Atmospheric Sensing on Unmanned Aerial Vehicles

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AggieAir

Introduction

AggieAir conducts research using aerial imagery and remote sensing for applications in agriculture. Unmanned Aircraft Vehicles (UAVs) are used to collect images to be further processed.

Currently, during the image processing, the thermal images are corrected by using Vicarious Calibration; which is not cost, area, and time-effective. However, Vicarious Calibration can be substituted by using a Bosch BME280 atmospheric sensor (Figure 1), Modtran, and 6V modeling.

Reasons for using the BME280 sensor:
● Faster image correction
● Cost effective
● Scalable to be used with a bigger set of data
● Ensure adequate atmospheric correction of thermal camera during flight
● Able to monitor weather conditions changes during the flight

Methods

Accessing the data from the BME280 sensor required implementing the driver code and writing an Arduino program to collect and display the data.

The testing of the BME280 sensor was done by mounting the sensor next to a Campbell Scientific weather station (Figure 2), and a Teensy IO Board was used to collect pressure, humidity, and temperature from the sensor. The data sets from the sensor and the station were then inserted into a spreadsheet and compared.

Figure 1

Bosch BME280 sensor size comparison to an American Quarter

Figure 2

Campbell Scientific weather station

Results

Figure 3 shows a graphical comparison of the pressure and humidity values collected from the weather sensor and station.

<table>
<thead>
<tr>
<th>Humidity Statistical Index</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>root mean squared error (rmse)</td>
<td>1.173</td>
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<tr>
<td>mean absolute error (mae)</td>
<td>1.108</td>
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<tr>
<td>coefficient of correlation (r)</td>
<td>0.977</td>
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<tr>
<td>coefficient of determination (d)</td>
<td>0.955</td>
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<table>
<thead>
<tr>
<th>Temperature Statistical Index</th>
<th>Value</th>
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</thead>
<tbody>
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<tr>
<td>mean absolute error (mae)</td>
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<td>coefficient of correlation (r)</td>
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<tr>
<td>coefficient of determination (d)</td>
<td>0.942</td>
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</table>

Tables showing error statistics from data collected

Figure 3

Graphical comparison of the pressure and humidity values collected from the BME280 sensor and Campbell Scientific weather station over the course of hours.

Conclusions

The humidity data shows a low resolution data collection by the BME280 sensor. The temperature data shows a constant bias error, which it can be easily adjusted.

The data from the sensor has not been used to correct thermal imagery yet, but based on preliminary results, the error margin is acceptable and the BME280 atmospheric sensor will be implemented in a future AggieAir aircraft.

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