Spacecraft Based Astrometry Description and Archival Status

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Space Based Astrometry
(Optical Navigation)

- Spacecraft on board imaging to aid in navigation
  - Determine spacecraft trajectory
  - Determine target body ephemerides
- Use science imaging instrument
  - Vidicon detector (Television camera)
  - CCD detector

Optical Navigation

- Images of target bodies (planet, satellite, comet, asteroid)
  - Inertial camera pointing direction
    - Spacecraft attitude control system
    - Star background (UCAC2)
  - Inertial direction from the spacecraft to the target
- Radio tracking measures spacecraft position relative to Earth
- Tracking plus imaging measures target body position relative to Earth

Optical Navigation Observation Features

- High precision observations of the target body
  - Order of magnitude more accurate than Earthbased (short observer-target range)
  - Center of figure for resolved objects
  - Optimal scheduling for sensitivity to target body orbit errors
- Unique observations for some objects
  - Small inner planetary satellites

Missions and Imaged Targets

- Planetary missions
  - Mariner 9, Viking, MGS, MRO (Phobos 88, MEX): Martian satellites
  - Voyager 1: satellites of Jupiter, Saturn
  - Voyager 2: satellites of Jupiter, Saturn, Uranus, Neptune
  - Galileo: Asteroids, Jovian satellites
  - Cassini: Saturnian satellites
  - New Horizons: Jovian satellites, (Pluto's satellites)

Missions and Imaged Targets

- Small body missions
  - NEAR: asteroids Mathilde, Eros
  - Deep Space 1: asteroid Braille, comet 19P/Borrelly
  - Stardust: asteroid Annefrank, comet 81P/Wild 2
  - Stardust NexT: comet 9P/Tempel 1
  - Deep Impact: comet 9P/Tempel 1
  - EPOXI: comet 103P/Hartley 2
  - Dawn: asteroid Vesta, (dwarf planet Ceres)

Optical Navigation Data

- Raw data: digitally recorded brightness distribution
- Image processing
  - Picture conditioning
    - Background noise removal
    - Blemish removal
  - Image centerfinding
    - Shape, size, orientation, phase angle
    - Albedo, surface reflection properties
  - Image location in picture
  - Picture sequence file

Optical Navigation Data Format

- Picture Sequence File (text file)
  - Camera information
    - Focal length
    - Focal plane transformation
  - Picture information
    - Time (UTC)
    - Inertial camera pointing
  - Image information
    - Observed object location
    - Corrected inertial position for stars

Data Availability and Distribution

- Raw images in Planetary Data System
- Observational Data for Planetary Satellite Ephemerides (http://iau-comm4.jpl.nasa.gov)
  - Picture Sequence Files
  - Documentation and usage instructions
- Spacecraft trajectories
  (http://naif.jpl.nasa.gov)

Picture Sequence File Status

- Currently available
  - Mars Reconnaissance Orbiter (MRO)
  - Mars Global Surveyor (MGS)
  - Voyager 2
    - Uranus
    - Neptune
- End of this year (planned)
  - Voyager 1 Saturn
  - Voyager 2 Saturn
  - Cassini