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Optical design of a compact near-infrared multispecies gas sensor
JOSHUA LARSON, FATIMA TOOR, Univ of Iowa — In this work we present the design of a compact and cost effective near infrared (NIR) gas sensor system that can detect nitrous oxide (NO_x), ammonia (NH_3), and methane (CH_4) simultaneously. These three gases were chosen as they are environmental pollutants and their monitoring is especially important in agricultural states like Iowa. As a first step in our design process, we have developed a Matlab model based on Beer-Lambert's law to generate sample sensor data for each of the gases at different concentrations. The data measured from the sensor system will be as a function of time instead of wavelength, so we performed Fourier Transform analysis on the sensor data to convert it to voltage versus time. The simulated sensor data will enable to design software algorithms to separate the absorption signals for each of the three gases. As a second step, we have developed a lab-based sensor system comprising of three components: (i) a NIR lead sulfide (PbS) photodiode, (ii) an LED that emits 1900 nm to 2600 nm, and (iii) an optical cavity where the gases are introduced. We are designing the optical cavity using ray optics COMSOL finite element method simulator using the principles of a compact chaotic cavity that will allow the LED light to have a path length of greater than 100 m within the cavity, enabling high sensitivity gas detection. Our end goal is to have an autonomous drone mounted device that is simple and inexpensive to use. We plan to license this technology to agricultural equipment manufacturers.

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