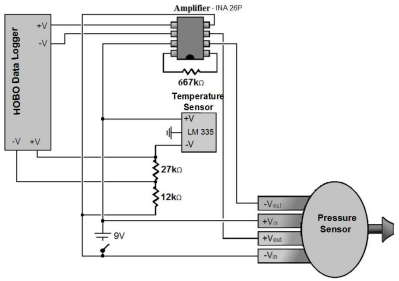
BalloonSat and HOBOware: High Altitude Data Logging

Jonathan White, Faculty Mentor: Dr. William Slaton
Department of Physics and Astronomy, University of Central Arkansas

Abstract

Vernier's LoggerPro is versatile piece of equipment that can easily be used in the classroom, as well as in the field to collect and store data. With a wide variety of sensors one can measure temperature, pressure and Carbon Dioxide levels, all of which are perfect for high-altitude balloon experiments. A downside to using LoggerPro is that the data logger and the sensors needed weigh nearly a kilogram and can be very expensive. A gas pressure sensor and a temperature sensor together cost $130. However a trip to the local electronic hobby store and a few short clicks on the Internet can fix this dilemma. In place of the LoggerPro a person can purchase and use a HOBOware data logger. A temperature sensor can be assembled using a LM 335 temperature sensor, a couple of resistors, and a stereo cable. Likewise a pressure sensor can be constructed using a pressure sensor from Mouser.com, an amplifier, a few resistors. The sensors work by measuring the voltage across two pins of each sensor, as the temperature or pressure changes the voltage across each sensor increases or decreases depending on the sensor. The HOBOware data logger measures and stores the voltage of each sensor. While the HOBOware data logger may cost as much as a LoggerPro unit, the two sensors total cost less than $20. In addition the HOBOware data logger and the new sensors only weigh 0.6 kilograms, a much lighter alternative.

Experimental Setup

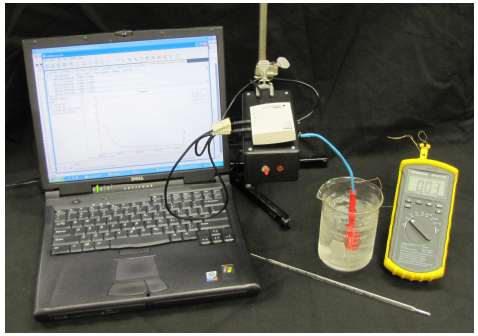


A LM 335 was used to construct a temperature sensor for the system. The HOBOware U12-006 data logger can only measure voltages ranging from 0 to 2.5V. The voltage measured from the LM 335 was higher than this, so a voltage divider was used to lower the signal form the temperature sensor. A pressure sensor was used to measure a change in air pressure. The signal received from the pressure sensor is in mV, which is too small for the data logger to record accurately. An INA 126P amplifier was used to amplify the signal from the pressure sensor to a range that the data logger could read.

Temperature Sensor Calibration

The temperature of the room was recorded by using a thermocouple and the voltage across the temperature sensor is measured by using the HOBO datalogger. The two devices are then placed in an empty balloon and submerged in an ice water bath. When the temperature stabilizes, the voltage from the temperature sensor and the temperature from the thermocouple are again recorded. The recorded values are used to solve the equation of a straight line in which the voltage is a function of the Temperature.

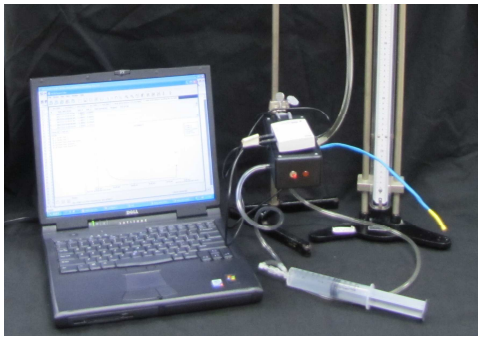
$$T = (V-1.47003)/0.00446$$



Pressure Sensor Calibration

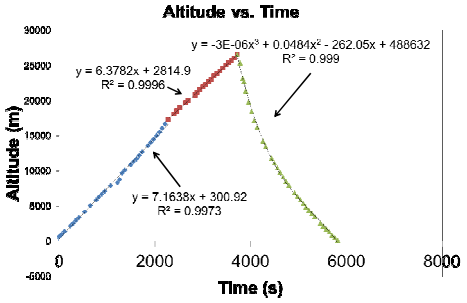
The initial voltage from the pressure sensor and the atmospheric pressure for the area are recorded. The pressure sensor is then attached to a water manometer. A syringe is used to decrease or increase the pressure in one side of the manometer. The other side is still at atmospheric pressure so height of the water in each side of the tube changes. Since the atmospheric pressure is known, the difference in height between the two sides can be used to determine the amount of pressure that the air is exerting on the sensor. The voltage from the sensor is also noted. The initial recorded values and the final values are used to solve the equation of a straight line where the voltage is a function of the Pressure.

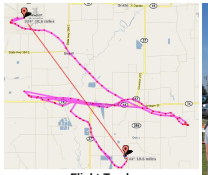
$$P = 47.062*V+0.0013$$

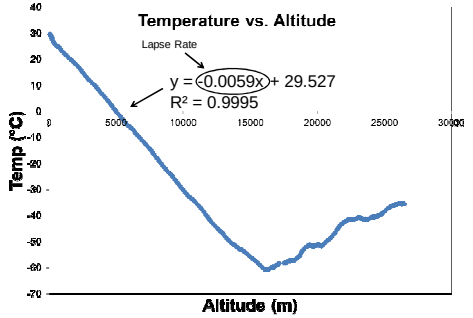


Flight Information

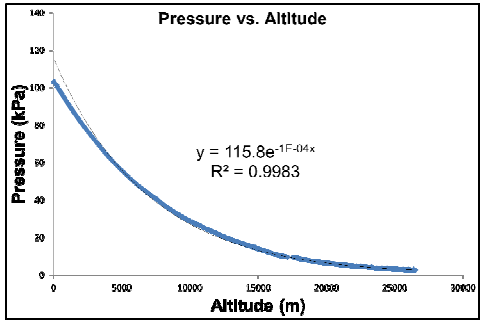
The launch occurred on June 19, 2010 at 9:10am from ASU Newport. The balloon landed near Amagon, AR. Overall the balloon travelled eleven miles and reached an altitude of 86,916 feet.




Flight Track



The International Civil Aviation Organization (ICAO) defines an international standard atmosphere as having a lapse rate of 6.49 C per 1,000 m.



Acknowledgements

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