Capacity Building Activities on GNSS in Japan

Hiroaki Tateshita
Japan Aerospace Exploration Agency

Akio Yasuda
Tokyo University of Marine Science & Technology
Contents

• Back ground of Geospatial Information System (GIS)

• University Consortium on GIS/GNSS Education
  GESTISS (Geospatial and Space Technology consortium for Innovative Social Services)

• Summer Seminar on GNSS organized by IPNTJ

• Conclusion
Social Benefit Services with Space Infrastructure (Observation, Communication, Positioning), Flood Warning Service for Bangladesh

Satellite observation

Data relay

3D topo data
Land cover data

Real-time data

Precipitation measurement from space

Satellite communication

Satellite positioning

Data sharing with cellular phone network

Estimating people distribution for better evacuation guidance

Information dissemination to people through cellular phone

Geospatial analysis with GIS

Water level forecast
Flood forecast
Human Resource Development for individual technology

Designing/managing innovative social services with space infrastructure

Space infrastructure
- observation
- positioning
- communication

Service designer/manager to integrate space infrastructure and social benefit services

Social benefit services
- transportation
- disaster
- Environment

collaborative relations
Three Universities Involved in GESTISSL

GESTISSL (Geospatial and Space Technology Consortium for Innovative Social Services)

- University of Tokyo: GIS
- Tokyo University of Marine Science and Technology: GNSS
- Keio University: SDM (System Design and Management)

Visiting Lecture in Asian Institute of Technology (Bangkok): 6-class hours for each subject in each semester.

Three-year project sponsored by MEXT (Japanese Ministry of Education)
The First Summer School on GNSS in Tokyo

Organized by The Institute of Positioning, Navigation and Timing of Japan
Co-organized by Faculty of Marine Technology, Tokyo University of Marine Science and Technology
Supported by Multi-GNSS Asia and GESTISSION
2013/08/19-24
Outline of International Summer School

• Period : 2013/08/19-08/24
• Place : Tokyo University of Maine Science and Technology (TUMSAT), Japan
• Organized by : Dr. Yasuda, Prof. Emeritus of TUMSAT
  The Institute of Positioning, Navigation and Timing of Japan

• Instructors:
  Dr. Yasuda : Professor Emeritus at TUMSAT
  Dr. Kubo : Associate Prof. at TUMSAT
  Mr. Takasu : Inventor of RTK-LIB, GNSS Specialist at TUMSAT
  Dr. Petrovski : Guest Prof. at TUMSAT, Director of iP-Solutions, Japan, co-author of ‘Digital Satellite Navigation and Geophysics' CUP book

• Expected Attendees : Japanese and foreign students with post graduate level & young instructors who are in charge of teaching GNSS in their own countries
• Number of participants : 40 (Foreigner : 20, Japanese : 20)
• Supported by : MGA(Multi-GNSS Asia), GESTISS(Geospatial and Space Technology Consortium for Innovative Social Service)
• Language : English
Call for Participants 2013/4

• Potential Candidates
  --Beginners with master level (Preferable who Specialized in Electronics or Information & Communication Technologies)
  --Young instructors who are in charge of teaching GNSS in their own countries.
• Call for Scholarship* Application until 30th April.
• * (Round Trip Ticket + Accommodations + fee) up to 10 participants.
• Acceptance Notification by 15th May.
• Call for Application until 40 Applicants.
• Application form will be prepared shortly at http://www.gnss-pnt.org/
• Contact: Prof. Akio Yasuda at Tokyo University of Marine Science and Technology, yasuda@kaiyodai.ac.jp
## Participants

<table>
<thead>
<tr>
<th>Country</th>
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<tr>
<td>Taiwan</td>
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<tr>
<td>Thailand</td>
<td>4**</td>
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<tr>
<td>Philippine</td>
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<td>Russia</td>
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<td>Sri Lanka</td>
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<td>Nepal</td>
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<tr>
<td>Vietnam</td>
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<td>Italy</td>
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* One from Philippines
** One from Sri Lanka, another from Nepal
14 of them were invited including partial support

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<tr>
<th>Age</th>
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<th>JPN No.</th>
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<td>31-32</td>
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<td>30</td>
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<td>Officer</td>
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<th>Jobs of JPN Participants</th>
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<td>Private Co.</td>
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<td>Student</td>
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</table>
Introduction of GNSS Technology (1st day)

- 0. Introduction by Dr. A. Yasuda
- 1. History of radio navigation
- 2. What is GNSS?
- 3. Global evolution of GNSSs
- A. Overview of GNSS Positioning by Dr. N. Kubo
  - 1. Description of satellite orbits, coordinates transformation, and time systems.
  - 2. GNSS observables
  - 3. Pseudorange and carrier phase observables.
  - 4. GNSS errors (Atmosphere, ionosphere, multipath, satellite clock and orbit)
  - 5. Point positioning using pseudorange

Evaluation

- Degree of Difficulty: 3.1 (Std. 3)
- Satisfaction: 4.0

- Degree of Difficulty: 3.3 (Std. 3)
- Satisfaction: 4.3
Positioning Algorithm and RTKLIB

Class B (2nd & 3rd Days) by Mr. T. Takasu

1. Basic theory for GNSS data analysis
   It includes signal structure, models of observables, algorithms for least square estimation, error sources and their mitigation and integer ambiguity resolution. It focuses on carrier-phase based precise positioning techniques like RTK and PPP.

2. Introduction of RTKLIB
   RTKLIB is an open-source software package for GNSS data analysis. It includes program structure, AP functionality, usages of API, supported standard data formats and models involved in RTKLIB.

3. Practice of GNSS data analysis with RTKLIB
   It includes the usage of APs: RTKPOST, RTKNAVI, RTKPLOT and RTKCONV, options setting and detailed instructions to deal with real GNSS data for both of post-processing and real-time.

4. Advanced Topics
   It provides some advanced topics in GNSS precise positioning technology.

Evaluation (1 – 5)
Deg. of Difficulty 3.6 (Std. 3)
Satisfaction 4.3
Positioning Algorithm and RTKLIB

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4. Advanced Topics
   It provides some advanced topics in GNSS technology.

Evaluation (1 – 5)
Deg. of Difficulty 3.6 (Std. 3)
Satisfaction 4.2
GNSS Signal and Receiver
Class C (4th & 5th Days) by Dr. I. Petrovski

Day 1. Introduction into GNSS signals.
1. Spread-spectrum concept and benefits for GNSS. 2. GNSS frequencies and carriers.
3. GNSS navigation message.
4. GPS, GLONASS, Galileo, QZSS, Compass, particulars and comparison.
5. Signal generation using GNSS simulator. Practise to operate GNSS simulator in order to generate various GNSS signals.

Day 2. Receiver design and operation.
1. Main components and their functions. Antenna / RF front end / Baseband processor / Navigation processor.
4. Practice to operate real-time software receiver with simulated and live GNSS signals.

Evaluation (1 – 5) Deg. of Difficulty 4.0 (Std. 3) Satisfaction 4.2
Evaluation (1 – 5) Deg. of Difficulty 3.5 (Std. 3) Satisfaction 3.7
Total Average Evaluation (1 – 5) Deg. of Difficulty 3.5 (Std. 3) Satisfaction 4.1
Demonstrations

• GNSS Simulator (Spirent Communications)
• Indoor Message System (Hitachi Industrial Equipment Systems)
• Quasi-Zenith Satellite Reception Demo (Japan Aerospace Exploration Agency)
• Unmanned Aerial Vehicle Application & Demo (Information & Science Technology)
Demonstrations

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• Indoor Message System (Hitachi Industrial Equipment Systems)
• Quasi-Zenith Satellite Reception Demo (Japan Aerospace Exploration Agency)
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Demonstrations

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- Indoor Message System (Hitachi Industrial Equipment Systems)
- Quasi-Zenith Satellite Reception Demo (Japan Aerospace Exploration Agency)
- Unmanned Aerial Vehicle Application & Demo (Information & Science Techno-System)

UAV: Falcon-PARS

Simply Constructed 3-D Model
Workshop for the school participants
(6th day)

1) "Custom GNSS solutions for applied and infrastructural tasks, Russian experience", Anton Belokrylov (Industrial Geodetic Systems, Russia)

2) "My experience on GNSS in QZSS project", Ryo Iwama (NEC, Japan)

3) "The precise localization system for rail vehicle", (Italy)

4) "Ionospheric effect on GNSS Performance in Indonesia", Slamet Supriadi (LAPAN, Indonesia)

5) "Application of GPS radio occultation data to single-frequency GPS positioning", Ernest Macalalad (National Central University, Taiwan)

6) "Seismic wave investigations for far-field and near-field earthquake using Taiwan dense CGPS network", Huang-Kai Hung (Department of Earth Sciences, National Cheng Kung University, Taiwan)

7) "Identification of Characteristic of Kinematic GPS For Monitoring Earth Crust Deformation", Anjar Dimara Sakti (Bandung Institute of Technology, Indonesia)
Group Discussion (6th day) conducted by Mr. Tateshita (JAXA)
Supporters

• **Sponsors:**
  Furuno Electric
  PASCO Cooperation
  Spirent Communications

• **Cooperated by:**
  JAXA          iP-Solution       SensorComm
  Information & Science Techno-System
  Hitachi Industrial Equipment Systems
The First Summer School on GNSS in Tokyo

organized by The Institute of Positioning, Navigation, and Timing of Japan
co-organized by Faculty of Marine Technology, Tokyo University of Marine Science and Technology

The Institute of Positioning, Navigation and Timing of Japan, hereby certifies that

Rhonalyn L. Vergara

has completed the 6-day course on GNSS to cultivate the comprehensive knowledge, including receiver architecture and positioning software with practices and demonstrations, that was held on 19th—24th August 2013 at Tokyo University of Marine Science and Technology.

The organizer:

Prof. Akio Yasuda
President of IPN1J

Supported by Multi-GNSS Asia, and
GEospacial and Space Technology consortium for innovative Social Services
Conclude Remarks

- Introduce the framework of GESTISS.
- Introduce the first Summer School in Tokyo.
- The 6-day course of the lecture were successfully held with high satisfactions.
- Next Summer School will be held in August 2014.
- Please check the IPNTJ home page time to time. http://www.gnss-pnt.org/

Thank you very much for your attention.
# Time Table of the Summer School

## Time Table for GNSS Summer School

### 8/19-24

<table>
<thead>
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<tr>
<td>0840-0850</td>
<td>Opening/Guidance</td>
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<td>0850-1010</td>
<td>Introduction</td>
<td>Class B-1</td>
<td>Class B-6</td>
<td>Class C-1</td>
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<td>1010-1030</td>
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<td>1030-1150</td>
<td>Class A-1</td>
<td>Class B-2</td>
<td>Class B-7</td>
<td>Class C-2</td>
<td>Class C-7</td>
<td><strong>UAV Demo</strong></td>
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<td>1300-1420</td>
<td>Class A-2</td>
<td>Class B-3</td>
<td>Class B-8</td>
<td><strong>IMES-Demo</strong></td>
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<td>workshop</td>
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<td>1420-1440</td>
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<td>1440-1600</td>
<td>Class A-3</td>
<td>Class B-4</td>
<td>Class B-9</td>
<td>Class C-4</td>
<td>Class C-9</td>
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<tr>
<td>1600-1620</td>
<td><strong>Spirent Seminar (1H)</strong></td>
<td>Break</td>
<td>Break</td>
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<td>1620-1740</td>
<td>Self introduction (1H)</td>
<td>Class B-5</td>
<td><strong>QZSS-Demo</strong></td>
<td>Class C-5</td>
<td><strong>UAV-Appli</strong></td>
<td>Closing</td>
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<td>Welcome Party</td>
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<td>Farewell party</td>
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### Instructors

- **Introduction**: Dr. Akio Yasuda
- **Class-A**: Dr. Nobuaki Kubo
- **Class-B**: Mr. Tomoji Takasu
- **Class-C**: Dr. Ivan Petrovski

1 class=80 minutes
RTKLIB

- **Open source program package for RTK-GPS**
  - Has been developed by Mr. Takasu since 2006
  - Latest version: 2.4.1
  - More than 20,000 downloads
  - Version 2.4.2 will be released at the end of March

- **Portable C library + several positioning APs**
  - GUI APs on Windows
  - Console APs on Linux etc...

http://www.rtklib.com
Application Programs (APs)

RTKNAVI : Real-time positioning (Raw data from Receiver)
RTKPOST : Post-processing analysis (RINEX --------)
RTKPLOT : Plot GNSS data and visibility analysis
RTKCONV : RINEX converter for raw receiver data