Autonomous Industrial Lighting Auditing: Developing the Multi-Sensor Package

Executive Summary

The Industrial Assessment Center (IAC) at Texas A&M requires a more efficient way to audit lighting systems in buildings. There is a requirement for a lightweight sensor payload that can be placed on a UAV. The automated sensor payload must be capable classifying and quantifying lights in an industrial building. This data will then be processed to produce a lighting retrofit recommendation report; highlighting recommendations for increased energy efficiency and customer savings.

After carefully analyzing all distinguishable characteristics of lights, it was concluded that multiple sensors were needed to perform a comprehensive audit. These sensors, while serving their own particular purpose, must be able to communicate with one another in order to provide the necessary information needed for analysis. The final result was a design consisting of an optical camera, a spectrometer, a distance sensor, and an accelerometer.

In order to collect the data in an effective way, the audited space will be divided into grid-like sectors. The UAV will continuously navigate from sector to sector while the onboard sensors are gathering data. In an effort to increase the viewing angle of the spectrometer, the spectrometer’s sensing element will be positioned on a swiveling system. This swiveling system will expand the field of view for the spectrometer and allow it to gather data for the entire sector. All of the data will be locally stored on the onboard storage system and will be processed at the conclusion of the audit.

During the processing phase, images obtained from the optical camera will be run through the image processing program developed by the team. This software passes the image through a series of filters and outputs the quantity of bulbs present in the image, as well as the pixel dimensions of the identified bulbs. In conjunction with the distance sensor, the pixels of the image are scaled to determine the diameter or length of each respective bulb. This data, along with data obtained by the spectrometer is run through the spectral curve analysis program to classify what type of bulb is present (i.e., LED, fluorescent, incandescent, etc.). Spectral curves, intensity vs. wavelength relationships, provide distinct identifies for each light type. The end result is a table consisting of the classification of each bulb and the quantity present. Using the data table in matrix form, a program will be run to generate a retrofitting report. By knowing the classification and quantify of the bulbs, the program will to output potential power and cost savings by recommending alternative options.

The combination of the sensor payload, image recognition software, and data analysis programs presents an efficient way to audit industrial building lighting systems; providing a faster, easier process. The autonomously generated retrofitting report will provide the customer with a complete and organized blueprint of how to increase energy efficiency and reduce costs.