, thus making it possible to simulate situations similar to the actual internal waters flooding and enabling the user to respond to flooding intuitively and speedily.

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References

Joo-Chang Kim, Hoill Jung, Sungho Kim, Kyungyong Chung, 2016, *Slope Based Intelligent 3D Disaster Simulation Using Physics Engine*, Wireless Personal Communications, 86, 183-199.

Ioannis Pachoulakis, Georgios Pontikakis, *Combining features of the Unreal and Unity Game Engines to hope development skills*, 4 figures in Proceedings of the 9th International Conference on New Horizons in Industry, 5.

Jongyong Kim, Gyewon Lee, Joonyoung Cho, Dongwook Kim, Sanghun Park, *Visualization System for Natural Disaster Data*, 2018, J. of KCGS, 24, 21-31.