Immersive Web-based Classification Correction of Point Cloud Data

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Despite many advances in algorithm development for the classification of point cloud data from lidar, photogrammetric, and other sources, such systems are only roughly 90% efficient (Pingel et. al, 2012; Jeong and Lee, 2016; Becker et al., 2017). While improvements to algorithms can, should, and undoubtedly will continue (Grilli et al., 2017), there remains a rationale in some cases for a human-in-the-loop (HITL; Holzinger, 2016). HITL-based systems may directly improve the classification itself or, more usefully, for improved products derived from the point cloud (e.g., ground classification of a lidar point cloud to yield a more accurate digital terrain model). More significantly, more accurately classified point clouds may spur the development of better classification algorithms by acting as improved training and "ground truth" data in a feedback loop referred to as Interactive Machine Learning (Ware et al., 2001; Amershi et al., 2014).

Recent advancements in virtual reality platforms make an immersive, open-source system for classification correction much more feasible. First, hardware platforms such as the Oculus Rift and Quest, the HTC Vive, and Microsoft Hololens are now commercially viable and in mass production with well-used APIs and strong development support. Second, web delivery and manipulation of point clouds and other kinds of large spatial datasets are now well-supported via Potree (Schuetz, 2016), CesiumJS (Cozzi, 2012), Plasio (Verma and Butler, 2014), and Entwine (Manning, 2019). And third, web-based virtual reality content has greatly matured through JavaScript libraries and specifications such as WebVR, three.js, and A-Frame. The nexus of these and other related technologies has significantly lowered the barriers toward the development of an immersive, web-based, and open-source point cloud interaction system.

Research in this domain has already shown the potential of immersive point cloud visualization systems for interaction with these complex data sets (Kreylos et al., 2008; Burwell et al., 2012). We present our work-in-progress for the development of such a system based on web-delivery of immersive point cloud content with the intent of engaging with the GIS and Geovisualization community to further drive development. We detail efforts to solve technical problems of integration as well as user interface issues associated with navigation and interaction, and detail future work implementing multiple feedback loops between algorithmic classification and user correction.

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