Active Hyperspectral Sensing for Border Control

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INTRODUCTION

There is a need for sensor technologies capable of identifying illegal border crossings through foliage. European Union project Foldout (grant agreement *787021)* is addressing this need. As a part of the FOLDOUT project, this work evaluates the use of an active hyperspectral sensor (AHS) for person identification through foliage for border control applications.

METHODS

The AHS sensor uses a broadband supercontinuum laser source for illumination. The spectrum of the backscattered light from an unknown object is analyzed for target identification.

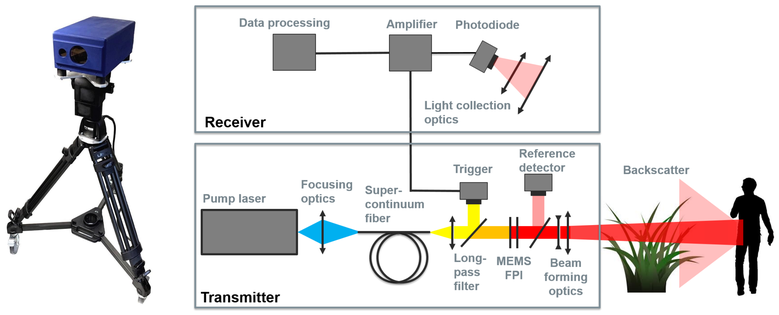

Fig 1. Concept of active hyperspectral sensor

For eye-safe operation, the wavelength selection is done already at the transmitter. This is done by integrating a voltage tunable microelectromechanical (MEMS) Fabry-Perot Interferometer (FPI) in the broadband supercontinuum source. The MEMS FPI allows for rapid tuning of the transmitted wavelength.

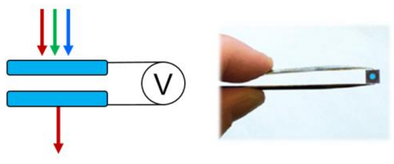

Fig 2. MEMS FPI

The tuning characteristics of the MEMS FPI were measured to produce a custom waveform, that results in a linear wavelength sweep.

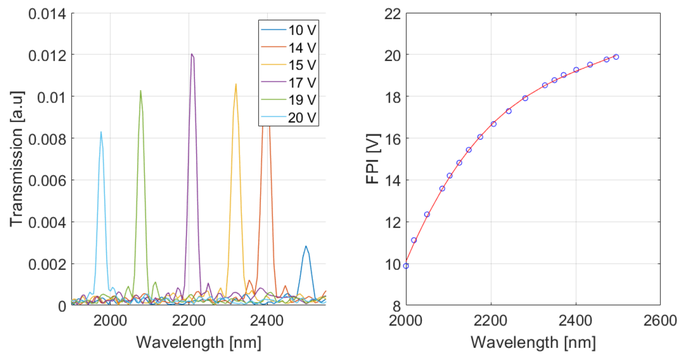

Fig 3. Wavelength tuning of the MEMS FPI

Supercontinuum is generated by using a 1550nm ns pump laser and standard telecommunication fiber. Total output power is 1W between 1500 nm and 2500 nm.

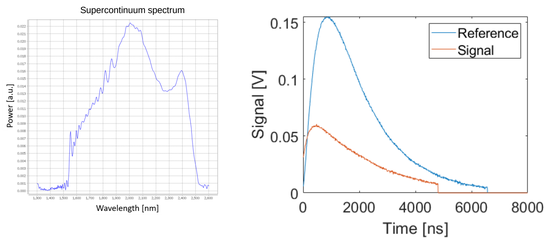

Fig 4. Supercontinuum laser spectrum and measurement of single pulse with the AHS receiver.

RESULTS

Comparison against Fourier transform infrared spectrometer (FTIR) measured spectra show good agreement. The limited resolution of the MEMS FPI broadens the smaller absorption peaks.

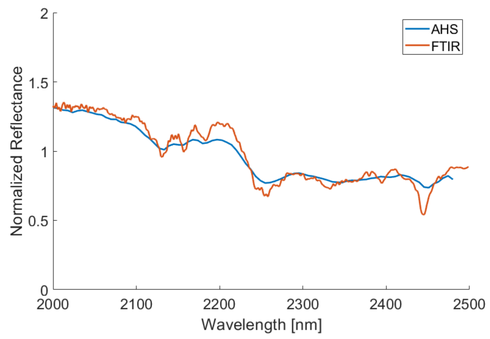

Fig 5. Comparison of spectrum measured with AHS vs FTIR.

The wavelength region between 1900 nm and 2500 nm allows for discrimination between several fabrics and common terrain.

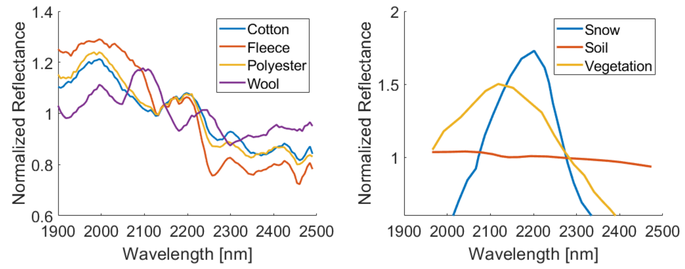

Fig 6. AHS measured spectra of selected fabrics and common terrain (recreated from [8])

AHS sensor was demonstrated in field conditions. Distance to target was ~8m. The measured spectrum from vegetation was used as a reflectance reference.

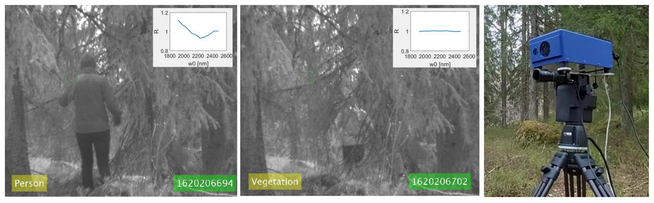

Fig 7. AHS sensor field demonstration

CONCLUSIONS

In conclusion, active hyperspectral sensor was developed for the detection of illegal border-cross activities through foliage. The sensor data has been validated against FTIR and the sensor has been tested in field conditions. Further work include validation of the sensor performance for different levels of foliage.

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