氏　　名	高　　婵		
学位の種類	博士（知識科学）		
学位記番号	博知第 370 号		
学位授与年月日	令和 6 年 12 月 24 日		
論文題目	Advancing the Understanding of Historic Landscapes: Spatial Analysis of Jiangnan Traditional Gardens through Object Detection and Image Depth Estimation		
論文審査委員	KIM, Eunyoung	JAIST	Assoc. Prof.
	HUYNH, Van Nam	JAIST	Professor
	YUIZONO, Takaya	JAIST	Professor
	XIE, Haoran	JAIST	Assoc. Prof.
	Du, Shuxin	Huzhou University	Professor

論文の内容の要旨

Jiangnan gardens exemplify traditional Chinese landscape design, blending natural aesthetics with architectural innovation. While extensive research has been conducted on these gardens, a comprehensive spatial analysis of their complex landscapes remains lacking. This research aims to enhance the understanding of historic landscapes through advanced spatial analysis of Jiangnan traditional gardens using object detection and image depth estimation. The primary objective is to develop and apply an improved object detection algorithm, tailored for the intricacies of Jiangnan gardens, to identify and catalog key visual elements like pavilions, rockeries, and plants. This research introduces enhancements to the YOLOv8 algorithm, including the Diverse Branch Block (DBB), which optimizes feature extraction across different scales; the Bidirectional Feature Pyramid Network (BiFPN), enhancing feature integration from multiple layers; and Dynamic Head Modules (DyHead), which dynamically adjust the detection heads for better object recognition performance. Concurrently, the research seeks to analyze the depth and complex spatial relationships within the gardens to understand their design and functional aesthetics better. Employing the enhanced YOLOv8 for object detection and the Marigold algorithm for depth estimation, the study has provided exceptional insights. YOLOv8 effectively cataloged various elements, while Marigold mapped their spatial interactions with high precision, revealing the interplay between architectural and natural features and enhancing understanding of the gardens' historical and cultural contexts. This integration of object detection with depth mapping offers a novel methodology for exploring complex cultural landscapes. The findings suggest substantial implications for enhancing virtual tours and educational programs, promoting broader access to these cultural heritage sites. Overall, this research not only enriches our understanding of Jiangnan traditional gardens but also advances methodologies for preserving and interpreting complex heritage sites, promising innovative solutions for challenges in historic landscape conservation.

Keywords:

Jiangnan Traditional Gardens, Space Analysis, Object Detection, YOLOv8, Image Depth, Marigold Algorithm

論文審査の結果の要旨

Traditional gardens have integrative values for their natural beauty and architectural design. Her research bridges the gaps between cultural heritage study and advanced techniques to enhance the understanding of historic landscapes, focusing on Jiangnan traditional gardens, through spatial analysis facilitated by advanced algorithms. She developed a specialized object detection algorithm of YOLOv8 to accurately identify and classify garden elements such as pavilions, rockeries, water features, and plants, capturing the visual and functional complexity of these gardens. In addition, She adopted the Marigold algorithm to analyze the spatial relationships and depth among these elements to illustrate interactions that form the layered, depth-filled perspectives characteristic of Jiangnan gardens.

The results highlight how architectural and natural features coexist and interact, offering new insights into the gardens' cultural and historical contexts. This study represents novel application of machine learning technologies—YOLOv8 for object detection and Marigold for depth estimation—in the study of historic landscapes. The interdisciplinary approach allows for more precise documentation and analysis of cultural heritage sites, enhancing conservation and preservation efforts, offering an original perspective that enriches our understanding of their design and cultural significance. It can be utilized for analyzing gardens and cultural heritage sites globally, potentially influencing conservation of cultural heritage sites.

This is an excellent dissertation and we approve awarding a doctoral degree to GAO, Chan.