AN OVERVIEW OF THE FIRST PARAGUAYAN NEAR-SPACE EXPLORATION USING A HIGH ALTITUDE BALLOON

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Abstract

In the attempt to join the global community on space exploration, by using low-cost scientific payloads on a balloon-borne platform and, as a result of the creation of the Paraguayan Space Agency in 2014, the program EMOÑEPYRUPY (genesis in Guaraní) was created under the initiative of a local academic institution, i.e., Facultad Politécnica at Universidad Nacional de Asunción (FPUNA). The main objective of this program was to promote space related activities, to undergraduate engineering students and, to audience in general. This first activity was conducted under the mission AEP-UNA-GS001. The academic unit leading this mission was the Department of Aeronautics. The payload consisted on, two different global positioning systems, two image capturing devices, a temperature sensor and a pressure transducer for altitude measurement purposes. The total weight of this payload including a radar reflector and a parachute was 8 Newton. The balloon positive lift was measured to 2 Newton. A 600 grams latex balloon was utilized for this mission. This launch was carried out on the clear morning of January 27, 2017, at 7:38 AM local time, 11:38 UTC, on location Latitude/Longitude -25.356541/-57.257389 (Yvytu), San Bernardino, Paraguay. Total flight time was 5 hours approximately. Apogee reached at Latitude/Longitude -25.0/-57.7 approximately, attaining a maximum altitude of 27046 meters from ground. Impressive images from different altitudes as well as video recordings were captured on this mission. Flight data recordings, i.e., Global Positioning Data, Barometric Pressures and Temperatures,
were recovered from memory card installed in the flight data logger. One important outcome of this mission was the validation of a Landing Prediction Software, from the Cambridge University Spaceflight. This simulation proved to be very accurate in this particular mission.

1 Introduction

In spite of the early creation of the Paraguayan Space Agency by congress in 2014, Law 5151/14, [1] it didn't start office up until 2017 by executive order Act 6466/17 and Act 7364/17. During this period of time, by initiative of academia, i.e. FPUNA, an attempt to conduct a near space exploration was performed. This space related activity had the purpose of expediting the establishment of an official national space agency.

Following previous successful experiences on balloon-borne platform, also known as High Altitude Balloon (HAB), by several foreign Space Agencies [2] [3] [4], the Aeronautics Department at FPUNA pioneered the near-space exploration activity in Paraguay, by launching the first HAB dedicated for this purpose [5]. As a result, a program and a mission were defined. The name of the program was EMOÑEPYRUPY (genesis in Guaraní), the mission was named as AEP-UNA-GS001.

The availability of low-cost hardware to integrate as payload, as well as, the open source nature of these, supported the active participation of the academia in the development of this payload. Existing publications on the application of this kind of

low-cost open-source hardware are widely available [6].

2 Mission Descriptions

2.1 Hardware Setup

The payload architecture was based on Arduino environment. In order to guarantee the accomplishment of the mission, the recovery of this flight data was critical. One of the goals was to capture images at high altitudes, never captured before over Paraguayan air space at stratospheric altitudes.

For tracking this flight computer and data logging device, two Global Positioning System (GPS) devices were utilized. An Arduino based GPS shield and a commercial on-the-shelve satellite messenger SPOT. The Arduino based GPS data was continuously sent to a cellphone by text message using a carrier network. The SPOT device GPS data instead, was obtained directly from the SPOT satellite constellation through the cloud. (See Fig. 1)
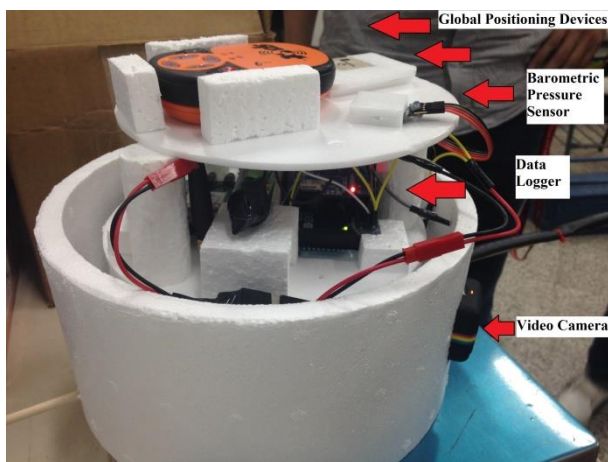

Fig. 1. Payload hardware configuration.

Two image capturing devices were utilized. An Arduino based Arducam shield was used for a "selfie" mode. This was taking a low resolution picture every 5 minutes. The second camera was a commercial on-the-shelve action camera from Polaroid. This was taking video in high definition from launch to landing.

Finally, a temperature sensor and a pressure transducer were included in the payload. The pressure sensor intended to indirectly measure the altitude of the HAB.

The balloon utilized for this mission was a 600 grams latex balloon. The gas used to fill this balloon was helium, flyby type. It was needed about 1 m^3.

In addition, a radar deflector as well as a parachute was integrated to this HAB. It totally weighted about 800 grams. (See Fig. 2)
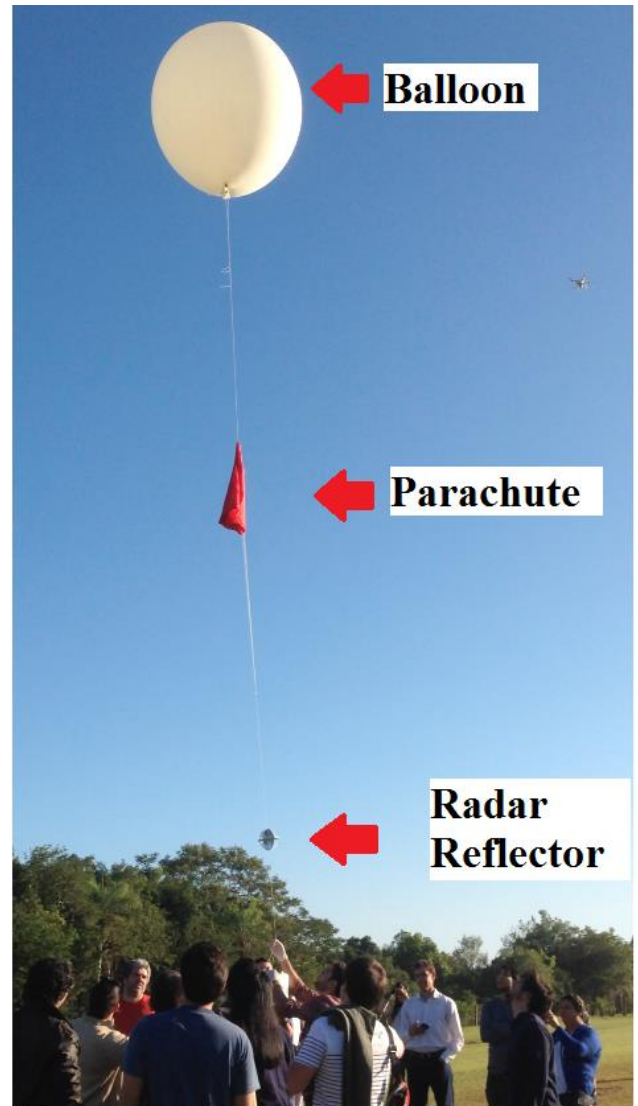

Fig. 2. HAB components before launching.

2.2 The Launch

The scheduled launch day was January 27, 2017. The planned launch time was 7am however, the actual flight started at 7:38am. The precise launch location was Latitude/Longitude

-25.356541/-57.257389 (Yvytu), San Bernardino, Paraguay.

At the moment of launching, the lift force was measured, by using a dynamometer; it showed a total force of 10 Newton.

2.3 The Landing

The landing site was located at Latitude/Longitude -24.994230/-57.729099 (Lower Chaco), Paraguay. After 5 hours of flight, it landed on a plain land at 12:07 pm. No visible structural damage was observed.

A free simulation tool from Cambridge University Spaceflight was utilized to predict this landing location. The prediction proven to be reliable, since actual landing occurred at a very close location.

2.3 Picture and Flight Data

According to the flight data recordings, the HAB reached its apogee at Latitude/Longitude -25.0/-57.7 approximately, attaining a maximum altitude of 27046 meters from ground. (See Fig. 3)

The range traveled was about 55 Km. According to the Fig. 4, from simulation result, the HAB went towards east and then west, this helped the payload not to cross country's borders.

3 Conclusions

The deployment of this type of stratospheric platforms for near-space exploration in Paraguay was a successful experience. Massive press media covered this event [7]. A month after this activity, the local government issued an executive order to appoint the Paraguayan Space Agency's president and the twelve members of the board of directors. Two months later, agency started to function.

An important finding on this experience was the validation of a Landing Prediction Software, from the Cambridge University Spaceflight. This simulation proved to be very accurate in this particular mission.

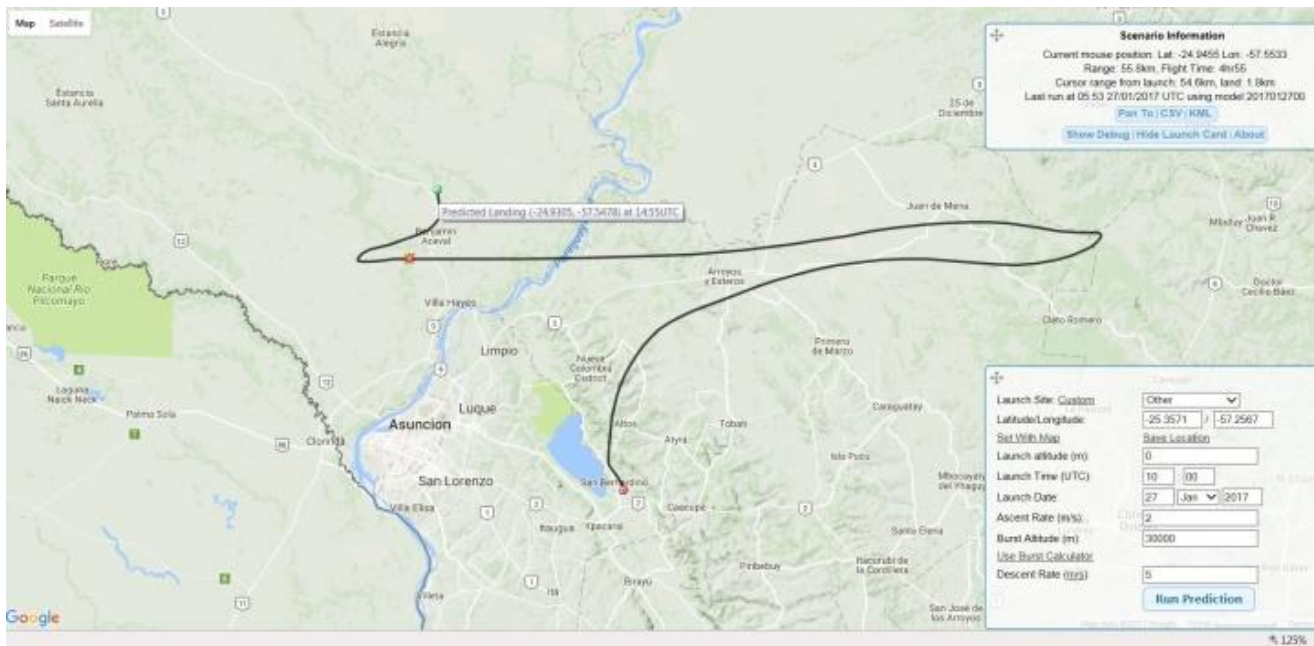Fig. 3. High definition picture from action camera.

Fig. 4. A screen capture of the simulation result.

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