

TransFinder Manual

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2024-06-28

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1. Overview

Mephisto¹ has a 1.6 m primary and is equipped with three CCD cameras of a field-of-view 3.14 sq deg, capable of simultaneously imaging the same patch of sky in three bands (*ugi* or *vrz*). Mephisto can yield real-time colours of astronomical objects with unprecedented accuracies and deliver for the first time a coloured documentary of our evolving universe.

The amount of raw data obtained from nightly observations by Mephisto will be on the order of terabytes, and the amount of annual data will be on the order of petabytes. To improve the observation efficiency and ensure real-time processing, the project team is committed to the development of an automated sky survey system, a survey data processing system, and a system for detecting, classifying, and disseminating early warnings of variable and transient sources. This will lay a foundation for fully utilizing the advantages of Mephisto and maximizing its scientific output.

Transient identification and classification from huge volumes of observational data are challenging under the strict requirements of real-time and high-accuracy. The real-time alert and fast follow-up spectroscopic observations are crucial to study different types of transients. In this manual, we will introduce our customized transient detection pipeline, TransFinder², which is developed for Mephisto time-domain surveys. Starting with the pre-processing products, the image differencing algorithm proposed by Zackay et al. (2016) is implemented to subtract the new image from the reference image for each CCD chip separately. Then we perform object detections on the residual image. The multi-band data and cross-correlation analysis will be combined to reduce the spurious objections in an automatic fashion. We introduce artificial intelligence (AI) technology to improve the efficiency and accuracy of transient identification and classification. Transients with high probability will trigger the alert system for further follow-up observations. The execution time of the whole system is less than 5 minutes, and the reliable identification, classification, and rapid release of warning information for a large number of variable temporary source candidates are completed within 1-2 minutes.

¹<http://www.mephisto.ynu.edu.cn>

²<https://github.com/LiuDezi/TransFinder>

2. Reference Image Preparation

3. Module I: Image Differencing

4. Module II: Real/Bogus Classification

5. Module III: Transient Classification

6. Pipeline Performance

References

Barak Zackay, Eran O. Ofek, and Avishay Gal-Yam. Proper Image Subtraction—Optimal Transient Detection, Photometry, and Hypothesis Testing. *ApJ*, 830(1):27, October 2016. doi: 10.3847/0004-637X/830/1/27.