

Monocular Depth Estimation for Polar Bathymetry: A Case Study from Horseshoe Island, Antarctica

ŞAHİN Aylin¹, GÜNAYDIN Esra², BAKIRMAN Tolga³, KARABULUT M. Fahri²,
BAYRAM Bülent³, SELBESOĞLU M. Oğuz²

¹ Satellite Communication and Remote Sensing, Istanbul Technical University, Istanbul, 34467, Türkiye, sahinal7@itu.edu.tr,

² Geomatics Engineering, Istanbul Technical University, Istanbul, 34467, Türkiye, esgunaydin@itu.edu.tr, karabulutmus@itu.edu.tr, selbesoglu@itu.edu.tr

³ Geomatics Engineering, Yildiz Technical University, Istanbul, 34220, Türkiye, bakirman@yildiz.edu.tr, bayram@yildiz.edu.tr

Abstract

Accurate and up-to-date bathymetric data are essential for understanding hydrological dynamics, monitoring environmental change, and supporting logistical operations in polar regions. However, conventional bathymetric surveys in areas like Antarctica are often constrained by harsh weather conditions, logistical limitations, and high operational costs. These challenges highlight the need for alternative, scalable methods for depth estimation. The primary objective of this study is to investigate the potential of deep learning models combined with high-resolution aerial imagery for bathymetric mapping in polar regions. We utilized an orthophoto generated from Unmanned Aerial Vehicle (UAV) imagery obtained during the National Antarctic Science Expedition (TAE) of a lake located in Horseshoe Island, Antarctica. The orthophoto was processed using the Depth Anything (DA) models, a recent vision-based deep learning architecture capable of monocular depth estimation (MDE) from standard RGB images. Then, the depth predictions generated by the model were compared against a set of ground-truth reference points collected within the study area. Preliminary results indicate that the Depth Anything V1&V2 models are capable of producing reasonable depth estimates from aerial imagery in polar areas. While certain discrepancies were observed particularly in shadowed or ice-covered areas, the overall correlation with the reference data demonstrates the model's potential for fast, non-invasive bathymetric analysis. These findings suggest that vision-based monocular depth estimation models can be effectively applied to remote and logistically challenging environments where traditional bathymetric survey methods could be impractical and underscore the potential of integrating lightweight Artificial Intelligence (AI) models with high-resolution imageries to support bathymetric assessments in data-limited regions.

Keywords: Antarctica, Bathymetry, Monocular Depth Estimation, Orthophoto, Deep Learning.