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Topic of Research: Acquisition, Processing and Analysis of LIDAR Signal for Remote Detection of Species in the Atmosphere

Findings

It is very important to detect a variety of hazardous chemical species from standoff distances in real time in order to take protective measures and countermeasures.

• Although, many remote sensing techniques are available for the remote detection of hazardous chemicals in the atmosphere, the Differential Absorption Lidar (DIAL) which is laser based active remote sensing technique is the most promising technique in terms of range, sensitivity and selectivity.

• Theoretical evaluation has been carried out for given design parameters to analyse the detection capability of Mid Infrared DIAL system for different chemical species under different weather conditions.

• It is concluded that a tunable mid infrared laser based DIAL system with 5 mJ of energy and a 203 mm telescope with a suitable detection module is capable of detecting a variety of chemical species in ppm level of concentration from standoff distances.

• A high resolution and high-speed 12-bit, 30 MSPS DACS has been designed and developed to acquire the low differential signals and to control all DIAL subsystems.

• Control of subsystems like the laser, energy meter, etc through various digital ports and protocols has been established.

• A suitable advanced custom design GUI has been developed in LabVIEW in order to perform the automatic and sequential operation

• Signal processing methodologies such as spatial averaging, automatic background subtraction, and temporal averaging have been incorporated.

• Methodologies for improvement in lidar signal quality have been analyzed. It was seen that it is very much essential to remove low frequency fluctuations and the negative signal from LIDAR signal profile as it will give an impression of false chemical clouds and topographic targets.

• The conventional signal processing techniques i.e. spatial averaging and temporal averaging have been compared with the EMD denoising technique for denoising LIDAR signal.

• It is seen that the EMD technique is a much better technique for removing time varying noise of LIDAR signals and reducing the errors in information processing from LIDAR signals.

• DIAL system with given design parameters has been used for successful testing and detection of diesel and acetone vapors in the laboratory and open atmospheric conditions.

• It was seen that the absorption spectra of diesel recorded with DIAL is in good agreement with experimentally measured FTIR spectra.

• Experiments have been conducted for recording the dispersion behavior of acetone dynamics for a duration of about 30 minutes. The recorded maximum column content of about 13180 ppm.m was recorded and the same has come down upto 30 ppm.m during the final stage of dispersion.

• The hardware and software have also been used for the measurement of the concentration level of 2 ppm of atmospheric methane and 38 ppm.m of TDG.

1. Summary of Abstract (only 2 pages)

2. Soft Copy in PDF format with Hardcopy