Microcontroller-Based Atmospheric Sensing System

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Global warming, while a problem widely recognized by the scientific community, is still a phenomenon which is yet to be fully comprehended. By monitoring atmospheric conditions along with the concentrations of different greenhouse gases, the effects and sources of greenhouse gases can be better understood. As a result compact and portable laser based systems have been developed. Open path laser based sensors are more portable than other methods of gas detection such gas chromatography. Unfortunately, these laser based sensors sometimes require large and fragile electronic modules in order to operate. The data that they collect also needs to be corrected to account for atmospheric conditions such as humidity, temperature, and pressure. The modules used to operate the laser also consume a large amount of electricity, a problem which becomes apparent when working in the field where grid power is not immediately available.

By replacing these modules with smaller, more power efficient, microcontroller based solutions; standalone atmospheric sensors can be created and attached multiple sensor platforms such as cars, aircraft, or UAVs. This will allow data to be collected more easily, and in places that were previously inconvenient or inaccessible. Miniaturizing the electronic components of these laser based sensors also is a step towards making sensor equipment affordable and portable. We considered many different approaches to miniaturizing the electronics and eventually settled on a hybrid FPGA and arduino microcontroller based approach due to its small size and power efficiency.

Using a microcontroller based system to monitor atmospheric conditions allows us to create stand-alone devices that can collect weather information. These devices can be powered by battery packs and are inexpensive and small enough to create multiple devices that can be left in the field to collect data unattended. They also can record GPS time-stamped data onto memory cards so multiple sensors can be deployed and their data synchronized. Devices such as these can also be shielded from the elements in a way so that they can be deployed into environments that would otherwise be hazardous to electronic equipment, for example areas that are very wet, frigid, or vibration prone. We have also field tested these devices both in gas sensor chambers deployed in the New Jersey Meadowlands, and on UAV sensor operations in Texas. In both of these operations the pressure, temperature, humidity, and location data was useful in processing and correcting the data collected by open cell laser sensors.

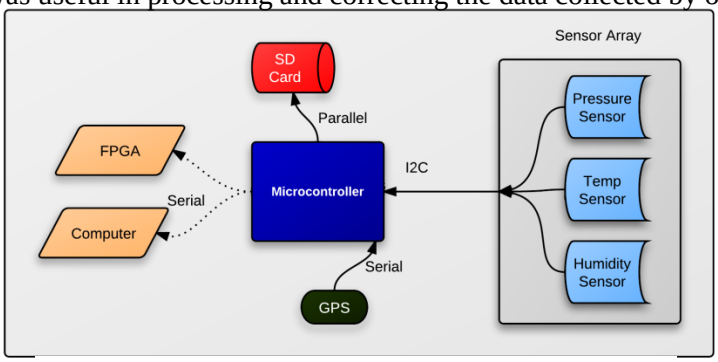

Figure 1: An overview of the microcontroller based atmospheric sensing system. Data is read from the sensor array and GPS and stored on the SD Card. Optionally data can also be sent to a computer for real time analysis.

Figure 2: A microcontroller system being deployed in a gas sensor chamber.