



Report on the COSPAR Capacity Building Workshop

"Small Satellites, Big Sciences"

SaTReC/KAIST, Daejeon, Korea – September 10th ~ 17th, 2017

Introduction

The COSPAR Capacity Building Workshop (CBW) took place at SaTReC (Satellite Technology Research Center) of KAIST (Korea Advanced Institute of Science and Technology), which is located in the Daedeok Science and Technology Town, Daejeon, Republic of Korea from September 10th to 17th, 2017. SaTReC is the pioneer of Korean small satellites, and still in charge of developing Korean next generation microsattellites.

The workshop was proposed and locally organized by Dr. Y. D. Park, a chair of the Korean COSPAR Committee and Dr. G.H. Choi, a chair of the Korean Committee for Capacity Building Workshop. The full list of Korean CBW Committee members is given in Appendix I. Primarily organized by COSPAR, the local committee of the workshop received support from the COSPAR headquarters. The workshop is hosted by KASI (Korea Astronomy and Space Science Institute) and supported by KARI (Korea Aerospace Research Institute) and SaTRec. The program largely consists of theoretical lectures on satellite and its applications, hands-on training for the satellite orbit and data analysis, visits to the space related institutes, and lastly team activities for the mission challenges, to enlarge the scientific and engineering capacity of the participants from Korea and other countries.

The main objective of the workshop is to introduce PhD students, Postdocs and junior/young researchers who take part in the space projects, to the systematic approach on the small satellites, cubesats, and space applications. It also includes lectures on space mission design and satellite subsystems, as well as the practical exercises of satellite development.

Details about the workshop can be found in the capacity building workshop program web pages (<http://cosparhq.cnes.fr/events/cb-workshops>) and in the local web pages (<http://www.cospar2017.org/cbw>).

I. Participants

A total of 32 applicants were selected out of a total of 66 candidates. The selected participants were from Asian countries (2 from India, 1 from Indonesia, 1 from Kyrgyz Republic, 2 from Malaysia, 1 from Nepal, 1 from Pakistan, 1 from Singapore, 2 from Taiwan, 1 from Vietnam, and 11 from Korea), European countries (1 from Belgium, 1 from Netherlands), African countries (2 from Algeria, 2 from Ethiopia, 1 from Uganda), and Latin American countries (2 from Peru). Five participants (1 from Belgium, 1 from Uganda, 1 from Kyrgyz Republic, 1 from Pakistan, and 1 from Korea) of the originally chosen participants have withdrawn their participation prior to the workshop, so the total of 29 students and researchers have participated in the workshop including two alternatives from Korea. And 11 participants among 29 participants were asked for financial support, therefore Korean CBW committee has offered financial support (550,000₩/person) support of COSPAR headquarters. The full list of participants is given in Appendix II.



II. Lectures

A. Lecturers

For the core lecturer of Cubesat, Prof. Jyh-Ching Juang from National Cheng Kung University of Taiwan was invited. The CBW SOC has invited 7 more lecturers from various institutes and/or universities in Korea for following subjects: Small satellite overall system, ADCS (Attitude Control & Control System), Space environment test, Ground station and satellite data application, Space sciences, Satellite orbit simulation, Structure modeling & simulation. The attendees were actively participated in the satellite orbit and data analysis S/W part through hands-on training. The full list is given in Appendix III.

B. Overview of Each Lecture

a) “Cube Satellites” by Prof. Jyh-Ching Juang

In this lecture, the recent developments and trends in Cubesats are introduced. It is designed to develop participants’ understanding of Cubesats, mission planning, system engineering, payloads and orbits on Cubesats. Some examples of typical Cubesats and their subsystems are also introduced.

b) “Space Research and Development Activities at SaTReC” by Dr. Kyungin Kang

This course covers activities of SaTReC, a leading research center for small satellites in Korea. SaTReC was founded in 1989 and launched the first Korean satellite KITSAT-1 in 1991. After successful launches of KITSAT-2 in 1992 and KITSAT-3 in 1999, it developed the Korea’s first astronomical satellite STSAT-1 in 2003 and STSAT-3 in 2013. The electrical power subsystem (EPS) of small satellite is also presented.

c) “Attitude Control System” by Dr. Son-Goo Kim

This lecture begins by describing how attitude dynamics and control arises in the operation of spacecraft. This is followed by a description of the fundamental attitude control concepts that are in widespread use. The attitude of a spacecraft, i.e., its orientation in space, is an important concept in spacecraft dynamics and control. The lecture focuses on the attitude motion of spacecraft in circular orbits, with a brief discussion of the attitude control system which was designed for Science & Technology SAT-3 (STSAT-3) and Next Generation Small Satellite -1 (NEXTSat-1).

d) “COSPAR AIT Lesson” by Dr. Yong-Sik Yoon

This course explores the space environment where a satellite is orbiting, and describes the AIT (Assembly, Integration and Test) concepts including the AIT engineering and its operation procedure. Finally, a definition of contamination and the method of the contamination controls are explained.

e) “Introduction to Space Physics Payload” by Dr. Jaeheung Park

This lecture serves as an introduction to the space environment according to the satellite altitudes. Several physical parameters, such as temperature, electron density, ion density and radiation property are described as the function of the altitude. It also includes space physics sensors for measuring those physical parameters by satellites in orbit.

f) “Satellite Mission Operations & Ground Systems” by Dr. D.W. Chung

This course offers the space mission operations: , space mission operation design, function of the operation, and how to conduct the operation for the space mission. As an example, KOMPSAT-2 ground system is introduced as well.

g) “Mission Design” by Dr. Hungu Lee

There are three parts in this lecture. First, the satellite design process is introduced. The satellite requirements & system hierarchy is described and the verification & validation process is shown. Second, the mission analysis is explained with the system design flow, the definition of operation concept, and the mission analysis examples. Finally, the system design and implementation is described as system specification and allocation, mechanical configuration, spacecraft architecture, and development processes.



C. Proportion of the Lectures by Subject

Of the whole lectures, approximately 25% are dedicated to Cubesat, 40% to missions' specifics (satellites system, instruments and data analysis software), and 35% to the team projects on mission design.

III. Practical exercise

A. “Orbit Simulation STK & GMAT” by Dr. Dong-Hyun Cho

In this class, some software for orbital simulation are introduced such as STK and GMAT. I also introduced GMAT which is the free and reliable another software. By using GMAT, you can propagate very high accuracy orbit with full dynamics and also calculate solar eclipse time. And it is possible to design orbital maneuver by using mission design function of GMAT.

B. “Primer on Python” by Dr. Jeonghyun Pyo

Python is an open-source programming language developed by community.

Nowadays, many scientific softwares are available in and developed with Python. This lecture introduces the very basics of the programming language and several advanced examples. For the mathematical and scientific calculations and data analysis, third-party libraries, e.g., NumPy, SciPy, matplotlib, IPython, are essential.

IV. Team Project

The participants largely defined their team projects by themselves. Each team assigned a team leader according to the subjects chosen. The team's mission is to provide the communication service for cubesat using cubesat constellation. The constellation system is to transfer the signal received from cubesat. S-band is used in order to establish the link between constellation system and ground stations. UHF/VHF is used in order to establish the link between constellation system and cubesats (customers). The main idea was suggested from Iridium service. At the end of the workshop each participant team gave a short presentation (15 minutes for presentation and 5 minutes for discussion time) summarizing the results of team activity.



V. Logistics

The workshop took place at SaTReC/KAIST, and all participants and lecturers stayed at the Innopolis guest house within easy distance from each other.

VI. Cultural Experience

On the last day of the workshop, all participants joined a half day culture tour to Gongju City (an ancient capital of Baekjae Dynasty). Located in the mid-west of South Korea, the heritage related 3 capital cities represents the latter period of Baekje Dynasty reaching its cultural peak through active exchange with neighboring countries. Baekje's Historical Areas serial national property consisted of 8 heritages from latter period of Baekje Dynasty (475~660CE). These heritages show that Baekje accepted urban planning, architectural technology, art and religion from China and passed them to East Asia countries as well as Japan after developing them.

Appendix I. List of CBW Committee Members

A. Scientific Organizing Committee (SOC) Members

- G. Choi (Chair, KARI)
- K. W. Min (KAIST)
- H. C. Bang (KAIST)
- D. H. Lee (Secretary, KASI)

B. Local Organizing Committee (LOC) Members

- K. I. Kang (Chair, SaTReC)
- S. D. Park (Satrec Initiative)
- J. H. Lee (Secretary, KARI)
- S. G. Lee (KASI)
- J. J. Lee (KASI)
- H. D. Kim (KARI)

Appendix II. List of Participants

| No. | Title | Family Name | Given Name | Gender | Organization | Country |
|-----|-------|--------------|-------------------|--------|--|-------------------|
| 1 | Mr. | Perea Tamayo | Robert Glen | Male | CONIDA (Space Agency of Peru) | Peru |
| 2 | Mr. | Castro Mejía | Percy Junior | Male | CONIDA (Space Agency of Peru) | Peru |
| 3 | Mr. | Lee | Seunguk | Male | Chungbuk National University | Republic of Korea |
| 4 | Mr. | Bhattarai | Shankar | Male | Tribhuvan University | Nepal |
| 5 | Ms. | Zulkifli | Zuhafiza | Female | National Space Agency (ANGKASA) | Malaysia |
| 6 | Ms. | Shang | Jie-Rou | Female | Institute of Astronomy, National Tsing Hua University | Taiwan |
| 7 | Ms. | Hamidon | Nooraini | Female | National Space Agency (ANGKASA) | Malaysia |
| 8 | Mr. | Fuchs | Christian Martin | Male | Leiden Institute of Advancd Computer Science, Leiden University | The Netherlands |
| 9 | Mr. | Aguechari | Nassim | Male | Algerian Space Agency / Satellites Development Center | Algeria |
| 10 | Dr. | Smahat | Amine | Male | Algerian Space Agency / Satellites Development Center | Algeria |
| 11 | Ms. | Yang | Chien-Ying | Female | Institute of Astronomy at National Tsing Hua University | Taiwan |
| 12 | Mr. | Song | Ho-Sub | Male | Chungnam National University | Republic of Korea |
| 13 | Ms. | Hwang | Hyewon | Female | Yonsei University | Republic of Korea |
| 14 | Ms. | Kang | Seokju | Female | Yonsei University | Republic of Korea |
| 15 | Mr. | Park | Woosang | Male | KAIST | Republic of Korea |
| 16 | Mr. | Kwak | Pilwon | Male | KAIST | Republic of Korea |
| 17 | Mr. | Addis | Zelalem Wudu | Male | Entoto Observatory and Research Center | Ethiopia |
| 18 | Mr. | Sarpotdar | Mayuresh Nandkuma | Male | Indian Institute of Astrophysics | India |
| 19 | Ms. | | Luthfiandari | Female | Bosscha Observatory | Indonesia |
| 20 | Ms. | Suresh | Ambily | Female | Indian Institute of Astrophysics | India |
| 21 | Mr. | Areda | Eyoas Ergetu | Male | Ethiopian Space Science and Technology Institute | Ethiopia |
| 22 | Ms. | Li | Bing Xuan | Female | Nanyang Technological University | Singapore |
| 23 | Mr. | Lee | SungMoon | Male | Chosun University / UZURO Tech | Republic of Korea |
| 24 | Mr. | Jo | Gwang Hee | Male | Chungnam National University | Republic of Korea |
| 25 | Mr. | Shin | Hanseop | Male | UST Korea Aerospace Research Institute Campus | Republic of Korea |
| 26 | Dr. | Pham | Thi Mai Thy | Female | GIS and Remote Sensing Research Center | Vietnam |
| 27 | Mr. | Lee | Junho | Male | UST | Republic of Korea |
| 28 | Mr. | Kim | Taeho | Male | Korea Advanced Institute of Science and Technology | Republic of Korea |
| 29 | Mr. | Kim | Taeyoung | Male | Korea Advanced Institute of Science and Technology | Republic of Korea |

Appendix III. List of Lecturers

- Lecture 1 : Prof. Jyh-Ching Juang (NCKU, Taiwan, juang@mail.ncku.edu.tw)
- Lecture 2-1 : Dr. K. I. Kang (SaTReC, Korea, kikang@kaist.ac.kr)
- Lecture 2-2 : Dr. S. Kim (SaTReC, Korea, kimsongoo@kaist.ac.kr)
- Lecture 2-3 : Dr. Y. S. Yoon (KARI, Korea, ysyoon@kari.re.kr)
- Lecture 3-1 : Dr. Jaheung Park (KASI, pj@kasi.re.kr)
- Lecture 3-2 : Dr. D. W. Chung (KARI, Korea, dwchung@kari.re.kr)
- Lecture 3-3 : Dr. Hun-gu Lee (satreci, budgie@satreci.com)
- Practical exercise : Dr. J. Pyo (KASI, Korea, jhpyo@kasi.re.kr)
- Practical exercise : Dr. D. Cho (KASI, Korea, dhcho99@kari.re.kr)