WILLIAM & MARY

DATA SCIENCE

Advancing Infrastructure and Environmental Monitoring with Deep Learning and Satellite Imagery

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The convergence of satellite imagery analysis with deep learning techniques has significantly advanced our capabilities to understand social and environmental phenomena. This has been true across a wide range of domains, with scalable, satellite-based analyses now possible in the context of coastal vegetation, marine debris, landcover, the estimation of poverty, population, conflict, migration, education, and others. This dissertation contributes to this growing body of literature in three parts. First, using high-resolution aerial imagery and data from the NOAA's Continually Updated Shoreline Product (CUSP), semantic segmentation models are trained to map and classify shoreline stabilization structures in coastal Virginia. A semi-automated toolkit, pyShore, was proposed for shoreline structure classification in ArcGIS. Second, combining Sentinel-2 satellite imagery and National Agriculture Imagery Program (NAIP), a transfer-learning workflow was proposed to explore the potential of mapping coastal tidal marsh communities in Virginia. Finally, the last chapter introduces BathyFormer, a transformer-based architecture to predict nearshore bathymetry from multispectral satellite imagery at pixel level. These three chapters advance our understanding of many of the challenges unique to computer vision in the context of satellite data, and provide guidance on the application of deep learning for coastal resource management.