Results of the Whale Ecology Observation Satellite (WEOS)

Tomonao Hayashi[1]; Yoshiwo Okamoto[2]; K Y[3]; Shigeru Hosokawa[4]

[1] Chiba Institute of Technology; [2] EECE, Chiba Inst. Tech.; [3] Chiba.Inst.Tech.Research Lab.; [4] Chiba Inst. of Tech.

At Chiba Institute of Technology (CIT), we have developed a small satellite of 50 kg weigh with the name of Whale Ecology Observation Satellite (WEOS). Intending for developing it in low cost and in short period, we positively adopted industrial parts passed through stringent environmental tests made by ourselves, and manufactured it mainly by the help of venture businesses skillful in specific subsystems. We built a ground tracking system for the satellite simultaneously in the campus of CIT.

The WEOS was launched from Tanegashima on 14th Dec. 2002 by H-IIA-4 rocket as one of the piggyback payloads into a sun synchronous orbit of 800 km high.

Since then the WEOS worked perfectly for five years with the support of the ground control system, and we have learned a lot of valuable lessons during the operation in the design of satellite system, ground system, and data collection system, which are applicable to the future space activities.

As the source of the uplink signals of ecological data to the WEOS, we have developed a probe, which is comprised of a GPS receiver, several sensors, data processor, and an UHF transmitter. The design configuration depends on the theme applied, but small, light weight and low power consumption are important in any case.

We installed a GPS receiver on the WEOS, and by sending the localization data through telemetry, the orbital element can be obtained on the ground, which serves for reducing man-power for tracking operation. By combining Doppler shift in the uplink signal obtained in the WEOS and position data on the orbit obtained by the onboard GPS receiver, we can estimate the position of the probe, which constitute a redundant system for localization of the probe.

I would like to present our results obtained during this mission, which include fundamental experiment for accepting ecological data of a sperm whale by attaching a probe in the vicinity of Ogasawara Islands, tracking experiments via WEOS on a drift buoy on the sea surface, an activity of a horse in the step of Mongolia, and an activity of a Japanese black bear just before entering hibernation at the mountainous region of Ashio.

During the tracking operation, we experienced several occasions of solar flare, and found the influence of the flare on the orbital element obtained by the onboard GPS receiver. We have found a correlation between the change of the total energy calculated from the mean motion and solar proton flux emitted.

Through developing this mission, it was found that small satellite with gravity gradient attitude stabilization is very effective to improve the activity of space utilization. If we arrange many satellites of this kind uniformly surrounding the earth, bigger effectiveness will be expected. For example, if we install a GPS receiver and a gamma ray detector on the zenith pointing face of each satellite, and if four of the satellite would detect the gamma ray, the time differences of their detection allow the determination of the direction of the source very precisely. If we install a high gain receiving antenna on the panel facing the earth, it is possible to receive many weak uplink signals corresponding to an enormous amount of the identification codes. In this case, many output signals of environmental sensor array can be collected by the satellite with high time resolution, which would never be able to expect even with an expensive large satellite.

By correct analysis of these data best guidance for the refuge will be announced in case of disasters, fire or tsunami for example. This system can serve for rescue as it is, but

it is also applicable to precise tracking of small land animals including birds.