INTERACTIVE VISUALIZATION FOR COASTAL HAZARDS

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Augmented reality (AR) is a technology that integrates 3D virtual objects into the physical world in real-time, while virtual reality (VR) is a technology that immerses users in an interactive 3D virtual environment. The fast development of augmented reality (AR) and virtual reality (VR) technologies has reshaped how people interact with the physical world. This presentation will outline the results from two unique AR and one Web-based VR coastal engineering projects, motivating the next stage in the development of the augmented reality package for coastal students, engineers, and planners.

Three projects demonstrate the completed aspects of this effort – 1) ***AR-tsunami*** for promulgating education about coastal hazards, 2) ***AR-sandbox*** for combining laboratory experiments and numerical simulations in coastal engineering, and 3) ***WebVR-tsunami*** for providing a convenient tool for 3D tsunami visualization and education. AR-tsunami and AR-sandbox produce two user-friendly and GPU-accelerated iOS/iPadOS apps.

Adopting the features of plane detection and people occlusion in ARKit and the Boussinesq-type wave solver in Celeris (Figure 1; Tavakkol & Lynett, 2017, 2020), AR-tsunami can automatically render the tsunami on the ground and provide an immersive experience of the impact of tsunamis for the users. The goal of this experience is to elicit an emotional response in users and influence future planning decisions, and ultimately push a more proactive approach to tsunami preparedness.

AR-sandbox utilizes the LiDAR Scanner on Apple's new generation of iPad Pro in gather a "point cloud" sampling of arbitrary surfaces and generate a high-resolution digital elevation model (DEM) as the bathymetric map for the hydrodynamic simulation. The wave simulation and visualization start instantly after the DEM is transferred to wave solvers, and the resulting simulation is projected on the sandbox through a projector. With AR-sandbox, coastal engineers can view virtual waves interacting with the real-world sands. AR-sandbox combines laboratory experiments and numerical simulations and provides a better practicability and maneuverability.

WebVR-tsunami produces an online web-based VR tool using the numerical simulation of 2022 Hunga Tonga

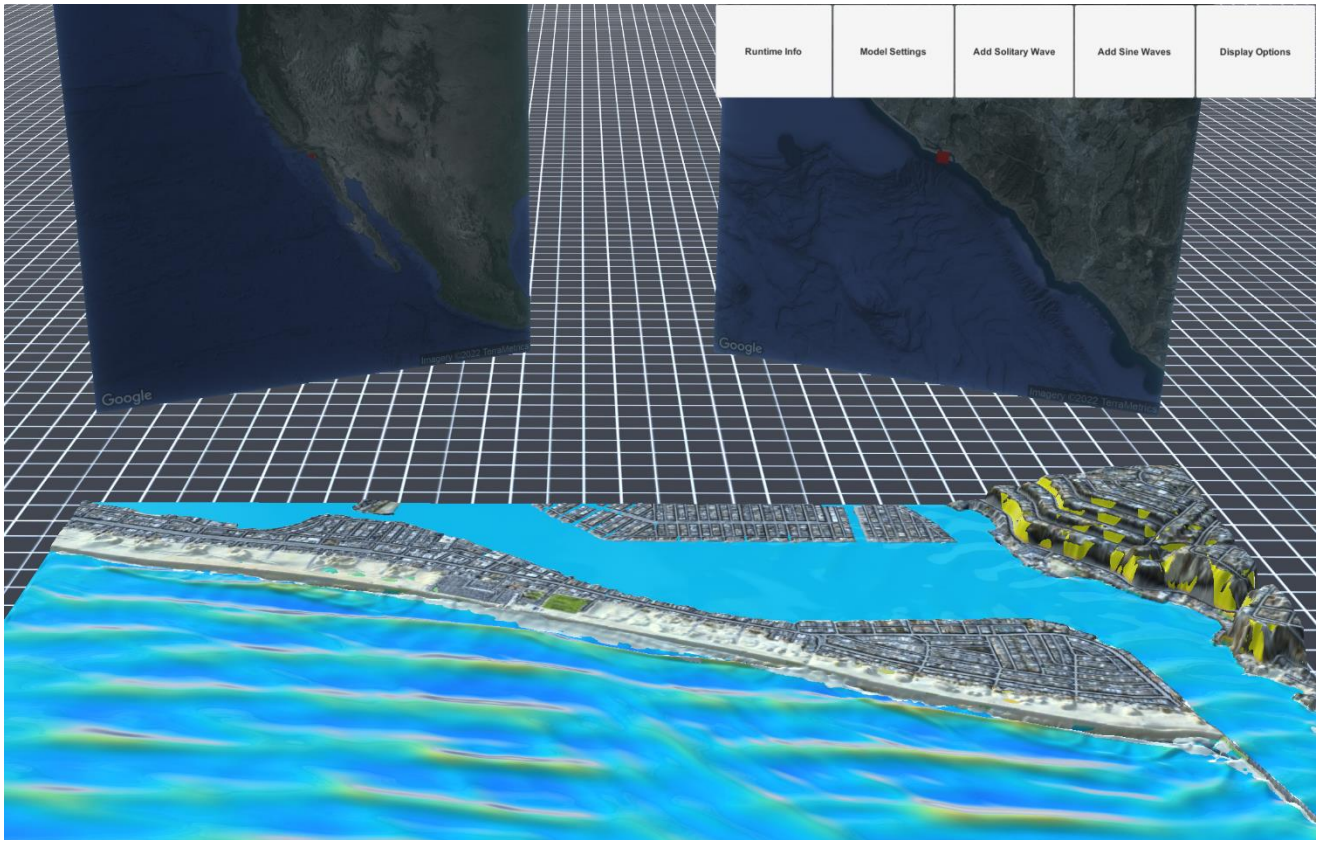

Figure 1. Unity-3D example of coastal wave modeling

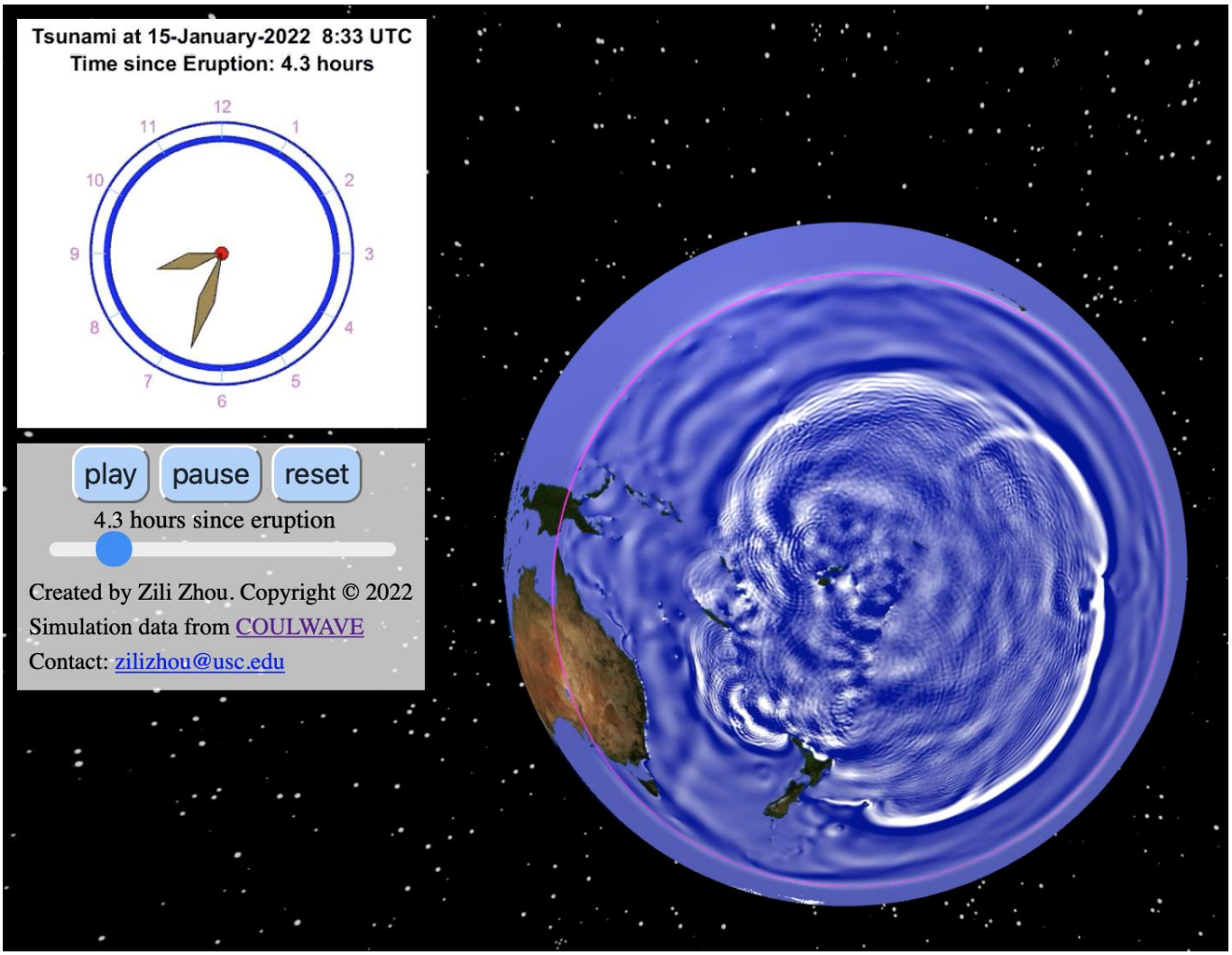

Figure 2. WebVR application of global tsunami data, from https://zilizhou.com/lynett

Tsunami (Lynett et al., 2022) by COULWAVE (Kim et al., 2009) as a showcase (Figure 2). These are the first apps of their kind to bring an interactive, immersive, and convenient experience to coastal hazard stakeholders and coastal engineers.

The objective of this research is to develop a software bundle ImCCE (Immersive Computing for Coastal Engineering), inlcuding all the applications and tools discussed here. A goal of this software package is to present users with a user-accessible interactive and immersive AR and VR experience that can educate and inform stakeholders on coastal processes and tsunami hazards. Additionally, this software suite will provide a testbed for developing new coastal protection and disaster preparedness solutions that can be utilized by coastal engineers, scientists, and planners.

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