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DESIGN AND IMPLEMENTATION OF AN AI-BASED SYSTEM FOR LIGHT POLLUTION MITIGATION IN GROUND-BASED ASTRONOMICAL IMAGES

Abstract

In pursuing advancing astronomical observations amidst escalating urbanization, this study introduces a novel artificial intelligence (AI) system designed to digitally mitigate the effects of light pollution in images captured by ground-based telescopes. Light pollution, primarily from anthropogenic light sources, severely impairs the visibility of celestial bodies, thus challenging astronomers operating from urban or suburban observatories. Our research aims to develop and validate a sophisticated algorithm capable of discerning between artificial light sources and genuine astronomical objects, thereby enhancing nighttime sky observations' quality and scientific value. The methodology encompasses a comprehensive approach, beginning with acquiring and annotating a diverse dataset of telescope images varying in degrees of light pollution. A critical phase involves preprocessing these images to correct for standard observational biases, followed by extracting distinctive features that differentiate artificial light from celestial phenomena. The study advances into the training phase by utilizing deep learning techniques, specifically, Convolutional Neural Networks (CNNs), where the model learns to identify and segregate light pollution effects from astronomical data. Subsequent stages involve the meticulous post-processing of images, employing the AI model to diminish or eliminate the identified light pollution, thus restoring the integrity of celestial imagery. Validation of the system's efficacy is conducted through rigorous testing against performance metrics, including the accuracy of artificial light source identification and the enhanced visibility of astronomical objects. Collaboration with the astronomical community is pivotal in refining the AI system, ensuring it addresses practical observational challenges and adheres to ethical standards concerning image capture and processing. This research not only paves the way for significant improvements in urban astronomical observations but also contributes to the broader field of astrophysics by providing a scalable, AI-driven solution to combat the pervasive issue of light pollution. The proposed AI system promises to revolutionize ground-based astronomical imaging, offering a bridge over the growing chasm between advancing urbanization and the age-old human endeavor to unravel the mysteries of the cosmos. Through iterative enhancements and potential real-time processing capabilities, this study marks a crucial step toward sustaining the accessibility and progression of astronomical research in the light-polluted skies of the modern world.