Cross-matching Engine for Incremental Photometric Sky Survey

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Abstract

We present the Ondřejov Southern Photometry Survey, being conducted at the Danish 1.54m telescope in remote observing mode by several groups of Czech stellar astronomers.

The automatic astrometry and photometry pipelines run on every CCB frame combined with astrometrical parallelized cross-matching and clustering algorithms result in an online fly-generation of light curves of every single object in the field.

To allow powerful querying and visualization of current database of more than half billion measurements, the technology of Virtual Observatory is used, combining VO protocols and powerful visualization tools as Aladin, TOPCAT and Splat-VO.

Introduction

Goals

• Access products during all phases of data processing (image management, preprocessing, data mining, ...) with VO protocols
• Images (Simple image access - SIA)
• Observations (Table access - TAP, Simple curve search - SCS)
• Light curves (Simple spectral access - SSA)

Benefits

• No need for pre-planned observation fields
• Can change observation fields anytime
• No need to have regular grid for observation fields
• Dynamic light curve generation (after adding new images)

Motivation

• Classical photometry analysis uses only small fraction of observed data (target variable + comparison stars)
• Can produce light curves from data of not primary interest

Pipeline

• Starts at La Silla remotely controlled telescope
• Changing priorities and targets
• Survey coverage is irregular, without any grid usable for differential photometry
• Individual astrometry and photometry needs to be calculated for each image, continues within Light curve identification

Light curve identification

• Starts with astrometry and photometry for individual observations
• Light curve identifiers need to be generated
• For speedup, HEALPix tessellation is used
• All of the intermediate data products are published via VO protocols and can be visualized via VO tools

<table>
<thead>
<tr>
<th>Equivalent source (Displayd via SCS or TAP in Topcat)</th>
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<tbody>
<tr>
<td>Table browser for 1: 470 130 0.0</td>
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<tr>
<td>Object</td>
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Observations of one star in multiple bands (displayed in Topcat via SCS)

Results

• We maintain data with GAVO DaCHS package as wrapper around:
  • Data ingestion
  • Data processing
  • Data publishing

All products are accessible in VO-compatible tools

• Publishing these products:
  • Raw + Reduced images (SIA)
  • Observations identified on images (SCS, TAP)
  • Light curves (SSA)

Light curve generation:

• Light curves for 400 mil. observations generated under 2h (100 cores, 32GB RAM)
• Consuming ~8GB RAM per 100 mil. observations
• Performance not dependent on number of objects observed

Publication

• We use Time Series Data Cube 3M for publication
• Latest effort driven by needs of all time series data, not only light curves

Unified publishing standard for all time series data

• Data mining from image sets where light curve extraction was not possible (need individual astrometry and photometry)

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References

2. Demleitner, M., 2015, Astronomy and Computing 7, 253