STARSHADE DATA CHALLENGE

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High-Level Objectives

• Independently validate and review the WFIRST Starshade error budget
  • Is the current error budget sufficient to achieve the science goals?
  • Are we able to loosen the tolerances in the current error budget?

• Development and comparison of algorithms for Starshade image processing and science recovery
  • What’s the state-of-the-art in the algorithms for Starshade image processing?
  • To what extent can algorithms overcome technology limitations?
Detailed Objectives

• The data challenge will ask to retrieve $X$, including e.g.
  • Detection
  • Relative astrometry
  • Absolute photometry (4 color filters)
  • Including confidence levels

• $X$ is extracted from a comprehensive image dataset (>10k) generated
  • Using the expected starshade performance by the current error budget
  • Increasing dedicated errors and their combinations such as
    • Solar glint
    • Formation-flying
    • Local defects (broken petal tip)
    • Global defects (thermal expansion)
SISTER software (http://sister.caltech.edu/) can be used to generate images.

Several starshade shapes can be generated to include different errors from the budget based on their magnitude.

Images are labelled with ground-truth data $X$ which describe the simulated scene, type and magnitudes of errors.

Stuart Shaklan and Sergi Hildebrandt (JPL)
Image Generation (2)

• Does SISTER include all the capabilities we need? Such as
  • accurate solar glint calculation (time-varying dependency on sun angle)
  • time-varying formation flying dynamics
  • starshade rotation

• Has SISTER been verified? Such as through comparison with
  • Princeton hardware-in-the-loop testbed
  • Recovery of ground-truth through image processing
  • Other tools?
Scoring

• Scores are used to rank submissions

• Scores capture the relative deviation of the submission $X_{est}$ from the ground-truth data $X$ for each image and for each parameter

• Consolidated scores for each parameter can be computed by averaging across images or groups of images

• A global score can be computed by a weighted average across parameters using normalization weights which take into account units of measure

• Robustness to perturbations can be scored by the ratio between the perturbation magnitude (truth) and the estimation error (computed above)
Implementation

- The competition is hosted by a web server which provides access to:
  - The challenge: competition in a nutshell, credits
  - Image datasets: for training (labelled), for competition (not labelled), scripts
  - Scoring: formulas and rationale
  - Rules: eligibility, winner, license, honor code, etc.
  - Leaderboard: dynamic table with columns for rank, name, scores
  - Final results: final leaderboard evaluated on complete dataset
  - Discussion blog: Q&A

- There are websites that can host competitions for free, such as CodaLab (https://codalab.org/)

- Or we can collaborate with ESA as for other competitions (https://kelvins.esa.int/satellite-pose-estimation-challenge/)
Deployment

• The competition is deployed through the following tentative milestones for a total timeframe of 15 months since start

  • Drafting: 2 months
  • Internal review: 1 month
  • Finalization: 1 month
  • Public with nominal errors: 5 months
  • Public with increased errors: 5 months
  • Analysis and dissemination: 1 month

  Internal process

  Low barrier to entry

  Experts

  Deliverable to S5
Tasks and Resources

• The data challenge project entails the following tasks and full-time-equivalent-hours (fteh)
  • Overall technical and scientific management: 250 fteh
  • IT/Website/Scripts (if the website is not outsourced): 200 fteh
  • Dataset generation and testing: 300 fteh
  • PR/reach out: 200 fteh
  • Dissemination: 250 fteh

• S5 has indicated that $150k total is reasonable (= 1200 fteh?)

• S5 has indicated that the work should be done in tight coordination and oversight by JPL
Rewards

• **How do we engage the community to participate?**
  - Participants are given access to a more complete dataset
  - Participants are invited to publish with JPL hosts of competition
  - Winners are given award at JPL event
  - Winning researchers are offered internships opportunities at JPL
  - Potential of direct involvement and contribution to first Starshade mission
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SISTER Simulated Image for SRM

- 47 Uma
- 12 hour observation
- 425-552 nm
- Optical Throughput 0.434
- EMCCD 221, QE = 0.76
  - Simple noise model with equivalent noise
  - 7 s frames, EM Gain = 4000
  - CIC = 0.01
  - End-of-mission dark current
  - No cosmic rays, no hot pix.
- Exozodi = 5x Zodi, dynamical
- Local Zodi included
- Extra-galactic background
- $10^{-10}$ starshade (non-ideal)
- 15 mas telescope jitter
- 1 planet visible in this image