International Capacity Building Activity in Japan

Akio Yasuda (安田明生)

Professor Emeritus at Tokyo University of Marine Science and Technology (TUMSAT)

President of the Institute of Positioning, Navigation, and Timing of Japan (IPNTJ)

ICG-13 @ Xi'an, China

2018/11/06
International GNSS Summer School in Tokyo since 2013

• **Duration**: 6 days in Summer

• **Venue**: Tokyo University of Marine Science and Technology (TUMSAT)

• **Organized by** Faculty of Marine Technology, TUMSAT

• **Co-organized by** Institute of Positioning, Navigation and Timing of Japan (IPNTJ)

• **Sponsored by** Japan Science and Technology Agency (JST)
International GNSS Summer School 2018 in Tokyo, 7/30- 8/04

• Supported by
  MGA http://www.multignss.asia/
  GESTISS http://gestiss.org/
  QSS http://www.qzs.jp/
  FURUNO : https://www.furuno.co.jp/
  u-blox https://www.u-blox.com/ja
  Yokowo Corp. : https://www.yokowo.co.jp/
  JRC : https://www.jrc.co.jp/jp/index.html
  MSJ : http://www.magellan.jp/
  Septentrio : https://www.septentrio.com/
  KKE : https://www.kke.co.jp/
Tokyo University of Marine Science and Technology

- Tokyo University of Fishery
  (Founded in 1888)
- Tokyo University of Mercantile Marine
  (Founded in 1875)
- Two universities merged into a new university in 2003.
- TUMSAT was established.
Tokyo University of Marine Science and Technology

- School of Marine life Science 130 Staffs and 1600 Students
  4 Departments
  of Ocean Sciences, of Marine Biosciences, of Food Science and Technology and of Marine Policy and Culture
- School of Marine Technology 90 Staffs and 1000 Students
  3 Departments
  of Maritime System Engineering
  of Marine Electronics and Mechanical Engineering
  of Logistics and Information Engineering
- School of Marine Resources and Environment
  (Inaugurated 2017/04)
Map of Central Tokyo

Tokyo Central Station

Shinagawa Campus
School of Marine Science

Etchujima Campus
School of Marine Technology
Etchujima Campus (Faculty of Marine Technology)
Introduction of TUMSAT

Early April

Meijimaru built 1874

Main building built 1932
Outline of Summer School in 2018

• Date: 2018/07/30-08/04: 6 days
• Attendees: Japanese and foreign students of post graduate level & young engineers and instructors who are teaching GNSS in their own countries.
• Number of participants: 39
• Scholarship for 19 foreign attendees
• Language: English
• Fee: 60,000JPY, (20,000JPY for students).
• Supported by: MGA(Multi-GNSS Asia), GESTISS (Geospatial and Space Technology Consortium for Innovative Social Service), QZSS Services, and private companies.
• Sponsored by Japan Science and Technology Agency (JST)
Countries and Regions Eligible for Invitation by JST

Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Fiji, India, Indonesia, Kazakhstan, Korea, Kyrgyz Republic, Lao, Malaysia, Maldives, Marshall Islands, Micronesia, Mongolia, Myanmar, Nepal, Pakistan, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Tajikistan, Thailand, Timor-Leste, Tonga, Turkmenistan, Uzbekistan, and Viet Nam

We invited students from the other countries by our own budget.
Participants in 2013-2018

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<td>39</td>
<td>41</td>
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**Participants 2018**

19 of them are invited, selected from 103 applicants for the scholarship.

*Include 2 foreign students studying in Japan.*
# Time Table in 2018

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<th>Dr. Akio Yasuda</th>
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<td>Class-A</td>
<td>Dr. Nobuaki Kubo</td>
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<td>Fundamentals</td>
<td>Dr. Ivan G. Petrovski A-1,2,3</td>
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<td>Class-B</td>
<td>Dr. Takeyasu Sakai , B-1,2,3,4</td>
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<tr>
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<td>Mr. Tomoji Takasu B-5,6,Practice</td>
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<td>Class-C</td>
<td>Dr. Toshiaki Tsuji, C1,2,3</td>
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<tr>
<td>Receiver</td>
<td>Dr. Taro Suzuki, C4, SDR-Practice</td>
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13
Introduction to GNSS (Day 1)

Introduction (by Dr. A. Yasuda)

• 1. Outline of the summer school
• 2. What is GNSS?
• 3. Global evolution of GNSSs

A-1, 2, 3. GNSS and GNSS receiver overview (by Dr. Ivan Petrovski)

• 1. Positioning with GNSS and Satellite Orbits
• 2. GNSS signals
• 3. NAV Data
• 4. GNSS receiver
• 5. GNSS error budget
• 6. Acquisition
• 7. Tracking
• 8. SDR Receiver specifics
• 9. SDR ARAMIS
• 10. High accuracy positioning with SDR
• 11. Sensitivity
• 12. GPS simulator
Lunch Time
Lunch Menu (Sample)
Photo @ Welcome Party
Positioning Algorithm (Day 2)

B-1,2,3,4. GNSS Positioning Program (by Dr. T. Sakai)

- Positioning Algorithm by Pseudo-Ranges
- Processing of RINEX files
- Various Considerations for Improved Results
- Differential GPS

Bring your laptop with C compiler installed.

Special Lecture:

CLAS by ‘Michibiki’ (QZSS) (by Mitsubishi Electric)
What is MADOCA by Mr. Iotake(GPAS)
QZS Positioning Demo (by Magellan Systems Japan)
CLAS Demonstration
GNSS Signal and Receiver (Day 3)

C-1,2 Introduction into GNSS signals. (by Dr. T. Tsujii)

1. Spread-spectrum concept and benefits for GNSS.
2. GNSS frequencies and their specifics with regard to radio signal propagation.
3. Code and carrier generation in GNSS transmitters and simulators.
4. GNSS navigation messages.

C-3 Receiver design and INS integration.

1. Main components and their functions. (Antenna / RF front end / baseband processor / navigation processor.)
2. Baseband processor in detail. (Operation of baseband processor: Acquisition / Code and carrier tracking loops / Reading navigation message.)

C-4 Introduction of Software Defined Receiver (by Dr. T. Suzuki)

Signal structure of GPS, GLONASS, Galileo, QZSS, and BeiDou
GNSS-SDRLIB: Introduction of an open source software GNSS receiver
Positioning Algorithm and RTKLIB (Day 4)

B-5,6

GNSS precise positioning and RTKLIB (by Mr. T. Takasu)

- Carrier-phase-based positioning with GNSS
- Theory of RTK and PPP
- RTKLIB Practice
  - RTK and PPP practice with RTKLIB
- RTK-Demo G-I,II
  - RTK Practice on a cruising boat

Lecture on ‘What is AIS?’ and On-board Demonstration
(By JRC Corp. Team)

G-II, I Visit ECDIS Center
Gifts from Sponsors

1. u-blox GNSS receiver (M8T)
2. Allystar GNSS receiver
3. yokowo GNSS antenna
On board Practice, August 2\textsuperscript{nd}

AIS & ECDIS Demo by JRC Team

Yayoi Maru
Campus Tour: ECDIS Center and Virtual Bridge

ECDIS Center

Virtual Bridge
System Design Engineering by Dr. N. Kohtake.

- Study the important concept to resolve the global subjects and problems using the advanced GIS technology.

System Design Workshop

- They proposed targets and studied how to resolve the problems in 7 groups.
- The results were presented by each group.

Practice to operate real-time software receiver

By Dr. T. Suzuki
Presentation after the Group Discussion, 2018
GNSS Software Receiver by Dr. Suzuki
in the afternoon Day 5
Real-time positioning using front-end and GNSS-SDRLIB
Farewell Party at 2018
# Special Lectures and Workshop (Day 6)

## Special Lectures

- GNSS Signal Security
- Anti-Spoofing
- GNSS Raw Measurements from Android Device

By Dr. Dinesh Manandhar (The University of Tokyo)

## Workshop by Participants

## Closing Ceremony
Lecture on Spoofing by Dr. Manandha
Participants Workshop Program 08/04 (Day 6)

1) "GNSS status and applications in Mozambique,“ Israel Marcos Matavele, Mozambique, G2
2) "GNSS Precise Kinematic Positioning for Kinematic Platform Based on Multiple Antennas," Kaifei He, China University of Petroleum, China, G3
3) "Measurement of height of mount Everest using GNSS technology in Nepal," Khim Lal Gautam, Survey Department, Nepal, D2
4) "IRNSS/NavIC: Experiences," Atanu Santra, The University of Burdwan, India, G1
5) “Urban GNSS Positioning using Low Cost Sensors,” Guohao Zhang, The Hong Kong Polytechnic University, China, G1

10 – 15 minutes each

Special Lecture by Prof. Nobuaki Kubo
On the performance of recent GNSS receiver modules
Certificate for the Completion

GNSS Summer School 2016 in Tokyo
organized by School of Marine Technology, Tokyo University of Marine Science and Technology (TUMSAT)
co-organized by The Institute of Positioning, Navigation, and Timing of Japan (IPNTJ)

School of Marine Technology of TUMSAT, hereby certifies that

Akio Yasuda
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 from 1st to 6th August 2016 at Tokyo University of Marine Science and Technology.

The organizer: _____________ Prof. Tatsuro Tsukamoto, Dean of TUMSAT

Supported by Multi-GNSS Asia, Quasi-Zenith Satellite System Services, and GEospatial and Space Technology consortium for Innovative Social Services

Sponsored by Japan Science & Technology Agency
Contents of Lectures (July 31 - Aug. 5, 2017, 1.5h X 30 classes)

Day 1  Introduction (by Dr. A. Yasuda)
1. History of radio navigation
2. What is GNSS?
3. Global evolution of GNSSs
A-1,2,3  Basics of GNSS (by Dr. Li-Ta Hsu)
1. Description of satellite orbits, coordinates transformation, and time systems
2. GNSS observables
3. GNSS errors (Atmosphere, ionosphere multipath, satellite clock and orbit)
4. Calculating position and DOP

Special Lecture: GNSS RF Simulator by Kyron Howell (ip-solution)

Day 2 B-1,2,3,4  GNSS Positioning Program (by Dr. T. Sakai)
1. Positioning Algorithm by Pseudo-Ranges
2. Processing of RINEX files
3. Various Considerations for Improved Results
4. Differential GPS

Special Lecture: Sub-meter Class Augmentation by ‘Michibiki’ (QZSS)
By Mr. D. Matsumoto (NEC)

Positioning Practice: Quasi-Zenith Satellite Reception (NEC tem)

Day 3  GNSS Signal and Receiver (by Dr. T. Tsujii)
C-1, 2. Introduction into GNSS signals
1. Spread-spectrum concept and benefits for GNSS
2. GNSS frequencies and their specifics with regard to radio signal propagation
3. Code, carrier and navigation message
4. Signal generation using GNSS simulator

C-3  GNSS receiver and INS integration
1. Receiver Main components and their functions
   Antenna / RF front end / baseband processor / navigation processor
2. Baseband processor in detail. Acquisition / Code and carrier tracking loops
3. GPS & INS Integration ionospheric scintillation effect on GPS/GPS/INS tracking
4. Introduction of GNSS software receivers (by Dr. T. Suzuki)
   1. Introduction of QZSS, GLONASS, BeiDou, and Galileo signals.
   2. Navigation message structures of GNSS signals
   3. Front-end architecture
   4. Handwork of recording live GNSS signals using front-end device

Day 4  B-5,6 GNSS precise positioning and RTKLIB (by Dr. N. Kubo)
1. Carrier-phase-based positioning with GNSS

2. Theory of RTK and PPP
3. RTKLIB Practice - RTK and PPP practice with RTKLIB
4. RTK-Demo G-I, G-II - RTK Practice on a cruising boat

Demonstration: AIS demo (Japan Radio Company (JRC))
Campus Tour: Visiting Maritime Museum and Meiji- maru

Day 5  SDR Practice, Receiver design and operation (by Dr. T. Suzuki)
1. Introduction of GNSS-SDRUB
2. Practice of real-time positioning using GNSS-SDRUB

System Design Lecture and Workshop (by Dr. N. Kohtake)
Practice for System Design, Group Discussion, Workshop

Day 6  Special Lectures:
GPS/GNSS Meteorology by Dr. Y. Shoji (Meteorological Research Institute)
GNSS Signal Security, Spoofing, Anti-Spoofing by Dr. D. Manandhar (U. of Tokyo)

Participants Workshop

Instructors:
Akio Yasuda: Professor Emeritus at TUMSAT, President of IPNTJ
Li-Ta Hsu: Assistant Professor at the Hong Kong Polytechnic University, China
Takeyasu Sakai: Senior Researcher at ENRI
Toshiaki Tsuji: Senior Researcher at JAXA
Taro Suzuki: Assistant Professor at Waseda University
Nobuki Kubo: Associate Professor at TUMSAT
Naohiko Kohtake: Associate Professor at Keio University

Sponsors:
Japan Science & Technology Agency, QZSS System Services, PASCO Corp.,
Aisan Technology, u-blox AG, SkyTraq Technology, Yokowo Corp.,
Sensorcomm, JRC Nihon Musen

Organizer:
School of Marine Technology
Tokyo University of Marine Science and Technology
2-1-6 Etchujima, Koto-ku, Tokyo 135-8538, Japan

Co-Organizer:
The Institute of Positioning, Navigation, and Timing of Japan
C/o Tokyo University of Marine Science and Technology
2-1-6 Etchujima, Koto-ku, Tokyo 135-8533, Japan
Tel & Fax +81-3-5245-7365, e-mail: info@gnsstnt.org
# Evaluation (9 Lectures and 3 Practices) 2018

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<th>Min.</th>
<th>Max</th>
<th>Average</th>
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<td>Difficulty</td>
<td>3.39</td>
<td>3.67</td>
<td>3.51</td>
<td>Bit harder than their level</td>
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<td>Satisfaction</td>
<td>4.03</td>
<td>4.48</td>
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<td>Total Impression</td>
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<td>4.73</td>
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Outline of Summer School in 2019

• Date: 2019/07/29-08/03 (TBC) : 6 days
• Attendees: Japanese and foreign students of post graduate level & young engineers and instructors who are teaching GNSS in their own countries.
• Number of participants: 40
• Scholarship for up to 20 foreign attendees
• Language: English
• Fee: 60,000JPY, (20,000JPY for students).
• Supported by: MGA(Multi-GNSS Asia), GESTISS (Geospatial and Space Technology Consortium for Innovative Social Service), QZSS Services
• Sponsored by: Japan Science and Technology Agency (JST)
Scholarship Application

- Please prepare the following items. The scholarship includes round trip ticket, 7-night accommodation 6-day lunch and the fee.
  - 1. CV
  - 2. Certification of the graduation. (for your all career)*
  - 3. Transcript with student's records. (for your all career)*
  - 4. Certification for English ability (Score of TOEFL, IELTS or TOEIC)*
  - 5. Recommendations by two responsible persons*
  *Please attach the scanned original documents to email to yasuda@kaiyodai.ac.jp for the selection and bring the originals if accepted.

- Call for application will be announced early 2019.
- Please check http://www.gnss-pnt.org/index.html time to time.
Scholarship Applicants  2018

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Total 103

JST Supporting Countries

( # ):JST Scholarship Awarded #