LambdaSeek: A Vehicle-Mounted Sensing Platform for Automated Lamp-Type Identification

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1. SYSTEM DESCRIPTION

LambdaSeek, which is illustrated in Fig. 1, consists of the following components: i) an Oceanoptics USB 2000+ spectrometer, ii) a Konica Minolta T10a illuminance meter, iii) a Novatel FLEX-G2L-BPR-TTN GPS receiver equipped with GPS-702-GG antenna, and iv) A Raspberry Pi (RPi) B+ to manage the sensors. The RPi was interfaced to the sensors using the USB. Data acquisition programs were written to manage the sensors in a Debian Linux environment. We describe the system parameters of the sensors and the implementation details of the data collection routines below.

Oceanoptics USB 2000+ spectrometer: The diameter of the optical fiber used by the spectrometer dictates the intensity of the spectral measurements and thus is a critical parameter for data collection at night. After experimentation, we chose the 1000 μm QP1000-2-UV-VIS fiber, with the CC-3-UV-S cosine corrector for *LambdaSeek*.

After careful experimentation, the integration time was set to 500 ms. Lower values result in spectra with very low intensities leading to the loss of morphological features, which are crucial for the classifier. Higher values may result in saturation and also cause the spectra to loose critical features. The sampling rate, which cannot be less than the integration time, was set to 1 Hz. Each sample is a vector of intensities of length 2029 for wavelengths that are uniformly distributed in the range of 200 - 1100 nm in accordance with the product specifications [2].

Konica Minolta T10a Illuminance Meter: The communication protocol for the meter [1] was implemented for data collection. Adaptive ranging was enabled to handle the varying intensities of outdoor lighting that is encountered in typical urban areas. The sampling rate was set to 1 Hz.

Novatel Flexpak GPS Receiver: This receiver enables submeter accuracy using the Satellite-Based Augmentation System (SBAS). The RTKLib open source program package [3] was modified for the receiver and the RPi platform: the SBAS mode was enabled and the `sbas.conf` configuration file was changed to increase the sampling rate to 10Hz.

Power management: A SMAKN step-down transformer was used to convert the 12 V supply of a car's cigarette charger to 5V/3A output to power the RPi, which also powers the spectrometer and the Adafruit GPS. An adapter was used to convert the 12 V supply from the car to 110V AC supply for the illuminance meter. The Novatel GPS receiver was powered directly from the car's cigarette charger.

Mounting: Ten disc-shaped N48 neodymium magnets of size 1/2 × 1/4 inches were riveted to metal bars at the bottom side of the polycarbonate enclosure housing the various components. Appropriate holes were drilled for the cables and the fiber that faces out to the sky.

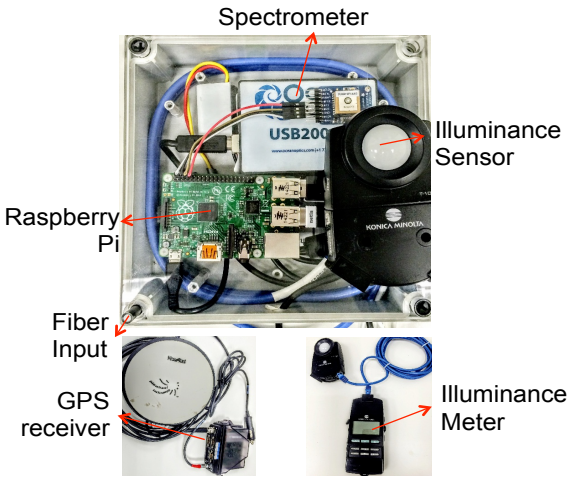

Figure 1: LambdaSeek: system description.

2. SYSTEM VALIDATION

We designed experiments to test the following hypothesis: *Drive-by data collection using LambdaSeek at reasonable speeds preserves the morphological features of the lamp spectra and offers requisite spatial separation to distinguish the signals from adjacent poles.* Based on observations from the experiment, LambdaSeek can be used to collect reliable data for lamp-type identification and proceeded for large-scale field trials.

3. REFERENCES

[1] Konica Minolta. Illuminance meter t-10a/t-10ma instruction manual. http://www.konicaminolta.com.

[2] Ocean Optics. Usb2000+ spectrometer data sheet. http://oceanoptics.com/wp-content/uploads/OEM-Data-Sheet-USB2000-.pdf.

[3] T.Takasu, N.Kubo, and A.Yasuda. Development, evaluation and application of rtklib: A program library for rtk-gps. In *GPS/GNSS Symposium*, 2007.