

Development of a realistic VR device using photogrammetry and clarification of evacuation behavior

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BACKGROUND AND PURPOSE

According to the report by the Central Disaster Management Council (2011), the tsunami triggered by the Tohoku-Pacific Ocean Earthquake revealed problems in disaster prevention measures that relied excessively on coastal protection facilities, etc. Originally, coastal protection facilities were supposed to be designed for frequent tsunamis, etc. However, the gap in residents' perceptions and high seawalls promoted a sense of security and could delay evacuation actions.

In recent years, research using extended reality (XR) technology has been attracting attention to take appropriate evacuation actions in specific disaster scenarios (Khanal 2022). Among others, research has been conducted on evacuation drills using virtual reality (VR) (e.g., Saitoh et al. 2018). The presence of a seawall may affect evacuation, but it is not yet clear how much it affects evacuation behavior and sentiment. Therefore, the aim of this study was to construct a VR tsunami experience system and to elucidate the changes in evacuation behavior and emotions with and without seawalls.

TSUNAMI INUNDATION CALCULATION

In this study, tsunami inundation calculations were performed using STOC-ML (Tomita and Kakinuma 2005), based on multilayer nonlinear wave equations. The target area is town A in Mie Prefecture, Japan, where tsunami damage is predicted by the Nankai Trough earthquake in the future. In this study, calculations were performed with and without seawalls, and the breakup of seawalls was not considered.

CREATION OF 3D MODEL

A 3D model of the study area was created to investigate changes in behavior and emotions with and without seawall. To create a realistic 3D space, photogrammetry was employed to photograph the town from various angles. Both sides of the road were moved from different angles, and photographs were taken while ensuring a 60% overlap.

VR TSUNAMI EXPERIENCE

The VR tsunami experience was built using the Unreal Engine 5. It visualizes inundation data and photogrammetrically created 3D models, allowing the user to experience an approaching tsunami. Figure-1 shows the combined 3D model created by photogrammetry and the inundation calculation. Utilizing a 3D model of the city greatly enhances the realism of the VR environment and may allow to explore the user's changes of emotion and behavior. Figure-2 shows the combination of inundation calculations and 3D models with and without seawall. A survey of individuals who experienced the created VR tsunami simulation is conducted. Through the experience, changes were observed in the sense of security and

evacuation behavior with and without the seawall.

SUMMARY

This study aimed to clarify changes in evacuation behavior with and without seawalls using a VR tsunami experience system. The results of the inundation calculations were visualized in unreal and combined with a 3D model of the city using photogrammetry to create a VR tsunami experience system. Through the experience, changes were observed in the sense of security and evacuation behavior with and without the seawall. Future issues related to seawalls and evacuation planning may be discussed based on the results of this study.



Figure 1 - 3D model of town A and visualization of inundation calculation result.



Figure 2 - VR Tsunami Experience Screens

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