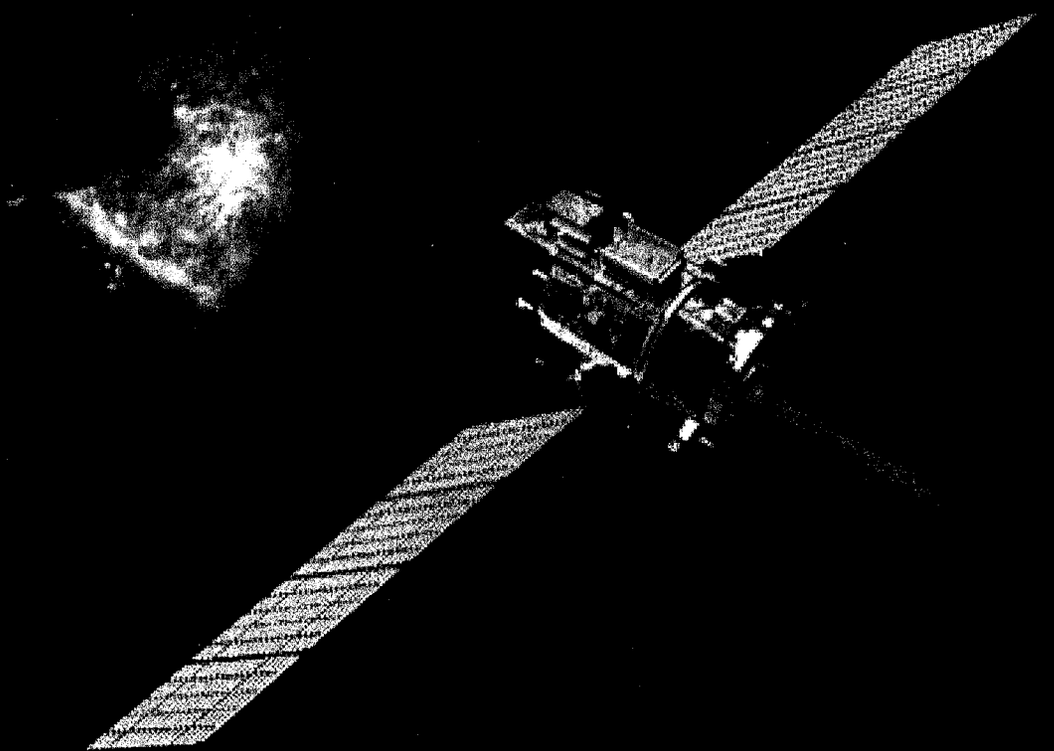
SECOND GENERATION AUTONOMOUS OPTICAL NAVIGATION SYSTEM

JPL

S. Synnott

December 6, 2001

Deep Space 1 Autonomous Navigation



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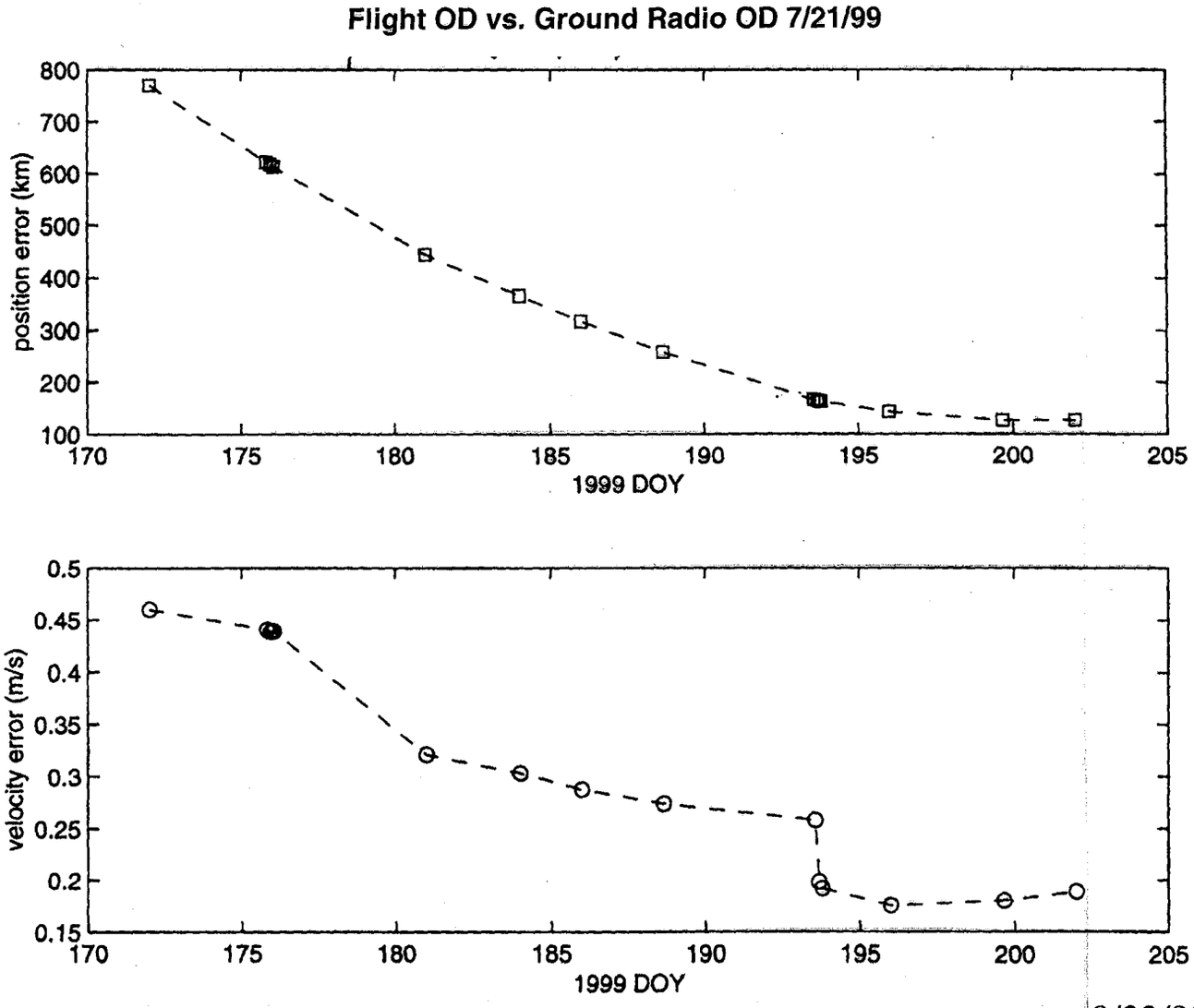
Performance of AutoNav on Approach to Braille



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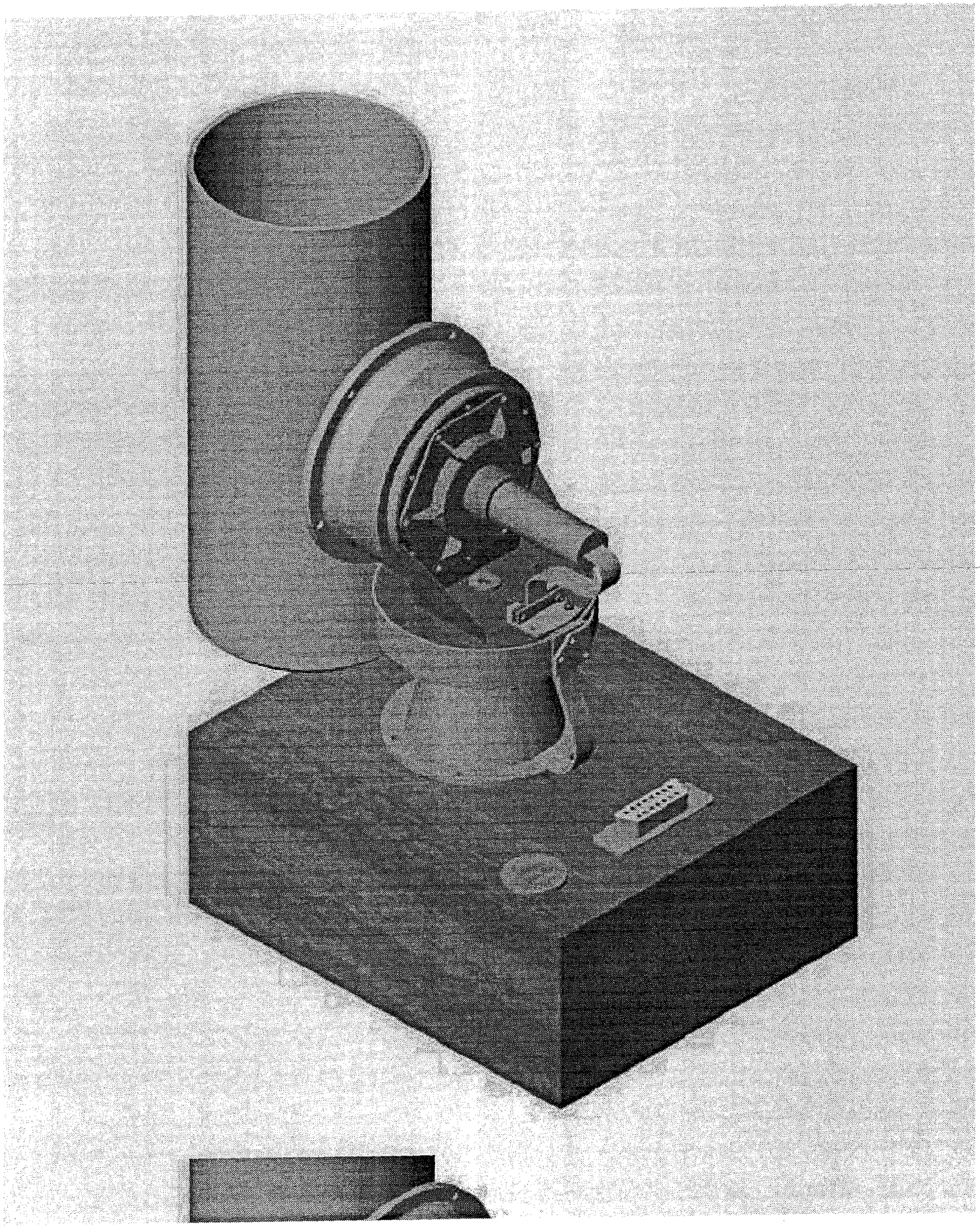
AUTONOMOUS OPTICAL NAVIGATION
"REQUIREMENTS" FOR SECOND GENERATION SYSTEM
(BEYOND DS1 DEMO)

- POINTABLE CAMERA (GIMBAL-MOUNTED CAMERA)
- CAMERA SENSITIVE TO 11th MAG OBJECTS
- LESS AUTONAV-GROUND TEAM INTERACTION
  (2.0 PEOPLE TO LESS THAN 0.5)
- AUTONAV COMPUTER

COLOR TRANSPARENCY

SYNDOT,



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AUTONOMOUS OPTICAL NAVIGATION

COMPARISON OF NEW SYSTEM TO DS1

- CAMERA AND DETECTOR
  - 5 cm APERTURE vs 10 cm DS1
  - HALF THE RESOLUTION BUT
    - 10 TIMES THE SENSITIVITY, AND
    - 10 TIMES SMALLER GEOMETRIC DISTORTION
- 24 mrad (1.4° FOV) vs 13 mrad (0.75° FOV)
- NEGLIGIBLE PATTERN NOISE vs 50 e^- FOR DS1
- NEGLIGIBLE SCATTERED LIGHT vs HUNDREDS TO THOUSANDS OF e^- FOR DS1
- NOISE OF NEW SYSTEM $\leq 20e^-$

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AUTONOMOUS OPTICAL NAVIGATION
DATA PROCESSING

- IMAGE PROCESSING
  - AUTONOMOUSLY DETECTING OBJECTS IN FOV
  - CENTROIDING IMAGES OF STARS AND BEACONS
- TRAJECTORY AND PARTIAL INTEGRATION
- TRAJECTORY ESTIMATION (FIT IMAGE LOCATION DATA)
- DATA EVALUATION/REJECTION
- MANEUVER COMPUTATION

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AUTONOMOUS OPTICAL NAVIGATION

DATA EVALUATION AND ERROR "TRAPPING"

- COMPARISON OF IMAGE BRIGHTNESSES TO APRIORI EXPECTATIONS
- COMPARISON OF RESIDUALS IN ~10 FRAMES TAKEN WITHIN MINUTES OF EACH OTHER
- COMPARISON OF LOCAL TRIANGULATION ESTIMATES USING PAIRWISE WIDE ANGLE BEACON LINES-OF-SIGHT
- EVALUATION OF POST FIT RESIDUALS FROM TRAJECTORY ESTIMATION PROCESS

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AUTONOMOUS OPTICAL NAVIGATION

AUTONOMOUS OBSERVATION PLANNING

- INPUTS
  - FILES OF BEACON ASTEROIDS/PLANETS' EPHEMERIDES
  - STAR CATALOG
  - SPACECRAFT TRAJECTORY
- OBSERVATION PLANNING ACQUISITION
  - AT ANY TIME, SAMPLE BEACON POSITIONS FOR SUITABLE STAR BACKGROUNDS, SUN CONSTRAINTS, S/C CONSTRAINTS
  - TEST FOR LOCAL ORBIT DETERMINATION "STRENGTH" – EX: ORTHOGONAL LINES-OF-SIGHT
  - COMMAND GIMBAL POINTING AND CAMERA EXPOSURE