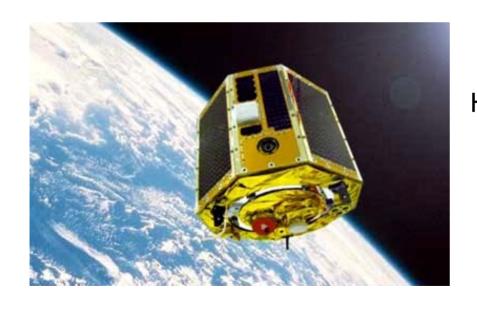
MICRO LABSAT

- Technology Demonstration Microsatellite for Future Missions -



JAXA:

Toru Yamamoto

Hidekazu Hashimoto Shinichiro Nishida

NICT: Shinichi Kimura

UNIV. OF TOKYO: Shinichi Nakasuka



Outline of This Presentation



- Motivation of The Project
- MICRO LABSAT System Overview
- On-orbit Experiments and its Results
- Next Project
- Conclusions

"Deadlock" of R&D for Future Space Technologies only in Japan?



- Projects become BIG → Much cost and high risk
- Study on improvement of reliability becomes important – especially for projects already authorized



- R&D is in "deadlock" situation
 - No opportunity of demonstration for new technology
 - No iteration of R&D cycle







On-orbit Experiments

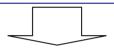


Next Project

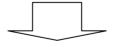
Solution – Microsatellite as Future Technology Demonstrator



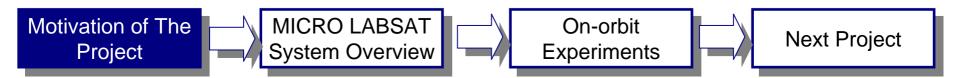
- Low cost
- Low risk
- Short-term development



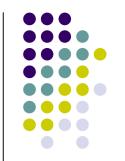
- Challenging experiments with reasonable cost and risk
- Rapid iteration of R&D cycle



 Microsatellites have potential to contribute efficient R&D activities and break the "deadlock" situation!



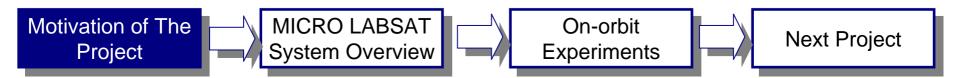
MICRO LABSAT – Challenge of JAXA for Technology Demonstration Microsatellites

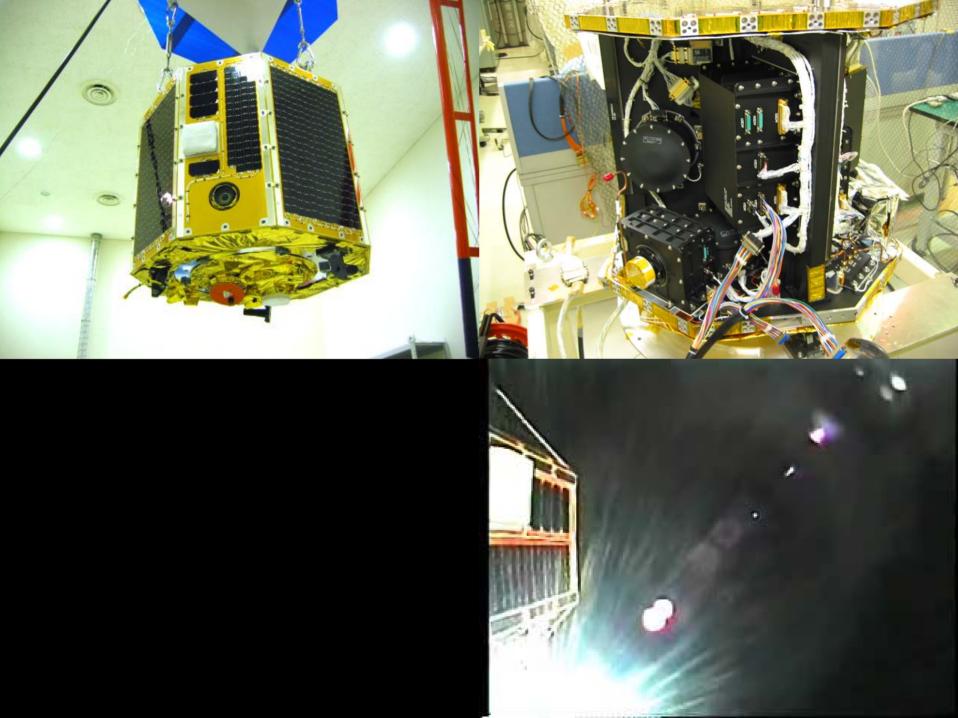


 Challenge: Can microsatellites contribute efficient R&D for new technologies of future missions?

Objectives of MICRO LABSAT Project

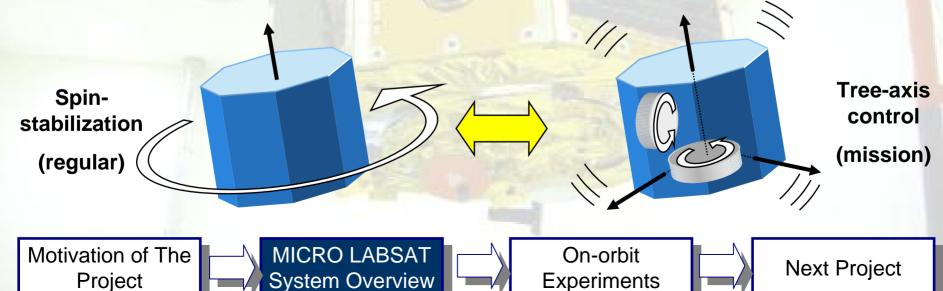
- Develop a low cost microsatellite which enables researchers to demonstrate several challenging technologies in space
- Provide hands-on training for young engineers
- Experiment on on-orbit servicing system is selected as a sample of the challenging technology to be demonstrated





MICRO LABSAT – System Overview(1/2)

- Spin-stabilization for regular operation
 - Passive, Simple, Reliable
- Tree-axis stabilization for mission operation
 - Temporary transfer from spin to three-axis control
 - Momentum bias control



MICRO LABSAT – System Overview(2/2)

- Use many Commercial Off-the-Shelf (COTS) components
 - Commercial 32 bit MPU
 - Commercial RAM and ROM with voting mechanism
 - Commercial Real-time operating system
 - Commercial Ni-MH battery cells
 - Mission components
 (Image processing computer, CMOS and CCD cameras)



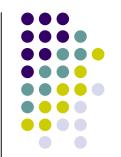


On-orbit Experiments

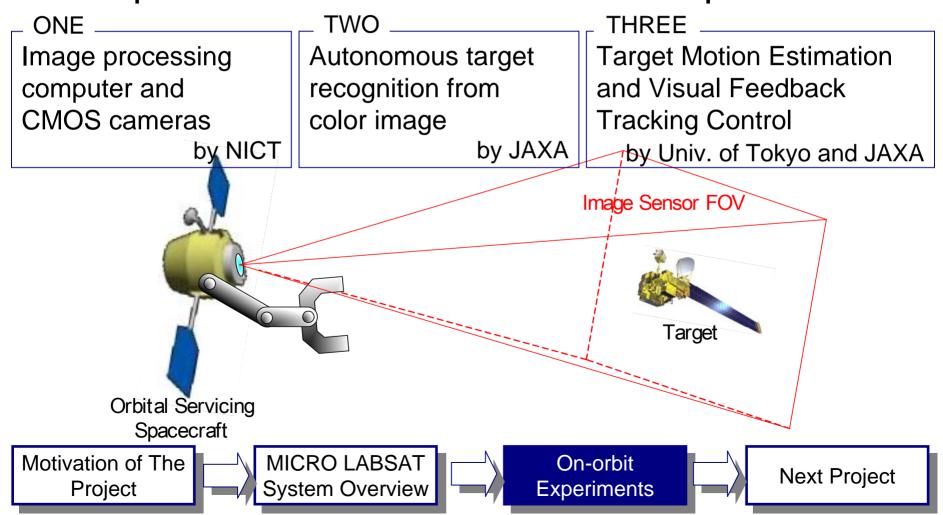


Next Project

Scenario of On-orbit Experiment for On-orbit Servicing Technology



Experiments are divided into three parts:



Experiment One:

Image Processing Computer and CMOS Cameras(1/2)

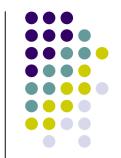
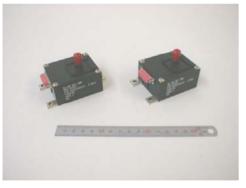




Image Processing Mission Computer (MOBC)

- Commercial
 64bit RISC MPU
- 100 MIPS
- 10 MFLOPS

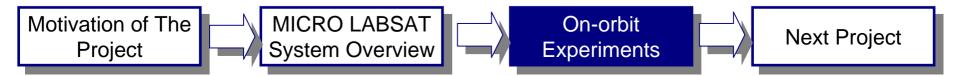
- 1.4 kg
- On-board
 Reprogramming



CMOS Monitoring Camera (CMR)

- Modified commercial digital still camera
- CMOS

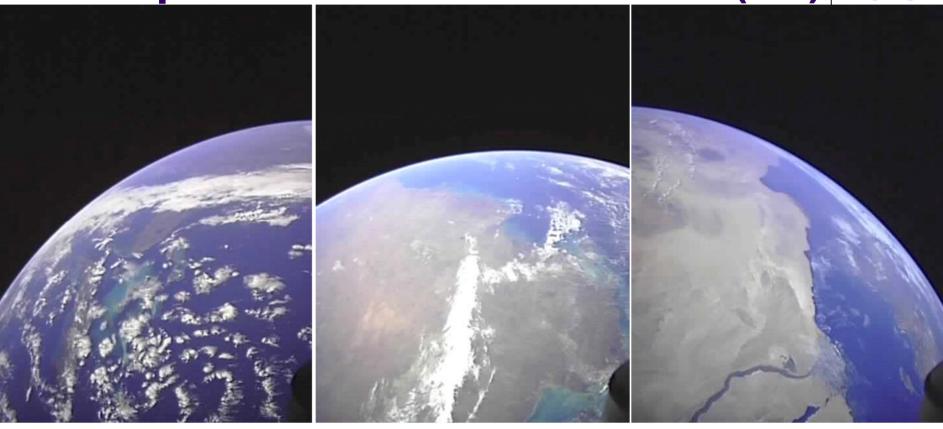
- VGA (640 * 480)
- 140 g
- 1.4 W
- Essential element of on-orbit servicing technologies
- Infrastructure of several on-orbit experiment



Experiment One:

Advanced Image Processing Computer and CMOS Cameras(2/2)



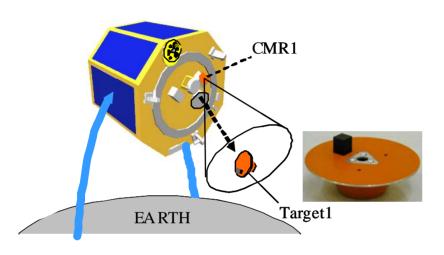


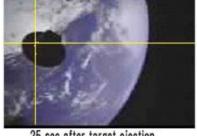
- MOBC and CMR works well on-orbit
- Re-programming is used for many advanced image processing experiments
- No sign of degradations in images by CMR for one and a half year

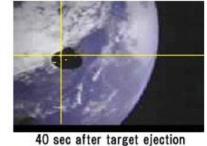
Experiment Two:

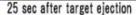
Autonomous Target Recognition









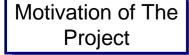


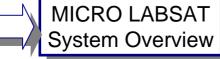


32 sec after target ejection

49 sec after target ejection

- Autonomous extraction and recognition software was developed and demonstrated on MICRO LABSAT
- Target is a flying orange-colored object released from the satellite
- Extraction and recognition of the target from image with bright and complicated background like Earth
- Autonomous extraction and recognition was successfully Result: achieved







On-orbit **Experiments**

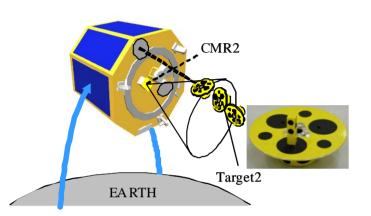


Next Project

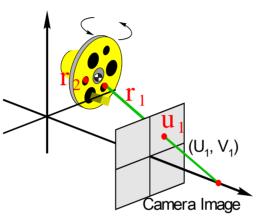
Experiment Three:

Target Motion Estimation and Visual Feedback Tracking Control (1/2)

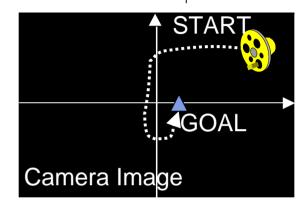




Flying target with black marker was released



Motion estimation using characteristic points



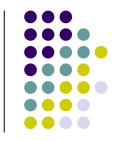
Visual feedback tracking control

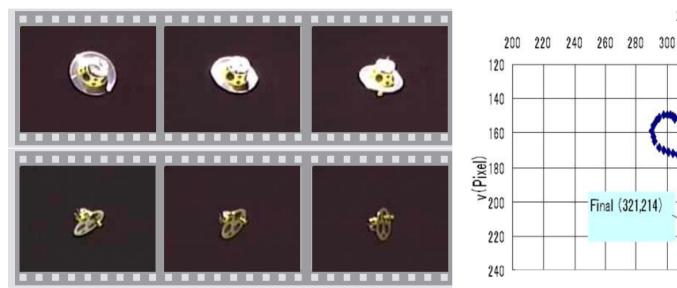
- Target Motion Estimation and Visual Feedback Tracking Control
- Essential technology to capture tumbling object in space
- Position, velocity, attitude, rate, and moment of inertia ratio are estimated by Kalman filter
- Two tracking control method for spacecraft with only two wheels:
 - Switching Time Search Controller: SWSC
 - Sliding Mode Controller

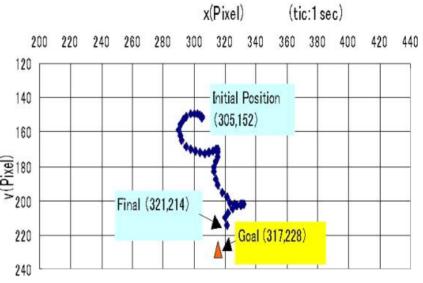


Experiment Three:

Target Motion Estimation and Visual Feedback Tracking Control (2/2)



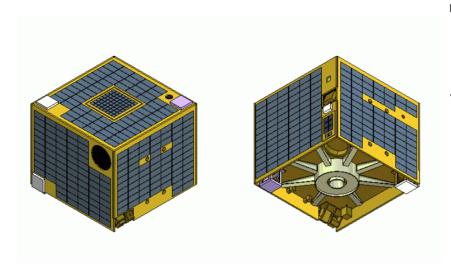


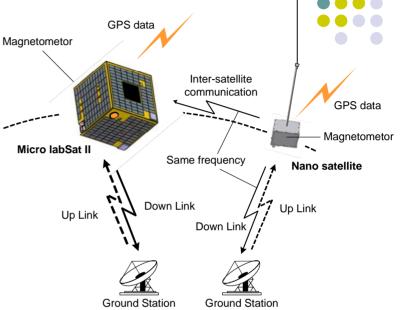


- 93 Images of the target was captured
- Extraction of characteristic points was performed on-board
- Motion estimation was successfully performed on-ground in near real-time fashion
- Visual feedback control experiment was successfully performed

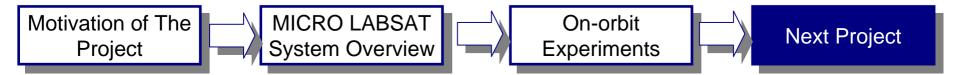


Next Project: MICRO LABSAT II





- Second microsatellite in MICRO LABSAT program
- Demonstration of highly-functional full-scale microsatellite bus for near future earth observation missions
- Advanced experiment: Collaboration with nano-satellite
- Concept design and development of critical components are now progressing...



Conclusions



- MICRO LABSAT is a technology demonstration microsatellite to evaluate its possibility to break the "deadlock" situation
- Experiments on on-orbit servicing technology were planned and accomplished
- MICRO LABSAT succeeded to provide many researchers an opportunity to perform experiments in space with reasonable cost and risk
- Now MICRO LABSAT is still in good condition and operated everyday
- MICRO LABSAT II project has already started