Application Note
METROLOGY

The University of Alabama in Huntsville (UAH)

Menlo Systems, Martinsried

Atmospheric Timing Transfer and Ultrafast Optical Sampling Based on Frequency Combs

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Remote transfer of timing/frequency references has attracted considerable research interest in recent years due to the increasing need for ultrahigh-precision timing synchronization in fundamental physics, large-scale precision instrumentation, navigation and communications. A drawback of the conventional fiber-optic scheme is that it relies on the availability of fiber links, which, in many cases, leads to higher overall cost and a lack of flexibility. In addition, future ultrahigh-precision atomic clocks are likely space borne, making any wired synchronization schemes impractical. Recently, the concept of free-space optical timing distribution has been proposed to address the above challenges.

"The Menlo Systems FC1500 frequency comb system has served as a reliable light source for all the above work. It has greatly enhanced our capabilities in these research areas. Moreover, it has helped other researchers in the Huntsville area to perform cutting-edge research in such fields as metamaterials, nanophotonics and plasmonic sensing."

One of the research programs led by Dr. Duan at the University of Alabama in Huntsville is to study atmospheric timing/frequency transfer using femtosecond optical frequency combs (OFC). Compared with cw laser-based transfer schemes, OFCs can simultaneously deliver multiple frequency references in both microwave and optical regions. We proposed the idea of free-space OFC clock transfer and reported the first experimental demonstrations of atmospheric remote delivery of both microwave and optical frequency references using an OFC.

More recently, we have expanded our research scope into other areas of OFC applications. For example, we have developed a novel ultrafast sampling technique called dynamic optical sampling by laser cavity tuning (OSCAT). It has the potential to use a single femtosecond laser to achieve similar functionalities as "dual-comb" techniques. We have successfully demonstrated applications of OSCAT in ranging, imaging, surface profilometry, and spectroscopy.

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Publications:

R. P. Gollapalli and L. Duan: Atmospheric Timing Transfer Using a Femtosecond Frequency Comb; IEEE Photonics Journal Vol. 2, p. 904 (2010)

R. P. Gollapalli and L. Duan: Multiheterodyne characterization of excess phase noise in atmospheric transfer of a femtosecond-laser frequency comb; Journal of Lightwave Technology Vol. 29, p. 3401 (2011)

L. Yang, J. Nie, and L. Duan: Dynamic optical sampling by cavity tuning and its application in lidar; Optics. Express Vol. 21, p. 3850 (2013)

L. Yang and L. Duan: Depth-resolved imaging based on optical sampling by cavity tuning; IEEE Photonics Techology Letters Vol. 27, p. 1761 (2015)

L. Duan and L. Yang: Ultrafast Optical Sampling Finds Applications in Precision Measurement; Journal of Scientific and Industrial Metrology Vol. 1, p. 1 (2016)

L. Duan and R. P. Gollapalli: Atmospheric clock transfer based on femtosecond frequency combs; in Photodetector, edited by Sanka Gateva, (INTECH, 2011, ISBN 979-953-307-350-6) Ch. 16.

Weblinks:

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