Title: Landslide Prediction Mission in Cooperation with Hillside Censor Network Robots
Primary Point of Contact (POC) & email: Associate Prof. Dr. Ryuichi SEKITA, sekita@fuee.fukuyama-u.ac.jp
Co-authors: N.A.
Organization: School of Engineering, Fukuyama University, Hiroshima, Japan

Need

There are about 530 thousands high risk place of landslides in Japan where Japanese government designated the place, and there have been occurred 1180 landslides recent ten years on average in Japan. What is more, statistical data past forty years, shows that 42% of fatalities in Japan's natural disaster come from landslides. Why do we have not been able to reach the solution for saving life from landslides long time? This is the necessity of our satellite mission.

Mission Objectives

I. Data Store and Forward for Landslide Prediction

Some measuring equipment with the most up-to-date technique can predict landslide just few minutes before the occurrence in certain conditions. The just few minutes is absolutely insufficient time for evacuation. The residents need six hours at least for evacuation from landslide. So, some breakthrough should be needed for data measurement technology related to landslide. One candidate of the technology may be hillside censor network precise data measurement system. Furthermore almost high risk places of landslide is liable to be very steep and thickly-wooded. Then no one can approach the places and no one can install any data measurement system on the places. So, some breakthrough also should be needed for the data measurement system. One candidate of the system should be automatic moving robot data measurement system. After all, the hillside censor network data measurement automatic robot system may be the only solution for the next generation landslide prediction. If the system would realize, no one will collect the measurement data from the system that exist on high risk place of landslide by ordinal measures. Then, only satellite data communication system will be able to collect the measurement data from the system. The realization of satellite data communication system need new data store and forward technology. This data store and forward technology verification is the first mission of our satellite.

II. Cooperation for Data Communication between Micro Satellite and Small Robot

The concept design of hillside censor network robot has a characteristic small size then the robot should have very low level signal output naturally. Besides, the robot is hidden in the forest or grass and is uncooperative with any outside system. How do the microsatellite find the robot and secure data communication in a short time? The microsatellite should need innovative technology with attitude control system and communication system for the cooperation with robot. This cooperation verification is the second mission of our satellite.

III. Children's Science Education

The children of these days come to dislike studying science especially physics. Japan is a science and technology nation, so this tendency should be modified by good education in the internal and external school. The satellite is very useful for children's understanding of physics and mathematics. Our microsatellite is open to various regional private-tutoring schools for using some interesting science experiments. This education is the third mission of our satellite.

Concept of Operations

Our satellite mission has an essential characteristic of integrating with hillside censor network robot system. Then the key mission elements are listed below and shown in Figure 1.

I. Microsatellite Constellation

II. Hillside Censor Network Data Measurement Automatic Robot System. All over the world in near future.

III. Satellite Ground Station in Fukuyama University

IV. Landslide Data Analysis Center in Fukuyama University

V. Digital Signage System for Landslide Risk Information in Residents region

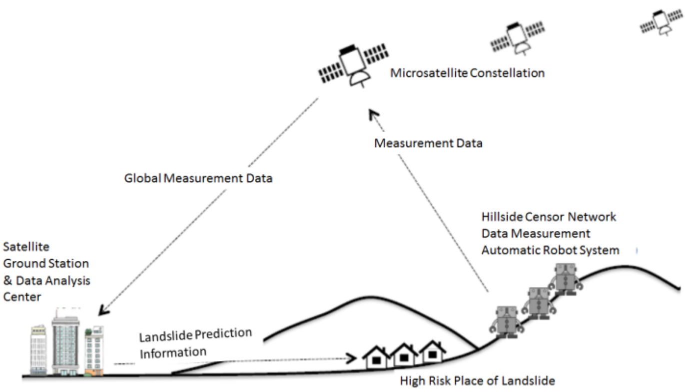

Figure 1 The Satellite Mission Elements

Key Performance Parameters

It is impossible to detect some sign of landslide from only earth observation spectrum data since landslide is caused by complex underground movement of a layer and water. Then the censor network data measurement robot should collect position, temperature, humidity, slight ground movement data, water content data in the ground, methane content data in the ground, and so on. Data sampling time of the system may be once per a minute, then the data recording system of our global data communication satellite may have around two hundred gigabyte space. Then the key performance parameters are listed below.

I. Data Uplink System from Robot to Microsatellite: Some new communication system for example raiser optical system, within small size, or 5.8GHz approx. 100kbps.

II. Data Downlink System from Microsatellite to Ground Station: X-band transmitter set 100Mbps.

III. High Speed Data Recorder System: Performance and Parameters are now investigating.

IV. Intelligence Satellite Attitude Control System: Performance and Parameters are now investigating.

Space Segment Description

Satellite specifications at concept design are listed below.

Mass: From ISO 3A size to 0.5m cubic size, now investigating

Volume: From 5kg to 50kg, now investigating

Average Power: From 10W to 50W, Li-Ion Battery, now investigating

Link Budget: About 20 minutes per a link, once or twice per day

Orbit/Constellation Description

Over 90% land coverage is needed for our satellite since the satellite correct the measurement data for landslide globally. Certain data communication between the satellite and hillside robot is necessary, then two or three satellite should be put almost same around orbit. Furthermore, real time landslide prediction is ideal plan, then data communication should be executed in a six-hour cycle at least. Finally, three times four = twelve satellites are needed for our mission.

Orbit: Altitude 400km, Sun Synchronous Circulars Orbit (To Be Determined)

Constellation: Three satellites on same around orbit and Four times access per day then twelve satellites constellation is necessary at least.

Implementation Plan

Futaiten project team is established for our mission project. Fukuyama University, School of Engineering has a leading role in the project team and implement the mission. Also many companies around Fukuyama city are each subjects function members and play the implementation. Futaiten project team organization and each main functions are shown in Figure 2. Total life cycle cost to include design, development, assembly, integration, testing, launch, and operations is shown in Table 1. Almost general mechanical and the electrical testing facilities are equipped in Fukuyama University and each companies. Futaiten project doesn't have shock test facility, vibration test facility, the thermal & vacuum chamber, and radiation exposure facility, then Futaiten project should rent all that facilities from some public test center or some University for example Kyushu Institute of Technology. A top-level project master schedule is shown in Figure 3. The current project risks are shown as below.

I. Incomplete research of data communication technology between satellite and robots
II. Incomplete research of cooperation technology between satellite and robots
III. Incomplete development of hillside censor network robots
IV. Decrease of Fukuyama University student member and company member
V. Lack of total cost

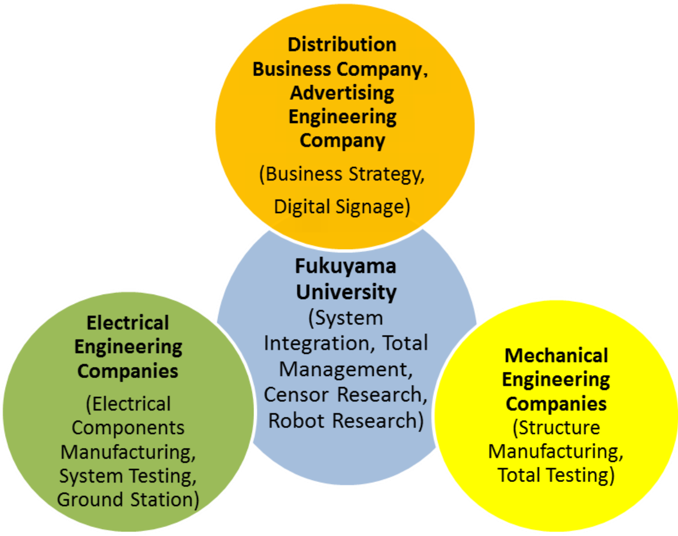

Figure 2 Implementation Player System (Futaiten Project Team)

Table 1 Lifecycle Cost

Phase	Procurement (thousand yen)	Testing (thausand yen)	Enginnering (thousand yen)	General Expenses (thousand yen)	Total (thousand yen)
Concept Design	1,000	0	300	500	1,800
Preliminary Design	2,000	500	300	500	3,300
Critical Design	2,500	500	500	3,000	6,500
Engineering Model Test	7,500	5,000	1,500	4,000	18,000
Protflight Model Test	15,000	3,000	1,000	3,000	22,000
Ground Station	30,000	5,000	10,000	2,500	47,500
Launch	0	500	0	500	1,000
Opwerations	1,000	0	3,000	500	4,500
Total(thousand yen)	59,000	14,500	16,600	14,500	104,600

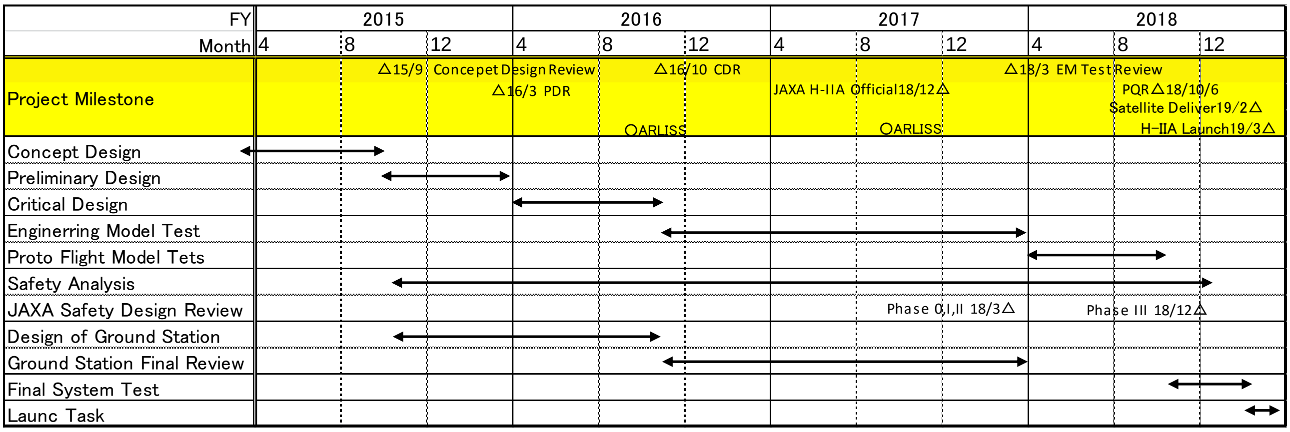

Figure 3 Master Schedule

References

I. The Feasibility Study of the Store and Forward at the Real Disaster Field; Wakayama

University

II. Development of a 5.8GHz-band High Speed Communication Radio Module for Small Artificial Satellites: Fukuoka Institute of Technology

III. Detection of Low-Level Signals for Visible Light Communication with Accumulative –Type Pocket Receiver: Keio University