Development of a Helium Gas Balloon Flying System for Aerial Photographing and Observation

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About me!

- Belong to Center for Telecommunications (Dept. Electrical and Electronic Eng., Univ. of Johannesburg, South Africa).
- Research interests include but not limited to: Coding theory, Shannon theory, Networking, Encoding/Decoding coding, wireless communication, computer systems...

Overview

Aerial observation unmanned systems

This refers to systems made for photographing of the atmosphere from high or low altitude; and send real time data to base station. They have many advantages like:

- Vegetation survey and weather predictions;
- Can be used for surveying disaster areas in case of earthquake, volcano, tsunami, typhoon;

There are many types of unmanned systems based on the application:

- Flying balloon systems: can fly continuously, reach steady buoyancy, suitable for high altitude, system control is very unstable.
- Unmanned aerial vehicles (UAVs or drones): autonomous control, can not fly for long time, stabilization endurance, suitable for low altitude.
- balloon - drone systems: combination of balloon systems and drones features.

Aim of project

Design a low cost flying system to achieve aerial photographing at the highest possible altitude above sea level.
The helium gas balloon was chosen for this task over other gases because of the following:

- Helium is less heavy than air; so the helium balloon due to less weight should ascend quicker in atmosphere according to Archimedes principles.
- Helium is an inert gas, environmentally friendly and less explosive than hydrogen or methane.

Helium gas balloon

The overall mechanism is made of a helium gas balloon connected by a rope to the payload containing 2 subsystems: the tracking and sensing subsystems.

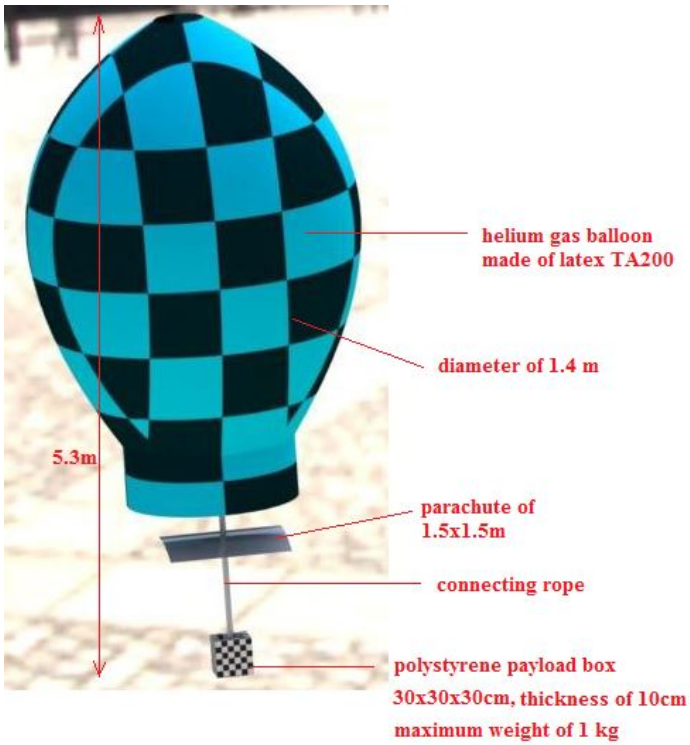


Figure: Balloon design

Sensing and tracking subsystem

The sensing subsystem was designed to read the temperature and the atmospheric pressure at regular time intervals of 10 seconds. Tracking subsystem for monitoring GPS location and taking photos during flight.

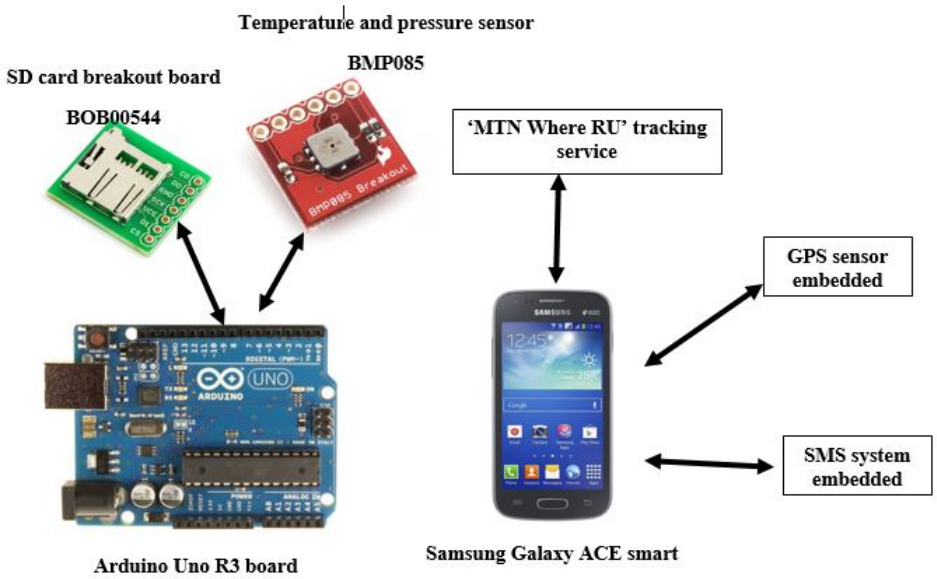


Figure: Sensing and tracking system

Tracking and sensing subsystems

$altitude = 44330 * \left(1 - \left(\frac{p}{p_0}\right)^{\frac{1}{5.255}}\right)$, computes the altitude from the sensed atmospheric pressure p; and $p_0 = 101325$ Pa at sea level.

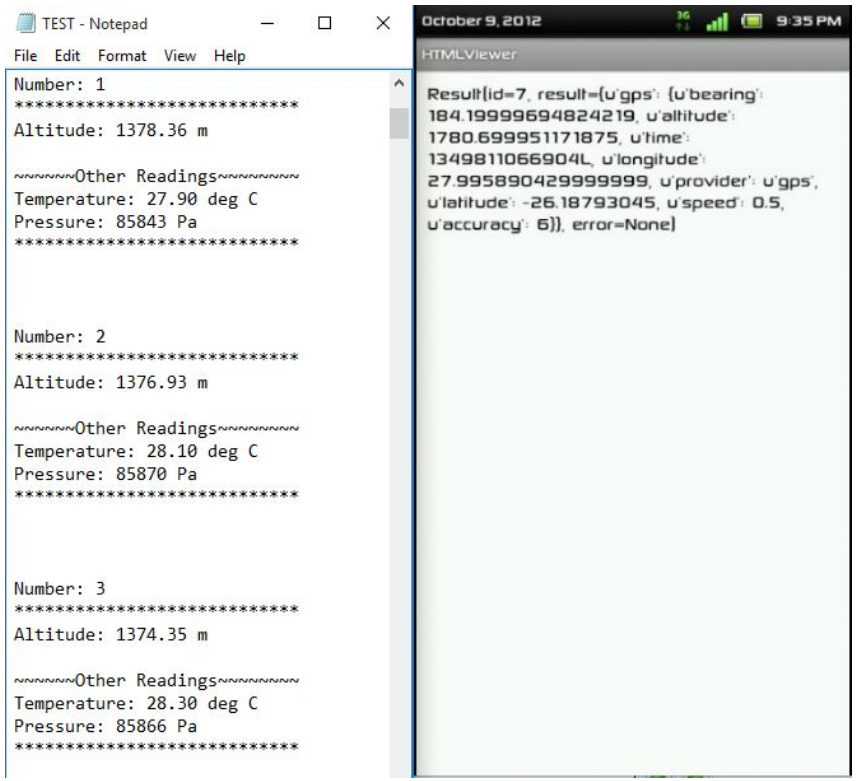


Figure: Textfiles from sensing and tracking subsystems

Implemented system read for launch

During the first test on the 29/10/2012...

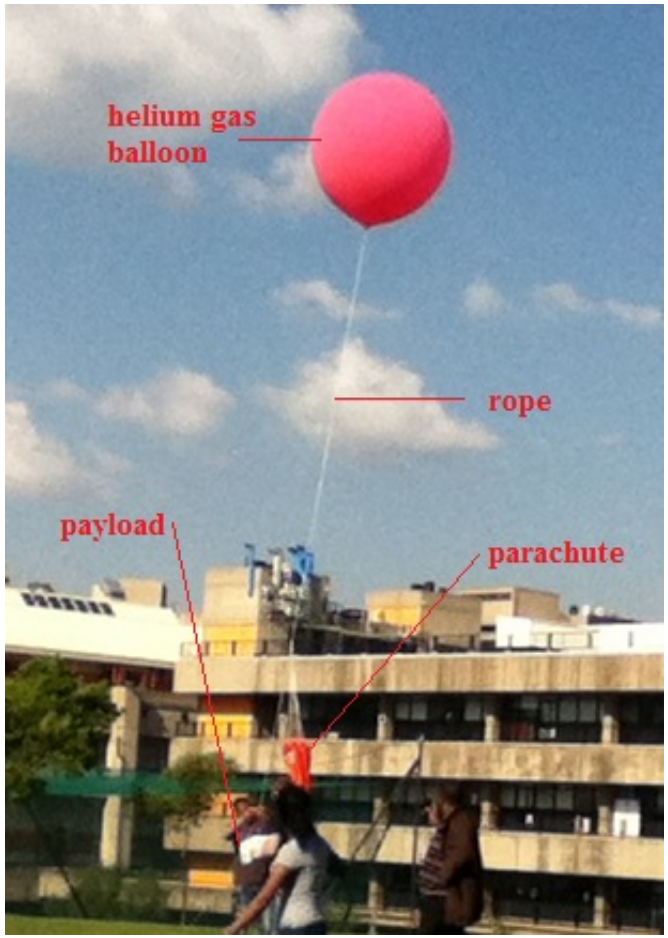


Figure: Implemented system

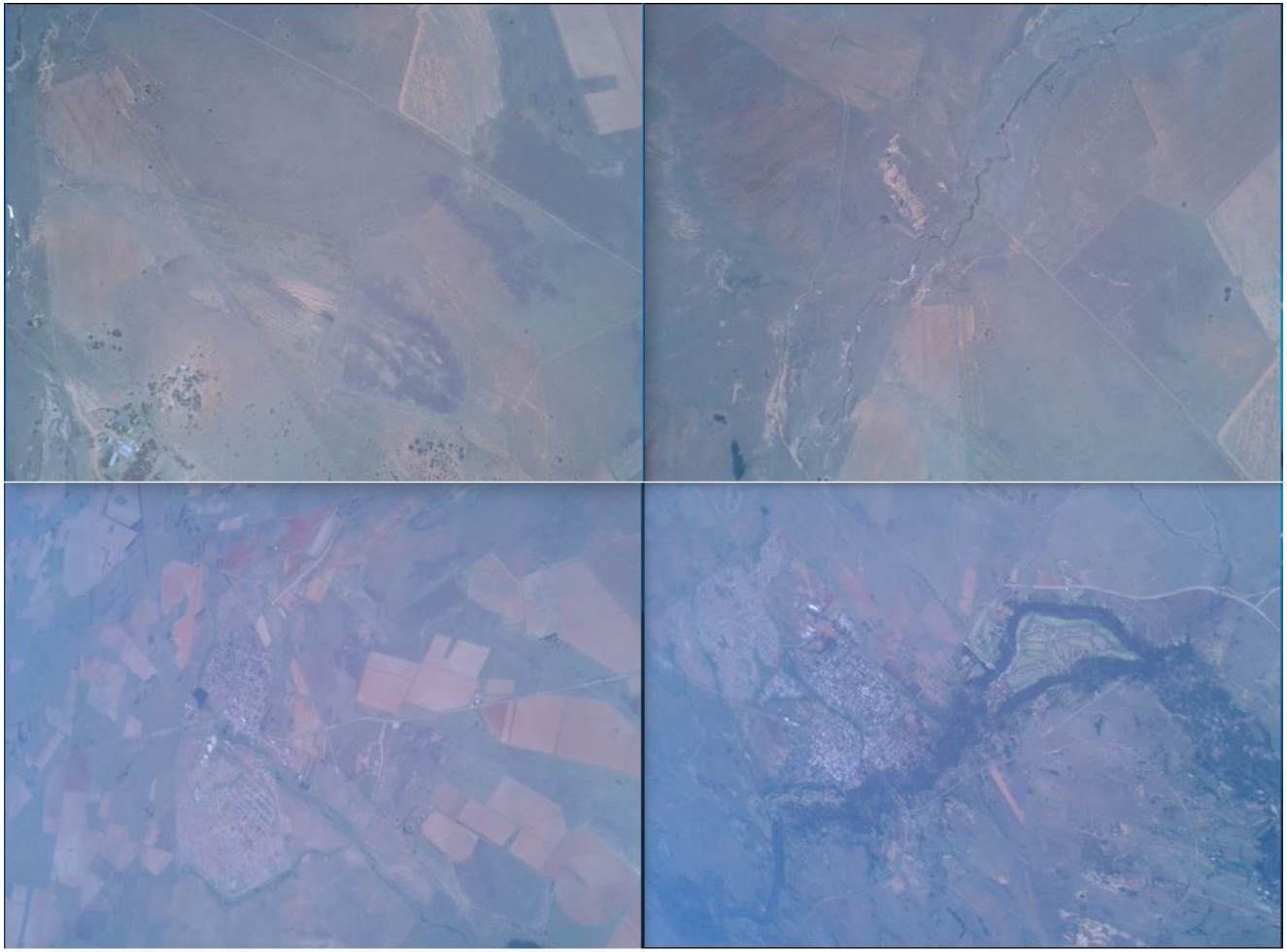
Launching position

The system was launched on a safe grass field in Parys, Free State, South Africa (wind direction SE, cloud cover 0/7, atmospheric pressure 104.7 kPa, average temperature 24°C).

- launching point: atitude:-26.97, longitude:27.31 and altitude:1443 metres above sea level
- launching date: 3rd November 2012.

Aerial random photos from payload

Photos from payload during the ascent,



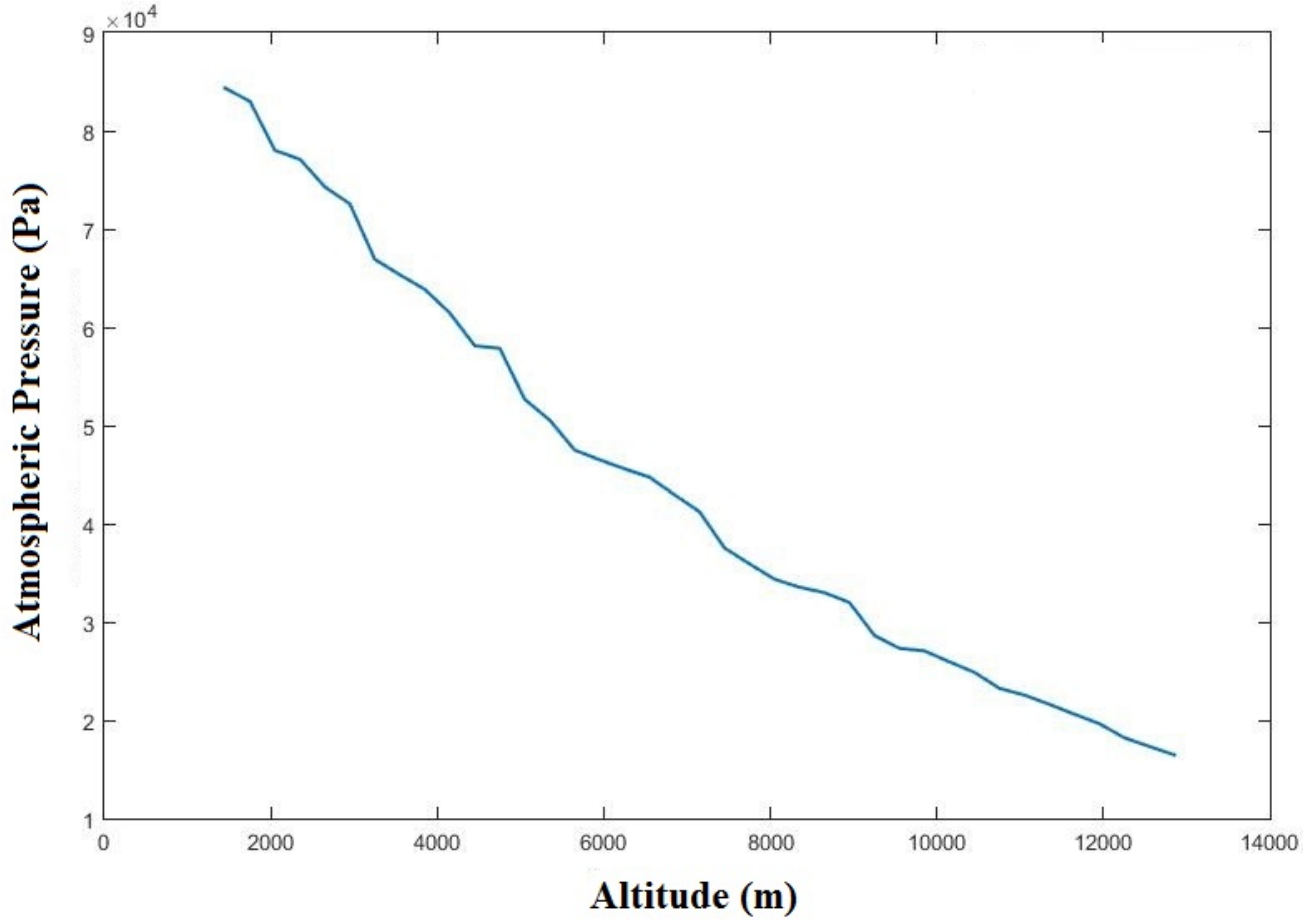
Photos at the highest altitude, 13.7821 km above sea level

Observations

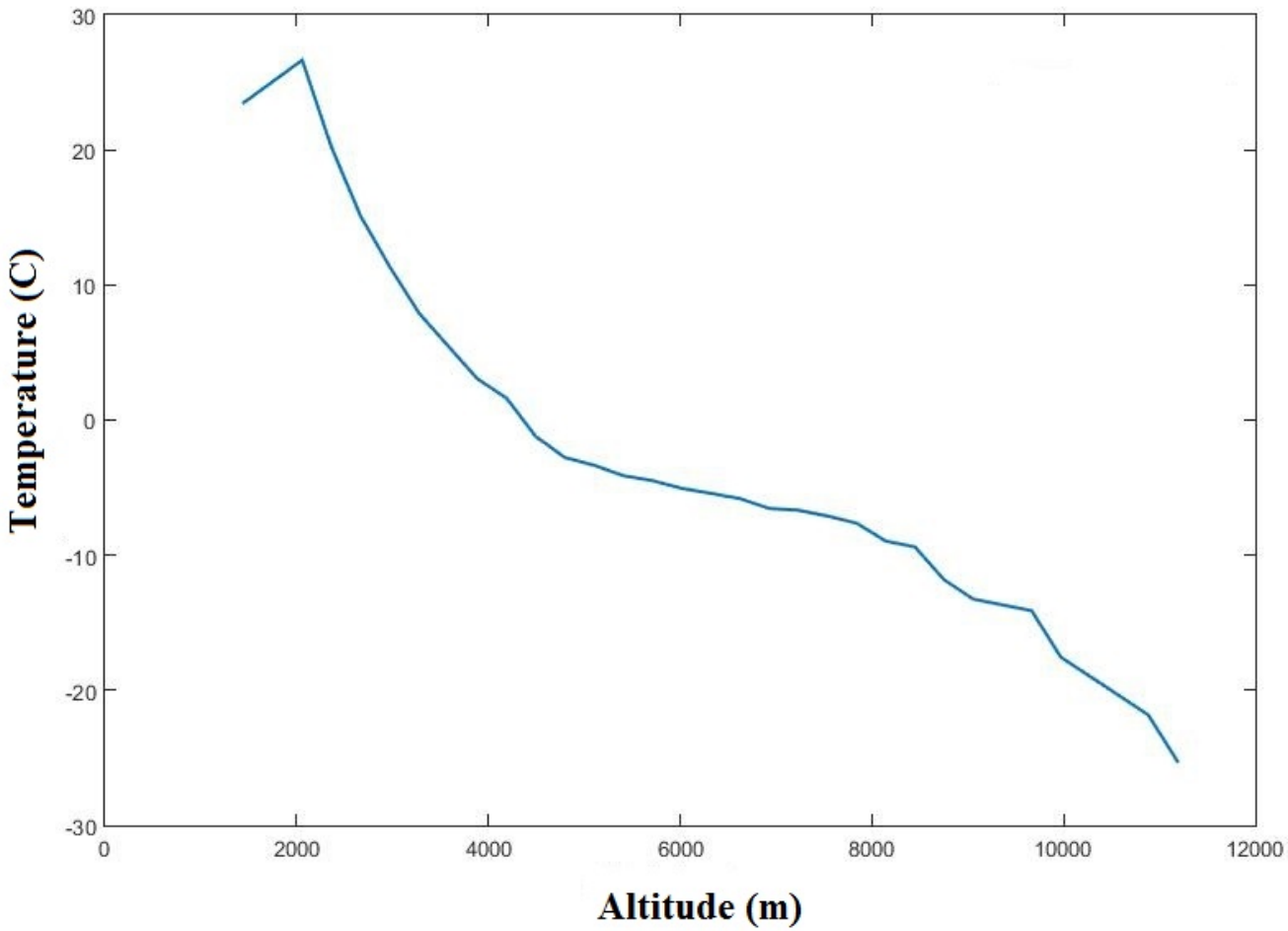
- The highest altitude was recorded at an altitude of 13.7821 km (45216.86 feet) above sea level at a point of latitude -26.69 and longitude 27.47.
- The payload landed back at beginning of December 2012 in the outskirts of Vereeniging (Gauteng Province, South Africa) around the point (latitude: -26.40, longitude: 27.55 and altitude: 1479 metres above sea level), this is approximately 125 km away from the launching position.
- The tracking subsystem was surrounded by insulation materials to avoid temperature dissipation at high altitude.
- The payload was ascending up with an average velocity of 5.5 m/s.
- The batteries or power supplies of the tracking and sensing subsystems were fully charged before the flight.

Pressure vs. altitude during flight

Sensor reading is not perfectly accurate, as result of no QNH correction, offset range is 2%.



Temperature vs. altitude during flight



Summary

- The highest altitude reached by our payload was 13.78 km.
- The world record of helium gas balloon flying system is about 30 km.
- Although our mechanism achieved less than records, it is ideal and advisable design approach for university projects or research laboratories in order to expose young engineering students to more practice as our design was based on low cost components.

References I

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Thanks for your attention!

"We cannot solve our problems with the same thinking we used when we created them." Albert Einstein

QUESTIONS AND COMMENTS