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Basic development of a small balloon-mounted telemetry with its operation system

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1. Introduction

In Japan, the high altitude balloon for scientific observation has been continuously launched by JAXA. The balloon has a possibility to reach 50 km altitude without severe environmental condition for onboard equipments, being operated with lower cost than sounding rockets, however, development of such large-scale scientific observating balloons by university laboratories is still difficult. Being coupled with rapid improvement of tiny semiconductor sensors recently, laboratory-basis balloon experiments using small weather balloons have been becoming easily in these years (e.g. Near Space Ventures, Inc., 2013).

Although the balloon is very small as its diameter of 6 feets, excluding its extra buoyancy and the weight of the balloon itself, it is expected that loading mass capacity of about 2 kg is remained for payloads to send it up to about 35 km. However, operation of such small balloons in Japan is not in general because precise prediction of a landing area of the payload is difficult, thus high-risk situation for balloon releases is still remained. In this study, we aim to achieve practical engineering experiments of weather balloons in Japan in order to operate laboratory level scientific observation within a university. Here we report an approach of developing many devices currently in progress.

2. Equipments development

We have been developing devices onboard a small tethered balloon for the future weather balloon release experiments. That is, one is a small-size and light-weight telemeter system of about 250 g that can be mounted on a commercially available balloon, while another is a ground station device that receives data from the telemeter. A combination of a wireless module, a GPS receiver, a barometer, a temperature and humidity meter, a camera, an accelerometer, an electronic compass, a power monitor sensor is mounted on the telemeter, and the measured values by each sensors can be transmitted in real time to the ground station device. Newly developed software for balloon operation can be run on a PC connected with the ground station device, it is possible to provide the operator the sensor information visualized in real time based on the position coordinates set on the ground station device using the software before the launch.

Real-time mapping of the balloon coordinates can be realized to rewrite a KML file to be input into the Google Earth continuously. In addition, azimuth and elevation of the balloon can be calculated by spherical trigonometry from obtained the GPS position. Providing these angles to a newly developed rotater to be mounted on a camera tripod, it is possible to track a small antenna automatically to the balloon direction continuously.

3. Result of the experiment

A tethered balloon experiment was performed for evaluating the developed telemeter system, however, there occurred unexpected issue in the communication distance. As a result, in the telemeter line, operating limit of the distance between the ground station and the telemeter is significantly shortened to approximately 110 m. It was almost different from our pre-experiment confirmation of a packet loss rate of 0% at 270 m distance in a preliminary experiment on ground.

Therefore, evaluation of the antenna rotator was carried out only at close range, i.e., in severe condition. It is because maximum elevation of the rotator was limited physically at 50 degrees or less, and there exists about 5 to 10 m error in the GPS positioning operated in the single receiver mode.

Nevertheless, it was possible to track the balloon continuously in a stable situation even in the shortened communication distance. In addition, the software and telemeter system worked as expected, the problem was not found in particular.

In this presentation, the data obtained by the tethered balloon experiment and detail of the developed equipments will be shown.

Keywords: Weather balloon, Tethered balloon, Stratosphere, Upper atmosphere, Telemeter, Embedded system