

# Representation and Compression Techniques for MPEG-I 3D Media Systems

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## ABSTRACT

With the rapid development of three-dimensional (3D) sensing and immersive media technologies, efficient representation and compression of large-scale 3D content have become essential for storage, transmission, and real-time applications. In particular, point cloud data acquired from Light Detection and Ranging (LiDAR) sensors and immersive visual media require standardized coding frameworks to ensure interoperability and practical deployment. The Moving Picture Experts Group (MPEG) has developed several standards for this purpose, including Geometry-based Point Cloud Compression (G-PCC) and MPEG Immersive Video (MIV). However, the efficient representation and compression of complex 3D data within these standardized frameworks remain challenging due to the massive data volume and structural characteristics of point cloud content.

This dissertation investigates advanced techniques for representation and compression of immersive 3D media, focusing on MPEG standardization frameworks including Geometry-based Point Cloud Compression (G-PCC) and MPEG Immersive Video (MIV) in the MPEG-I ecosystem. First, an enhanced inter-prediction framework for G-PCC is proposed by introducing a reference frame accumulation strategy and hybrid mode selection mechanisms. The proposed method effectively exploits temporal and spatial correlations among consecutive frames, improving geometry coding efficiency for dynamic LiDAR point cloud sequences. Second, a ground-plane prediction-based geometry coding approach is presented to leverage the structural characteristics of LiDAR data. By estimating dominant planar structures using principal component analysis and transforming point coordinates into a plane-relative representation, the proposed method reduces geometric redundancy and enhances compression performance. Third, a media conversion framework between 3D object representations and MPEG Immersive Video is developed, enabling heterogeneous 3D objects to be

integrated into MIV-compliant media systems through standardized coordinate transformation and rendering processes.

Experimental results demonstrate that the proposed techniques improve compression efficiency and media representation capability while maintaining compatibility with existing MPEG standards. The contributions of this research provide practical solutions for efficient representation and compression of 3D media content and support the advancement of standardized immersive media technologies.