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Integrating Textured 3D Models from Drone Images into Virtual Reality for Planetary Analog Training: A Case Study from the 2023 Vulcano Summer School

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In planetary exploration and analog studies, the fusion of diverse datasets and collaborative research outcomes from multidisciplinary teams presents an exciting yet complex challenge. This abstract outlines an approach to address this challenge, as demonstrated during the 2023 Vulcano Summer School on Vulcano Island, Italy. Vulcano Island's unique geological setting, characterized by an active volcano and extreme environments due to fumarolic activity, offers a compelling environment for researchers of different fields working on planetary analog studies [1,2]. During the Vulcano summer school, researchers from geology, geoinformatics, robotics, oceanography, and astrobiology conduct scientific experiments, test new technical equipment and procedures, and provide training for students and early career researchers [3].

Due to the interdisciplinary focus of the summer school's research teams, the associated research data generated during the field campaigns exhibit a remarkable degree of heterogeneity, reflecting the diverse research cultures and methodologies inherent to the respective research fields. Our focus lies in seamlessly integrating information from these diverse domains through generating and utilizing textured 3D models, subsequently incorporated into a virtual reality (VR) framework for planetary analog training. To that end, we performed drone flights in several locations where researchers conducted field experiments and employed open-source software [4] to create high-resolution data products such as orthophotos, digital surface models, and textured 3D models. In order to ensure consistent accuracy in the spatial representation of our data products, we measured ground control points using a differential GPS for accurate georeferencing.

Integrating textured models into a VR environment establishes a basis for immersive planetary analog training and opens doors to numerous applications that cover training, education, and outreach initiatives. It provides an interactive platform for users to engage with Vulcano Island's landscape and planetary analogs while synergizing diverse scientific findings that are connected to the Vulcano Summer School. We plan to further assess the potential in fostering collaboration, advancing knowledge transfer, and cultivating advanced research data management during the following field trips to Vulcano Island and the Summer School's collaborative efforts. To that end, our next steps involve developing precise use case scenarios based on the research projects working on Vulcano, eventually working towards a more advanced VR integration that leverages the full potential of this approach.

[1] Fagorzi, C., Del Duca, S., Venturi, S., Chiellini, C., Bacci, G., Fani, R., & Tassi, F. (2019). Bacterial Communities from Extreme Environments: Vulcano Island. *Diversity*, 11(8), 140. <http://dx.doi.org/10.3390/d11080140>

[2] Selva, J., Bonadonna, C., Branca, S., De Astis, G., Gambino, S., Paonita, A., Pistolesi, M., Ricci, T., Sulpizio, R., Tibaldi, A., & Ricciardi, A. (2020). Multiple hazards and paths to eruptions: A review of the volcanic system of Vulcano (Aeolian Islands, Italy). *Earth-Science Reviews*, 207. <https://doi.org/10.1016/j.earscirev.2020.103186>

[3] Unnithan, V. and the VulcanoTeam2022 (2022). Vulcano Summer School 2022: Overview of the field-based terrestrial, marine and planetary analogue studies campaign, Europlanet Science Congress 2022, Granada, Spain, 18–23 Sep 2022, EPSC2022-1109. <https://doi.org/10.5194/epsc2022-1109>

[4] OpenDroneMap Authors (2020). A command line toolkit to generate maps, point clouds, 3D models and DEMs from drone, balloon or kite images. <https://github.com/OpenDroneMap/ODM>

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