

Atmospheric Measurements using Unmanned Aerial System (UAS)

ONBOARD SENSOR DEVELOPMENT AND INTEGRATION

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ABSTRACT

With technological advances in unmanned vehicles ramping up, research that used to cost a fortune is becoming relatively cheap and less time consuming. This project is aimed toward incorporating atmospheric sensors into a UAS as a viable and inexpensive method for monitoring atmospheric properties and composition. The sensors will log temperature, humidity, air velocity, and ozone to better understand the mesoscale meteorological phenomenon of the Lake Breeze front along the coast of Lake Michigan. Currently we are in the stage of integrating the sensors with an on-board Raspberry Pi single-board computer into a Pixhawk flight controller for live-feed data, along with 3D printing housings for the onboard electrical components and sensor mounting hardware.



HMP60 Sensor

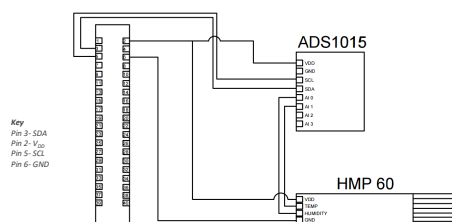
INTERFACING HMP60 WITH RASPBERRY PI

INTRO TO COMPONENTS

The HMP60 is a small rugged humidity and temperature sensor probe. The sensor has operating limits of 0 to 100% relative humidity and a range of -40° to +60°C. The probe will be mounted to the RV Jet using custom 3D-printed mounting hardware.

The Raspberry Pi is a small interactive computer that can be used to perform a variety of functions. For purposes of this project, it will be used to read and record data from the HMP60 (Humidity and temperature sensor).

WIRING SCHEMATIC



The sensor is connected to an analog to digital converter(ADC), which communicates to the Raspberry Pi/Arduino boards using I^2C protocol. I^2C is a serial protocol for a two wire interface to allow the boards to communicate with multiple devices simultaneously.

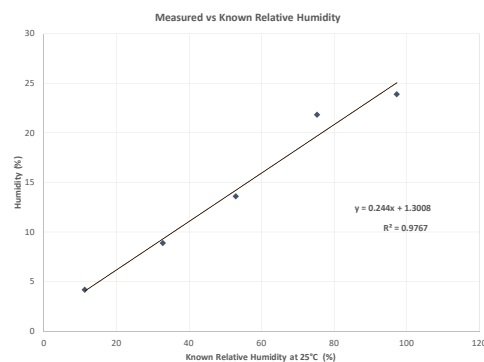
HMP60 CALIBRATION

Calibration of the HMP60 was with an Arduino and was required in order to understand the accuracy of the probe. To calibrate it, the probe was placed in an Erlenmeyer flask that contained saturated solutions with a known relative humidity.

Procedure:

1. Place saturated salt solution inside a sealed vessel.
2. Lower HMP60 into vessel.
3. Reseal the vessel.
4. Open Serial Plotter in Arduino IDE
5. Wait for readings to level and become consistent.
6. Record ADC reading.
7. Repeat with other salt solutions
8. Plot using excel

RESULTS

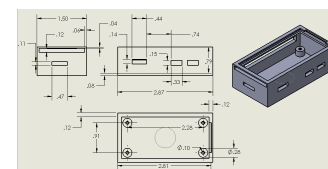


Salts	Known Humidity at 25°C	ADC Output
Lithium Chloride	11.3	4.16
Magnesium Chloride	32.78	8.87
Magnesium Sulfate	52.89	13.58
Sodium Chloride	75.29	21.81
Potassium Sulfate	97.3	23.87

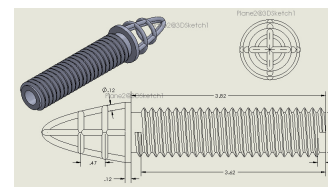
The calibration curve was used to edit the code that is used to run the HMP60 in order to output the relative humidity instead of the ADC value.

SOLID WORKS AND HARDWARE DESIGN

SOLIDWORKS is a solid modeling computer-aided design (CAD) and computer-aided engineering (CAE) computer program. It was used to design the mounting hardware for the HMP-60 probe and an onboard housing for the Raspberry Pi. The SOLIDWORKS files were then read into a 3D printer and printed with a hard plastic. Once the mounting hardware has been fitted properly they will be re-printed using a carbon fiber reinforced plastic in order to add some crash safety to the hardware and electronic components.



Raspberry Pi Zero Housing



HMP60 Housing

FURTHER RESEARCH

The next step with regards to the HMP60 is to calibrate the sensor for temperature and interface it with the Raspberry Pi. Test flights with dummy weights in place of sensors will take place to make sure the UAV is balanced correctly. The HMP60 will be mounted to the RV-JET using the 3D-printed hardware. Starting May 22nd, 2017 we will be participating in the Lake Michigan Ozone Study using the HMP60, POM(Ozone sensor), and Five Hole Probe.

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