Poster Presentation

4th International conference on "Physics for Sustainable Development & Technology (ICPSDT-2022)"

Title:

Design approach of an LTA system as aerostat for weather monitoring at a specific altitude: Md. Tasnim Rana and Md. Shahidul Islam

Abstract:

For weather monitoring or data collection from a certain altitude, traditional weather balloon or special types of drones are used by experts. But they are very expensive and time dependent. As they can give data for very short period of time for their limited fly time. In case of weather monitoring, LTA technology can add a new dimension for data collections. For collecting data from weather at a specific altitude can be achieved by using LTA technology. The work in this poster is mainly focused on environment monitoring system at a certain altitude using LTA technology and the design approach for the system. Through this work of LTA system is stablished for weather monitoring at a certain altitude and monitor them for a long period of time. Designed system can be used not for only weather monitoring but also other data collection or video surveillance from a certain height. The system can also be used for stablishing remote communication networking system and it has some valuable alternative approach.

Background and Motivation of the Proposed Research:

The capacity to fly for a long term of time at high heights has been a subtle objective. Be that as it may, in late year's sustainable power source innovation has created to the point where long span air vehicles can be considered. The airship is one sort of long perseverance air vehicle that has incredible potential. Aircrafts, it creates lift through the lightness impact by LTA gas rather than through optimal design. This implies the dirigible does not have to remain in movement to remain overhead. These attributes, contrasted with that of an ordinary flying machine are what make aircrafts an alternate contender for a long perseverance flight vehicle. Lately, the RC flying machine or automaton has an issue with solidness and long-lasting flight length[1]. An idea of including dirigible with conventional framework can be improved an outcome to conquer the current issue [2]. For security and longtime survey at a constant point with high altitude is easy to achieve with aerostatic inflatable body by the use of lighter than air gasses. This kind of inflatable LTA technology is very much dependent on weather condition. Because, flow direction of atmospheric air can affect the stability and this stability mainly depends on altitude and the weather condition. In different altitude the system can perform in different way while having weather dependency. Monitoring weather condition at different altitude using this LTA technology is not performed at our native weather. Receiving weather data with the system can add a new chapter for collecting information and predict environmental conditions. So, this thesis work will provide an overall concept regarding the system with LTA technology for weather monitoring in Indian subcontinent.

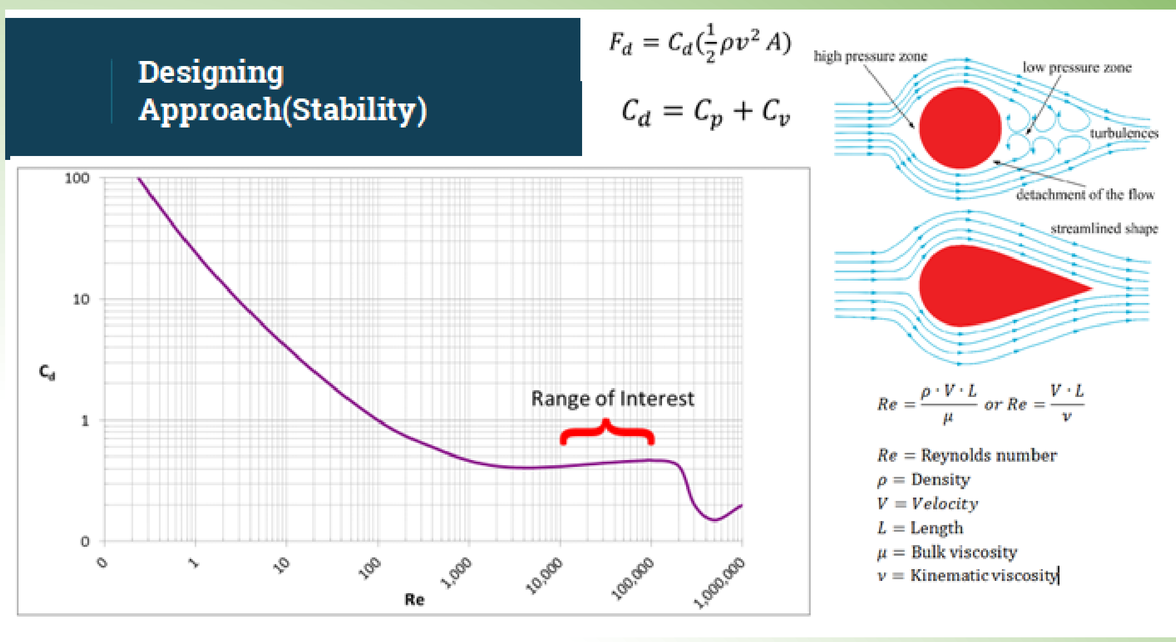


Figure: Finding out the range of Re from the simulation

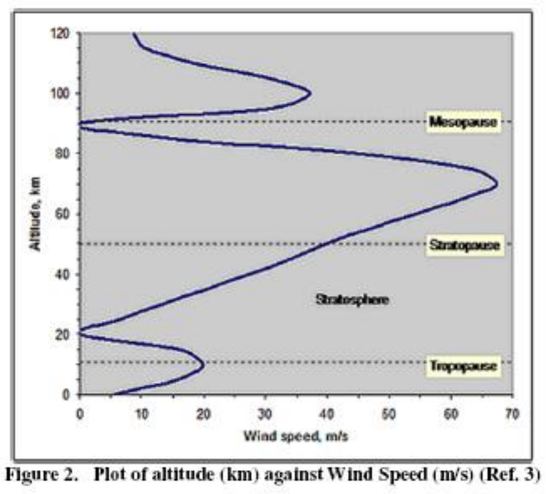


Figure 2. Plot of altitude (km) against Wind Speed (m/s) (Ref. 3)

Figure: Stability Range and practical Fabrication

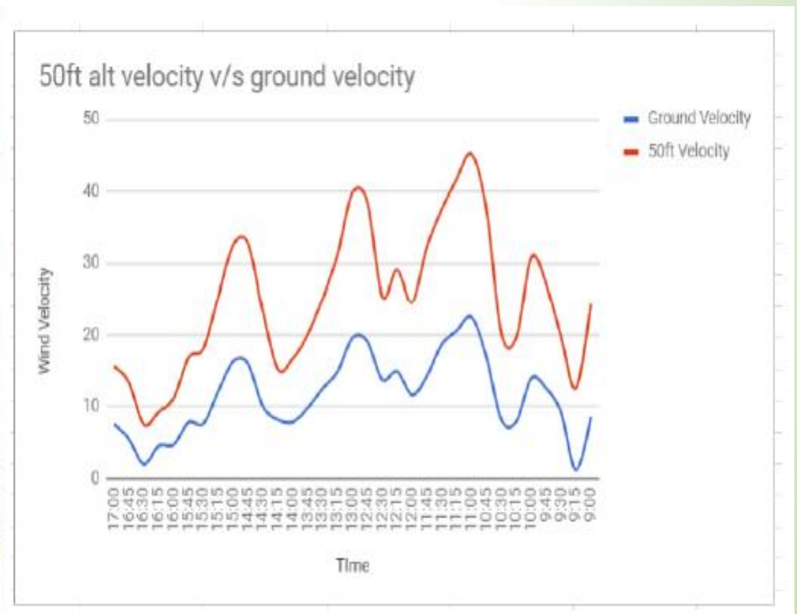
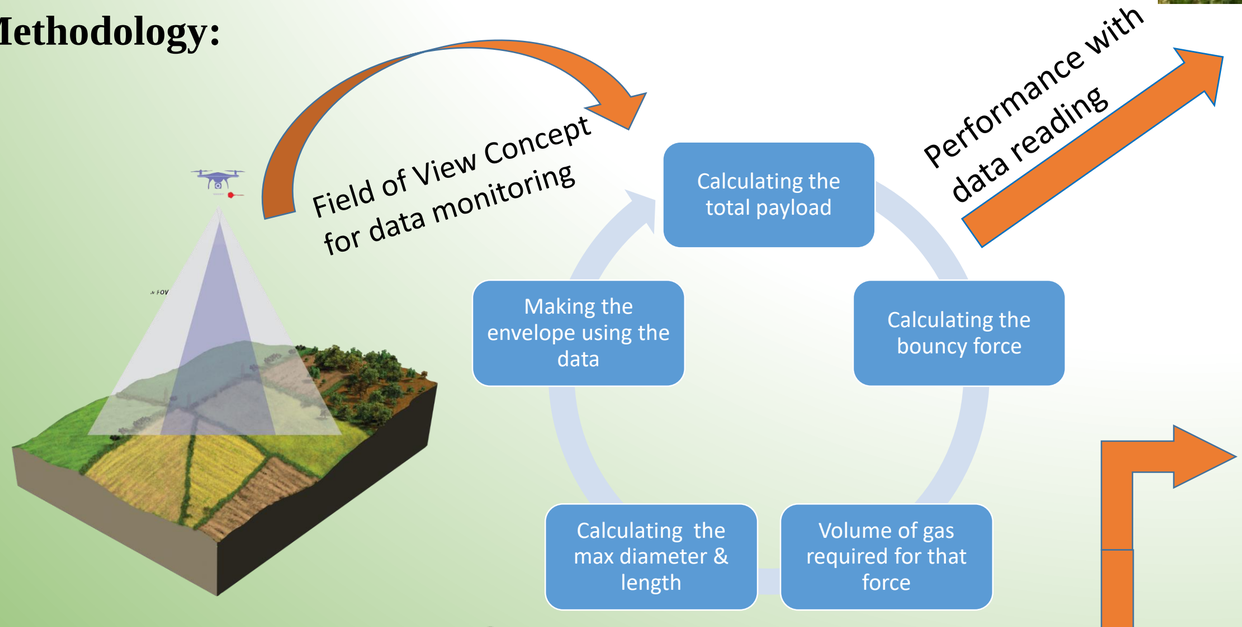
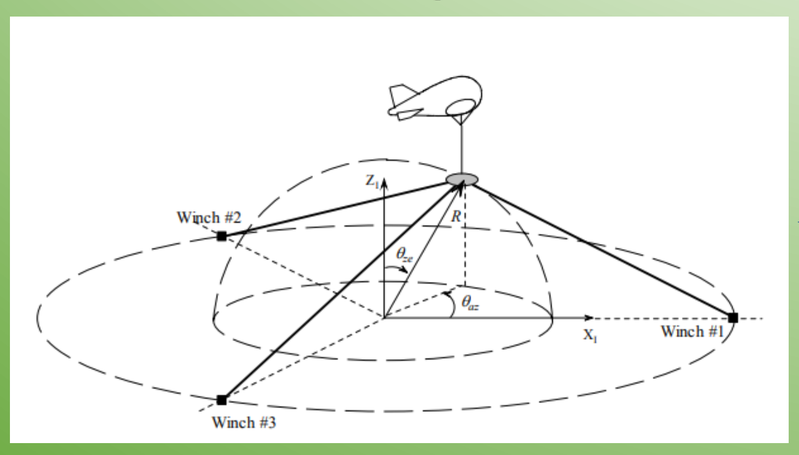


Figure: Sample data reading in different time at two different altitude

Methodology:



$$F_b=\{(\rho_a-\rho_{He})(\frac{\Pi d^3}{6} - Vm)-(M_m+f.\Pi d^2+M_p)\}g$$



Control System of the platform

For on air module:

The envelope of the aerostat is inflated with the lighter than air gasses and then, using a suitable parameter of the envelope the envelope has gain it's lift by its buoyancy force generated from the lighter than air gases. Then, the on-air part contained a sensor controller with proper gyro stabilization. The controller has collected the data from the various sensors like, temperature sensor, humidity sensors, Altitude sensor and the positioning sensor. From the sensor data the controller has collected the weather data at a specific point then the data is being transmitted with a radio frequency module to the ground station.

For ground station:

At the ground station the on-air envelope was there from the bottom point of the envelope for the stability and the end point was being grounded for a fixation of its location. The system were received from the on-air module via a radio signal condition with a receiving module. The mechanical construction of the ground station had the capacity to ensure safe landing of the envelope. The envelope can take off from the ground station over controller signal and also can land safely with a rotating shaft controlled by the operator. So, that at the bad weather, the system can have a safe protective environment.

Discussion & Conclusion: Over all, such type of tethered aerostat is common in use but the main aim of the methodology is to approach to the system for the weather of Bangladesh. Aerostat will be floated at different atmospheric condition with single point buoyancy force and collect some identical data as temperature, pressure, humidity, air density at a certain location. Farther work can be done with multiple tethered system.

References:

[1] M. Nahon, G. Gilardi, and C. Lambert, "Dynamics and control of a radio telescope receiver supported by a tethered aerostat," AIAA J. Guid., Control, Dyn., vol. 25, no. 6, pp. 1107–1115, 2002.

[2] M. A. Masterskikh, "A method for holding a pilot balloon or light aerostat at a predetermined height for meteorological observations," Meteorol. Gidrol., vol. 4, pp. 102–104, 1978.

[3] Kale, S. M., Joshi, P., and Pant, R. S., "A Generic Methodology to Estimate Drag on an Aerostat Envelope," 16th AIAA Lighter-Than-Air Systems Technology Conference and Balloon Systems Conference, AIAA Paper 2005-7442, 2005.