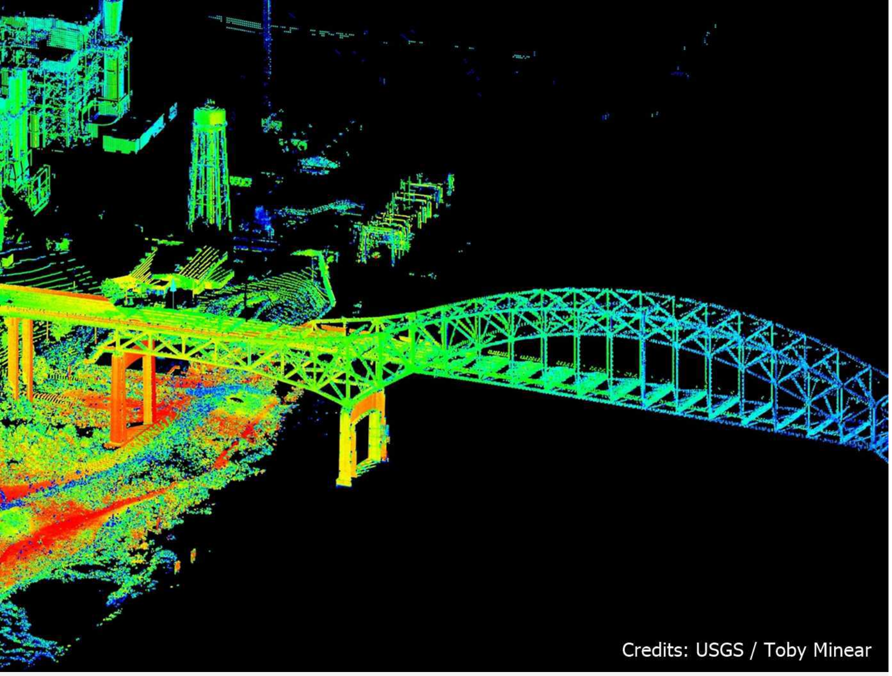
National Aeronautics and
Space Administration



Credits: USGS / Toby Minear

Optics

Hyperfine Interpolated Range Finding

Interpolation technique for continuous wave lidar, radar, and sonar using repeating waveforms, Fourier transform reordering, and Richardson-Lucy deconvolution

NASA Langley Research Center has developed a novel fine interpolation technique that is useful in signal processing for applications in lidar, sonar, radar and similar modalities. The interpolation technique uses repeating waveforms, Fourier transform reordering, and Richardson-Lucy deconvolution to obtain faster and more accurate results.The prime target application is range finding, but the technique is equally suitable for differential absorption studies, such as determining CO2 concentrations in the atmosphere.

BENEFITS

- Provides an interpolation scheme much faster than those currently in use
- Consists of a simple reordering of a Fourier transform array
- Can be applied broadly with any repeating waveform, and not confined to PN code and PSK modulation
- Compatible with lidar, radar, sonar and similar modalities
- Allows measuring objects smaller than the lidars resolution when combined with a nonlinear deconvolution technique
- Allows use of continuous wave (CW) lasers rather than the more costly and bulky pulsed lasers
- Has been flight tested with extensive data accumulated

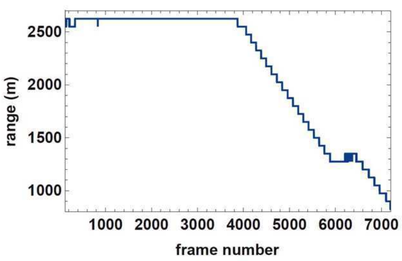
APPLICATIONS

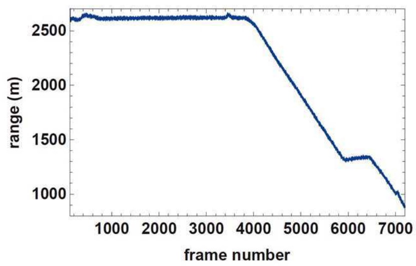
- Range finding
- Differential absorption studies
- Cloud and tree canopy thicknesses determination

technology solution

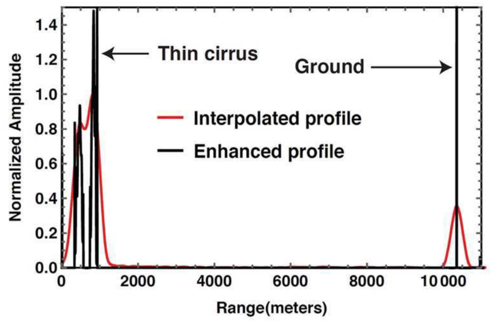
THE TECHNOLOGY

Compared to standard methods such as fitting, which tend to be slow, this technology uses a simple technique of reordering of an array used in the Fourier transform to obtain results much more rapidly and with greater accuracy. By applying certain nonlinear deconvolution techniques to single or multiple pulses, the pulses can be sharpened, allowing measurement of objects that are actually smaller than the resolution of the lidar. This is then enhanced further using Richardson-Lucy deconvolution. The resulting resolution and pulse width can be enhanced by about two orders of magnitude using the these techniques, thus breaking the fundamental resolution limit for BPSK modulation of a particular bandwidth and bit rate.





Plot of range from aircraft descent both before and after DFT reordering shows dramatic change in resolution, which shows fine detail not seen before reordering. This detail matches high-resolution altimeter results to a fine precision.



Transmission through thin cirrus clouds shows FTR interpolation combined with RL deconvolution is able to detect the thickness of thin cirrus clouds.

PUBLICATIONS

Patent Pending

Joel F. Campbell, Bing Lin, Amin R. Nehrir, F. Wallace Harrison, and Michael D. Obland, "Super-resolution technique for CW lidar using Fourier transform reordering and Richardson-Lucy deconvolution," Opt. Lett. 39, 6981-6984 (2014)

More Information

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