Development and evaluative flight experiment result of small high-altitude balloon system optimized for domestic operation

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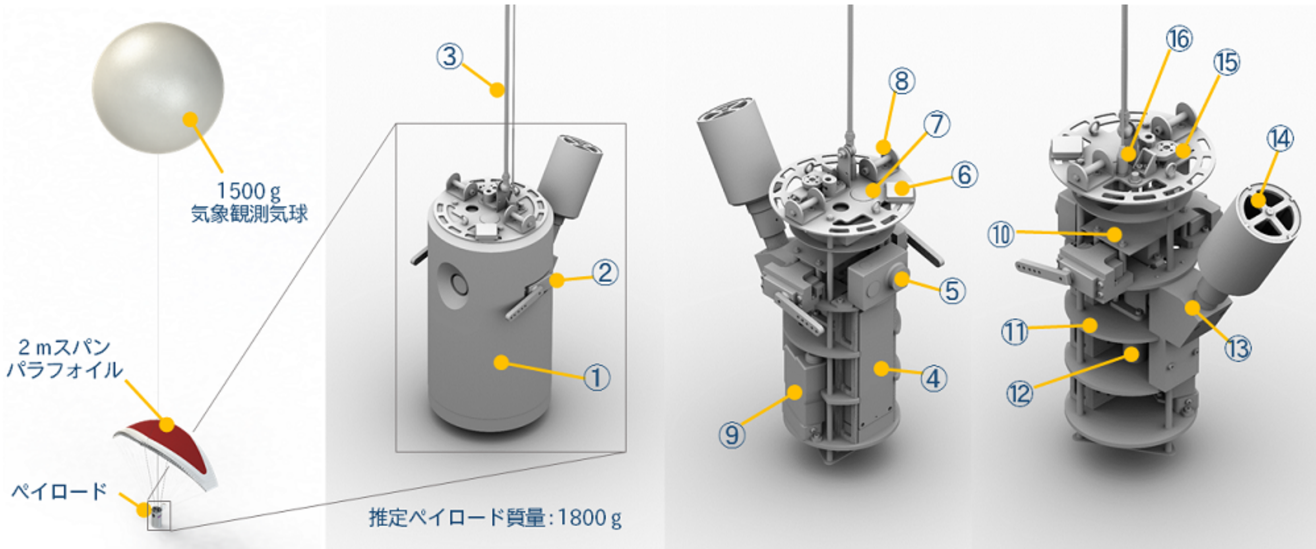
1.Introduction: Special high-altitude airplanes, sounding rockets and high-altitude balloons are used for observation technique in high-altitude area. High-altitude balloons have an advantage of making easy to product simple-structure payloads in comparison, therefore it has also an advantage of the cost per experiment when physical loads on the payload are small. In addition, high-altitude balloons are able to be launched slowly upward with a velocity of several m/s and do not use chemical reactions to provide lift-off, thus an advantageous technique in scientific observation. Applying these kind of advantages, the application of using weather balloons in high-altitude balloon experiment increased recently. Weather balloons are made of rubber that approximately 3 m in diameter, mounting payload weight is approximately 5 kg per balloon or less. In comparison with other observation techniques the small scale and low cost high-altitude balloon experiment may show the effectiveness in future when the weight of payload is not so heavy. Based on these backgrounds, the importance of the high-altitude balloon is greatly considered to escalate the role in high-altitude observation drastically depending on a way of the utilization. However, the observation technique using the small high-altitude balloons has not been spread in Japan rather than the continental countries mainly because ensuring safety of operation and recovery of the payload is difficult by geographical limitation in Japan. In this study, we are focusing on constructing operative system aboard the small high-altitude balloons that the development and inspection were possible at university laboratory level. We developed the controlled-descent-style payload technique using a small parafoil with automatic servocontrol to overcome the problem, and examined the validity of the developed system and utility through a performance evaluation experiments.

2. Developed airframe and low altitude flight experiment: We designed an examination airframe as is shown in figure to offer for various flight tests and conducted low altitude flight experiments by throwing down from a tower wagon an altitude of approximately 20 m, being controlled by remote console on ground.

3. Results of the experiment: The ratio of the gliding distance to the falling altitude was approximately 2 which we calculated from GPS position and barometer data recorded with a SD memory card. Long period flight is necessary for the evaluation with the stable gliding altitude of the parafoil, however, due to the short term evaluation period, obtaining the precise gliding ratio was difficult. Analizing the relationship between the heading orientation of the flight and the right and left servocontrol angles, it was confirmed that the state of airframe heading direction was changed from the east to the south when turning the servo controlled rudder with pulling down the right side arm.

4. Summary: Design validity of the developed airframe with the servocontrolled parafoil was confirmed by low altitude flight experiments. As for the future problem, it is necessary to evaluate with a flight from higher altitude, and to test it to confirm the ratio of the gliding distance to the falling altitude in the long-range flight. Assuming the more realistic large scale flight experiment in near future, we will develop a reliable bus apparatus and the balloon communication system to the ground stations. In addition, for the future mission, we have to confirm the design of mission and bus apparatus for the small balloon payload.

Keywords: small high-altitude balloon, parafoil, guidance control



① 保護外装（発泡スチロール）
② RC サーボモーター
③ パラフォイル固定ロッド
④ Li-Poバッテリー（耐衝撃外装）
7.4 V / 7500 mAh
⑤ 水平方向カメラ
⑥ 外部GPSアンテナ
⑦ 垂直方向カメラ
⑧ パラフォイル締結金具
⑨ 430 MHz帯アマチュア無線機
⑩ Main Control Unit (MCU)
⑪ 内部構造板（MDF材）
⑫ 緊急パラシュート射出ボンベ
⑬ 空圧シリンダー
⑭ パラシュート格納容器
⑮ 気球切り離し機構
⑯ UHF帯アンテナ

