Beyond Two-Dimensional Maps: Developing Virtual Environments for Geomorphological Map in Taiwan

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In recent years, the realm of cartography and geospatial visualization has undergone a transformative shift with the integration of virtual reality (VR) technology. With the increasing availability and accessibility of VR devices, researchers and cartographers have been exploring innovative ways to leverage this virtual platform for representing geomorphological maps. Currently, the National Science and Technology Center for Disaster Reduction (NCDR) in Taiwan has developed a range of geomorphological mapping products. These mapping products are made available to users through traditional paper maps as well as an online map platform. While offering the convenience of both paper maps and an online platform, the designed geomorphological map might face inherent challenges in fully achieving its original purpose as an indispensable medium for communicating geo-hazards.

The potential users of the geomorphological map extend beyond experts and scholars with geography or cartographic backgrounds, encompassing individuals without specific domain knowledge in topography. This diverse user group includes disaster education professionals in schools, disaster prevention volunteers from local communities, and engineering practitioners. Nevertheless, the interpretation of contour lines and shaded relief information varies among these users, and possessing this skill is critical for comprehending the formation of particular landforms and their topological relationships with other landform objects.

Furthermore, the lack of direct correlation between landform objects and their explanations could impede effective geo-hazard communication. While the primary goal of the geomorphological map is to depict the spatial distribution of characteristic landforms within the designated area, the accompanying Supplementary Documentation and Manual of Disaster Prevention Landform Classification, which contain crucial details, are dispersed and not readily accessible for direct reference by users. This fragmentation of information may create challenges for users seeking comprehensive insights and hinder their ability to connect specific landform features with relevant explanations.Additionally, Geo-hazard events involve dynamic interactions among diverse landforms. However, The Supplementary Documentation uses static text and 3D topographic images, requiring users' imagination to understand. This dependence may hinder grasping complexities and comprehending landforms' impact on geo-hazard occurrences.

In conclusion, the incorporation of virtual reality offers effective solutions to the identified issues. Firstly, virtual reality's immersive nature enables intuitive terrain exploration, surpassing the limitations of less intuitive contour lines and 2D maps. Secondly, the interaction capabilities of virtual reality enable users to directly retrieve information from the landform objects, mitigating the problem of fragmented information in the map and its supplementary documentation. Lastly, virtual reality's potential to visualize abstract processes through visible animations addresses the challenge of depicting dynamic landform processes using static text or images. These advancements in virtual reality-based geomorphological mapping pave the way for enhanced spatial understanding and improved communication of geo-hazard information.

The main objectives of present research include: (1) Reviewing current research on VR mapping design

(2) Establishing workflows for transferring current geomorphological mapping product to VR (3) Validation and discussion on UI/UX design of VR geomorphological map.

Keywords: Geomorphological map, Virtual Reality Environments, Characteristic Landforms