ASTEKS: The First End-to-End Auto-Detection Survey for Single-Transit Exoplanets in Known Systems

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A transit occurs when an exoplanet blocks the light from its host star to cause a unique dimming. The Transiting Exoplanet Survey Satellite (TESS) is an all-sky scanning space telescope that provides astronomers with high-frequency stellar light curves. Unlike our eight-planet solar system, most extrasolar planetary systems only contain one documented orbit. This discrepancy arises from the observational bias favoring near-orbit planets (especially hot Jupiters) as they produce more apparent dimming and are thus easier to confirm through follow-up observations. Compared to our expanding knowledge of near-orbiting exoplanets, the study of multi-planetary systems is inadequately investigated, with few systems to refer to beyond our solar system. Multiplanetary systems inform astronomers about gravitational interaction, planet migration, and habitable extraterrestrial worlds, and the lack of farther orbits obstructs the study of this matter. However, the continuous surveillance mode of TESS is ideal for detecting farther-orbiting planets, and no researchers have systematically examined distant planets in known planetary systems. This research uses TESS data to develop a novel data augmentation algorithm, a decision-tree-based preprocessing unit, a neural network model that identifies single-transit candidates through shape analysis, and an automated parameter fitting procedure. All these stages combine to form the first end-to-end auto-detection survey of single-transit exoplanets in known systems: ASTEKS. ASTEKS, focusing on single-transits, has achieved an accuracy of 93.6%, surpassing the state-of-the-art. This model also discovered 18 single-transit planet candidates (52<p<1530) and two close-orbiting candidates (p<1) from a set of just 1088 known planetary systems.

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