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Development and evaluation of a quasi decent-control type payload system for small sounding balloons

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In-situ stratospheric observation up to 30 km altitude by using small sounding balloons have been increasing as a transport equipment in the recent years. A small rubber balloon with a diameter of about 3 m is used with small observing sensor devices, being separated at a target altitude and usually landed with a parachute for recovery. By using a small rubber balloon, inexpensive and small-scale experiments become possible with somewhat freehand launching opportunities. However, as there is no vast flat land in crowded small islands of Japan, tracking and recovering of such sounding balloons in the area of urban, mountainous areas, and oceans are difficult, or it needs extra equipments and efforts for preventing a lost of the instruments. For this reason, the use of sounding balloons has not been advanced in small-scale balloon projects.

In order to solve the geographical constraints and realize efficient operation, our laboratory has been working on development of a sounding balloon system mounted with quasi decent-control type payload. The operation method is to perform a soft landing guidance working with a parafoil with on-board servo-motor control system while selecting the multiple reachable landing points among pre-set safety landing point candidates on the payload. As a final goal, we prepare a payload system with a total mass of 3 kg with a sensor mass of 500 g and the total payload size of 70 mm cube. Capability of landing with an accuracy of about 300 m radius from each pre-set landing point would be required when separated from a balloon at the altitude of 30 km. Throughout these evaluating flight tests, we aim to develop the entire decent-control system along with our main target.

In Kochi University of Technology (KUT), from October 2014 to February 2015, we studied the basic characteristics of parafoil (glide ratio and turning radius), examined appropriate control algorithm, and developed a prototype system. From low altitude of about 30 m, multiple flight tests were successfully operated at KUT in February 2016. As a result, we obtained a simple performance evaluation with a glide ratio of about 3 as well as a turning radius of about 15 m, resulting in a design validity of the developed system. On the other hand, we found such evaluation in fact was only very basic at that time due to the lack of complicated flight controller functions, and lack of rigidity of the parafoil system against landing impacts.

Therefore, based on the tasks found in the previous experiments, we are setting up another goal by manual control flight tests from about 100 m altitude in May 2018, and we are currently manufacturing the next experimental parafoil system. In this presentation, we will present our laboratory activities to make challenging small-ballon devices, details of the parafoil system to be used for manual control flight test, and future applications.