IMMERSIVE SIMULATION OF NATURAL HAZARDS FOR ENHANCED PUBLIC AWARENESS AND DISASTER PREPAREDNESS

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Virtual reality (VR) has become a transformative force in understanding and responding to natural disasters. The TsuRuni project is at the forefront of this innovation, offering a virtual reality experience that simulates natural hazards, such as tsunamis and flooding, with unprecedented realism and interactivity. By leveraging Unreal Engine and WebGPU technologies, TsuRuni creates digital twins of real-world cities to deliver immersive simulations that are not only visually stunning but also grounded in accurate data representations.

This immersive platform allows users to experience the raw power of natural disasters within a safe, controlled environment, promoting a deeper understanding of these events. TsuRuni's digital twin cities, reconstructed automatically using a data-driven pipeline from bathymetric and topographic data, satellite imagery, and land cover data, offer geographic accuracy down to topographical features and infrastructure elements. The VR environment is further enhanced with dynamic simulations of earthquakes, destruction physics for building collapses, and the integration of environmental factors like power outages and fires.

Figure 1. Chaos and tsunami signs in TsuRuni

Personalization features in TsuRuni enable users to tailor their experience, including character customization reflecting diverse ages, weights, and physical conditions, adding a personal dimension to the simulation. Users can choose their starting location within the digital twin city, affecting the challenges they face during the disaster simulation.

The TsuRuni project taps into the cutting-edge performance of GPU-accelerated computing, utilizing intricate shading programs alongside WebGPU for highly detailed hydrodynamic modeling. By harnessing the computational power of GPUs, TsuRuni achieves simulations of complex water behaviors with exceptional speed, surpassing real-time processing rates. This level of performance is made possible through an efficiently designed computational pipeline and the application of advanced texture and shader programming, which are crucial for executing the calculations required for high-resolution water simulations.

Integrated within the Unreal Engine framework, TsuRuni's simulations are dynamically informed by real-time data, enhancing the realism and responsiveness of the modeled scenarios. To provide further depth and flexibility, TsuRuni allows users to select between two mathematical models, the Nonlinear Shallow Water (NLSW) and Boussinesq methods.

TsuRuni's virtual reality experience offers a first-person perspective, interactive elements for user engagement, and narrative integration, all optimized for a range of VR headsets. This project not only aims to advance public awareness and education regarding natural hazards but also serves as a testbed for developing new coastal protection and disaster preparedness solutions. It is a leap forward in the nexus of science, technology, and community engagement, promising to shape the future of disaster response and preparedness.

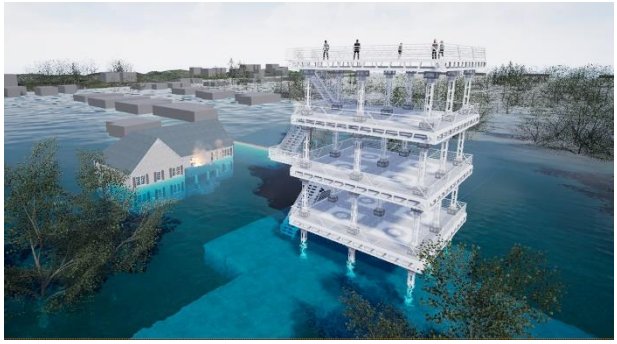

Figure 2. Chaos, water, and evacuation tower in TsuRuni