Current status of the Fly's Eye Camera System

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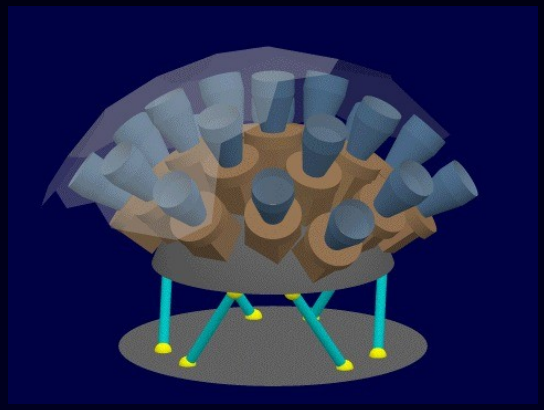
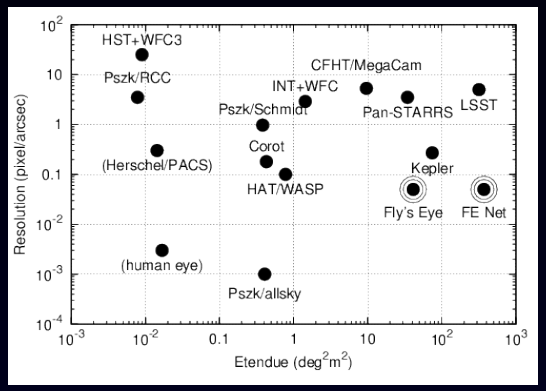
The Fly's Eye Camera System

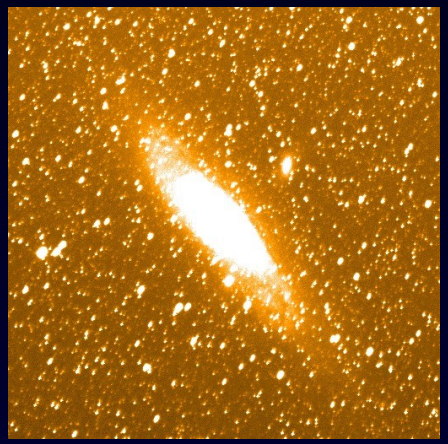
- 19 wide field cameras with Sloan filters with 22”/pixel resoluton, 26° FoV per unit
- Hexapod mount for sidereal tracking
- Autonomous operation, weatherproof enclosure



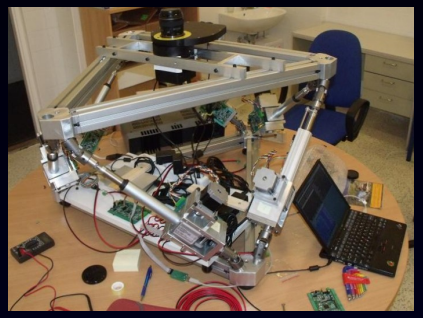
Scientific Goals

- Time-domain astronomy
- All-sky survey with high cadence and étendue (FoV multiplied by effective light collecting area[deg^2m^2])
- Planetary system development
- Star formation and evolution
- Extragalactic phenomena





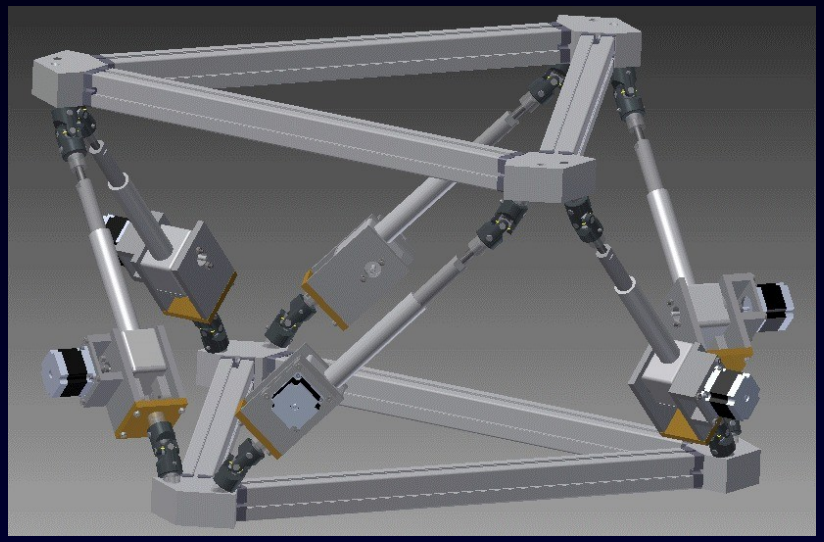
Hexapod

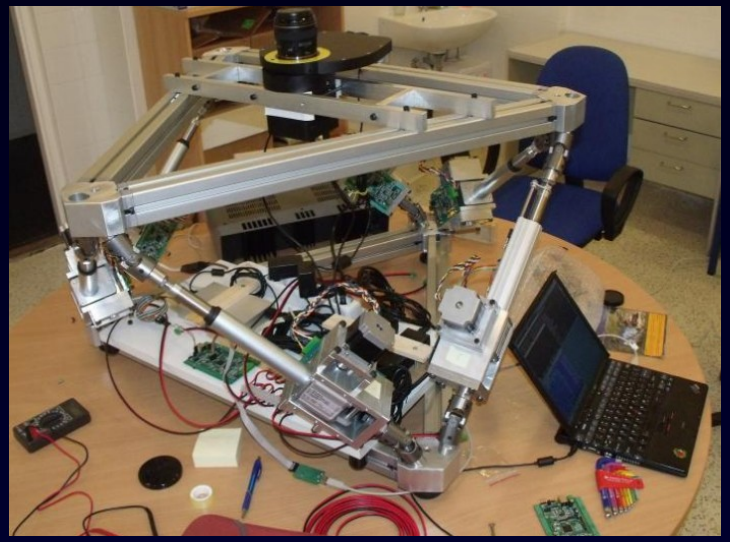


- 6 degrees of freedom, only 3 for tracking
- ⇒3 legs would stuck, tracking is still manageable
- Tracking drift: ~0.5”min^{-1}
- Self-calibration: independent from longitude and latitude (no polar alignment required)
- Also no leveling required

Hexapod

- Linear actuators (0.05µm stroke per motor step)
- Redundant monitoring



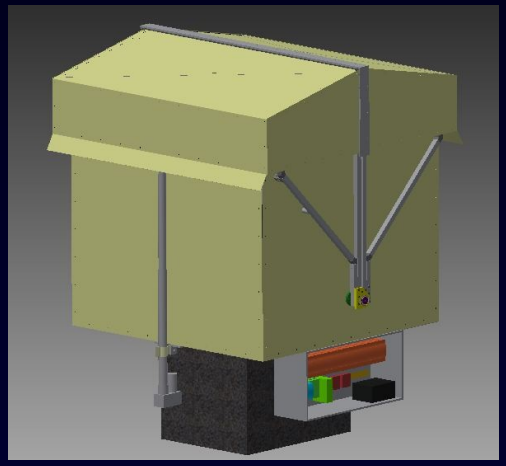


Cameras & Lenses

- 19 wide-field cameras with Sloan filters ('g/'r/'i optional 'u/'z)
- Lenses: f=85mm, f/1.2
- Photometric precision: ~4-5mmag
- Limit: ~9^m r ≲ ~15^m (close to LSST saturation limit)

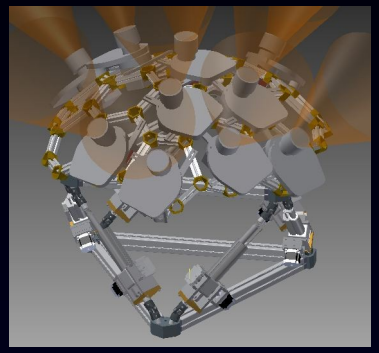
Enclosure

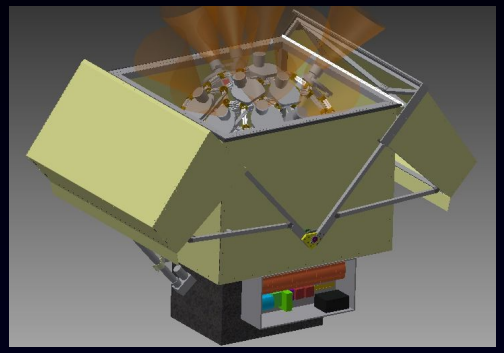
- Custom-designed waterproof enclosure
- Doors are moved by outdoor linear actuators



Current Status

- Hexapod - motion control ✓
- Camera rack ✓
- Camera units ✓
- Enclosure ✓
- Software ✓



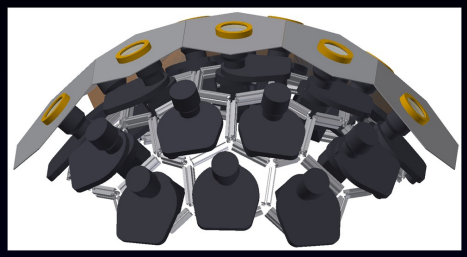


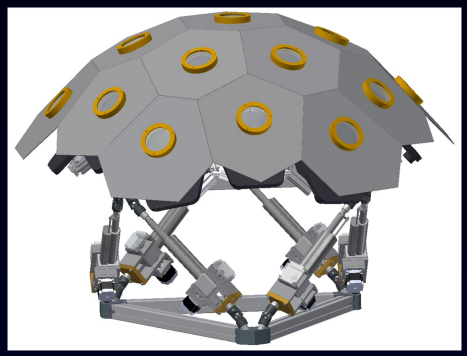
- To de done:

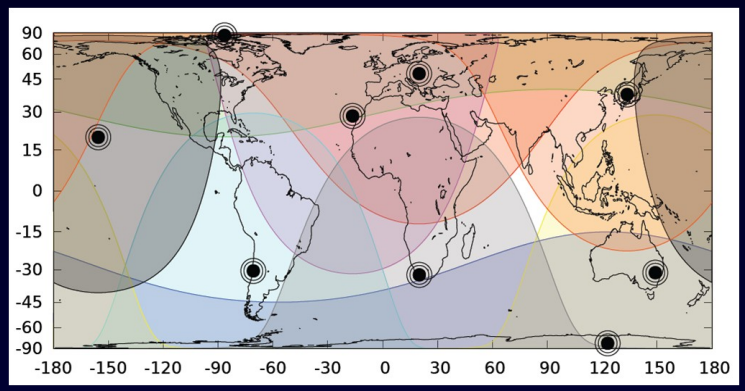
  System integration

Future plans

- Isolated enclosure, adjustable temperature, humidity within
- Fly's Eye Net: 8-9 units could monitor the whole sky in r<15^{m} regime (total étendue ~LSST)







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ABSTRACT

This project aims to provide a low resolution and multiple-passband full-sky survey with an imaging cadence of a few minutes. Based on our earlier tests, we found that a novel type of astronomical telescope mount on a hexapod platform can provide the accuracy of sidereal tracking needed by our instrumentation. The fully configured Fly's Eye device contains 19 wide-field cameras equipped with fast focal ratio optics which are arranged in a mosaic form and have an effective resolution of 20 arcseconds per pixel. The scientific goal of this project is to continuously monitor stellar brightness variations in the full Sloan photometric system down to the magnitude of r=15 or the limit of apparent stellar confusion. The data acquisition will then cover roughly 6 magnitudes of the time domain, from the scales of minutes up to the several years of planned operations. Fly's Eye data yield is complementary to that of the Large Synoptic Survey Telescope since the saturation magnitude of LSST is close to the faint limit of the Fly's Eye setup.

One of the main scientific yields of this survey is to recover time-domains of photometric variability of stars with magnetic activity. These timescales range from minutes through hours to years, just like in the case of the Sun. If active stars are monitored continuously, the measurements will give us data in the broad time range of the magnetic phenomena. By now, the Sun is the only active star, on which we have full picture of the manifestation of the magnetic field. In the solar active nests spots, faculae, plages and flares are observed and their spatial correlation studied. The Fly's Eye device allows similar research on different kinds of active stars individually, observing in five band passes from ultraviolet to near-infrared (365 to 900 nm) which is unprecedented. The results give us a broader view of the magnetic activity of stars of different ages. Through this, we will be able to reconstruct the past of the Sun and foresee its future.

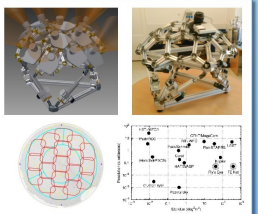

Figure 1. The Fly's Eye Camera System. 19 camera units are supported by a frame mounted on a hexapod mechanics. *Upper-left*: CAD model of the system (the brown cones are the FoV of the individual cameras) : current status in the laboratory (several cameras are already available) *Lower-left*: the FoV of the 19 cameras shown on an (inverted) all-sky image. *Lower-right*: Étendu and effective resolution for various known optical telescopes.

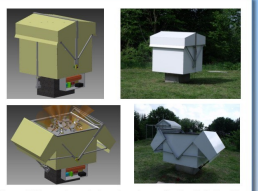

Figure 2. The custom-designed enclosure for the Fly's Eye. The housing is mounted on a concrete basement. The doors are moved by weatherproof linear actuators. *Left*: CAD models of the enclosure. *Right*: The system installed on the concrete basement at Piszkés-tető Observatory, Hungary.

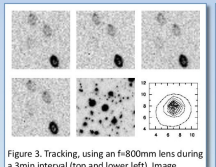

Figure 3. Tracking, using an f=800mm lens during a 3min interval (top and lower left). Image stamp of 64×64 pixels, taken with an f=85mm lens, exposure time: 130seconds (lower centre). PSF of the stellar profile at the center of the previous image (lower right).

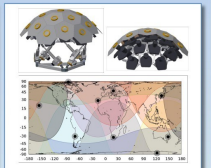

Figure 4. An opcional 2nd layer of isolated housing, within it the temperature, humidity can be adjusted. An example configuration of possible future Fly's Eye locations (lower).

SCIENTIFIC GOALS

- Time-domain astronomy
- All-sky survey with high cadence and étendue
- Planetary system development
- Star formation and evolution
- Extragalactic phenomena

INSTRUMENT PROPERTIES

- Hexapod mount for sidereal tracking
- 19 wide field cameras with filters
- 22"/pixel, 26° FoV per camera unit
- Autonomous operation, weatherproof enclosure

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Tracking

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