INTERACTIVE AUGMENTED REALITY TSUNAMI SIMULATION SYSTEM FOR COASTAL HAZARD EDUCATION

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INTRODUCTION

The abstract is based on the project of “extended reality” for effective communication of hazards from extreme coastal events, such as tsunamis and hurricanes. The project attends to use augmented reality (AR) and mixed reality (MR) to allow, for example, a coastal resident to see a digital tsunami crashing onshore and bulldozing through a community, all while standing on their beach or in their driveway. This type of experience provides an emotional impact and long-lasting memory that will guide future planning decisions and proactivity. Figure 1 shows examples of AR used in reporting severe weather. After dark clouds and a terrain map are added to the screen (as shown in Figure 1. a-b), audiences have a digitally-enhanced 3D layout of the weather in affected areas. In Figure 1 c-d, virtual natural hazards in AR overlaps with the meteorologist’s surroundings. This immersive vision allows audiences to better comprehend the destructive power of extreme events. In this abstract, we focus on applying mobile augmented reality (AR) to a tsunami simulation system and creating this digital extreme event experience. The tsunami modeling studies use the methods and models described in Tavakkol & Lynett (2017), Lynett et al. (2017) and Lynett & Tavakkol (2017).

Figure 1 – Weather forecast studio without AR in a) and with AR in b); The Weather Channels AR demonstration of hurricane flooding in c) and ice storm in d).

INTERACTIVE AR-TSUNAMI SIMULATION SYSTEM

The procedure of the interactive AR-tsunami simulation system is shown in Figure 2. Each color-filled box represents an operator or a solver. Since a mobile phone usually cannot computationally support tsunami simulation, the system will rely on the cloud to handle demanding wave computations. The system is based on ARKit, which is Apple’s AR framework and provides accurate tracking and plane detection, and also supports placing virtual objects on horizontal and vertical surfaces. Given by the arrows in Figure 2, AR-tsunami follows the procedure: (0) Use an iPhone Camera with A12 Bionic technology to record video of the coast. The video is in *.mov format. (1) Use ARKit to perform plane and object detection in the recorded video. The output is a 3D model which contains detected flat ground and vertical coast infrastructure. (2) Send the 3D infrastructure model to a Fluid Dynamics Model, which performs the tsunami simulation. The Fluid Model takes the 3D information and user configuration (e.g. wave height) as inputs. The output is a scenario of water wave propagation. The wave propagation combined with the 3D infrastructure model is referred to as the 3D tsunami model. (3) Use ARKit to add the virtual 3D tsunami model to the original video. It generates a video which shows the simulated tsunami waves within the real-time camera video. In the Fluid Dynamics Model, the Nonlinear Boussinesq model controls the coastal wave transformation, breaking, and runup in the tsunami simulation. For the numerical method, the system does not apply traditional methods like Finite volume method on a meshed geometry. Instead, a meshfree method represents and evaluates the Boussinesq equations. Radial basis functions are used for the meshfree method to overcome common mesh distortion issues.

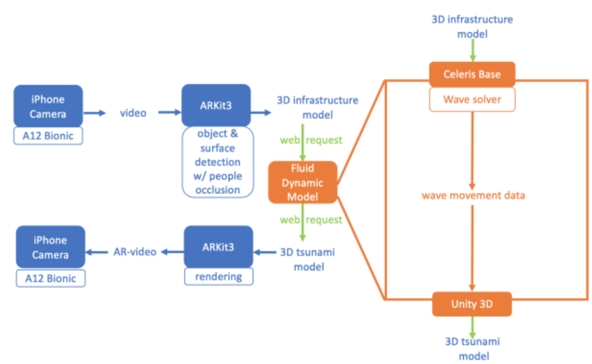

Figure 2 - Diagram of AR-tsunami Simulation System

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