

Spectral Linewidth Measurement of Linear Frequency Modulated Continuous Wave Laser with Short Delay within the Coherence Length

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Abstract : Optical frequency modulation technology for FMCW LiDAR based on Optical Phase Locked Loop(OPLL) configuration is addressed in this paper. The spectral linewidth measurement method of the linear frequency-modulated laser is also described. The single-frequency laser with narrow spectral linewidth is generated using an external cavity diode laser and the excitation frequency of the laser is adjusted by controlling the injection current of the laser. If the injection current of the laser is increased, the lasing frequency is decreased because of the slight increase in the refractive index of the laser gain chip. Dynamic optical frequency change rate is measured by using a Mach-Zehnder interferometer and compared with a proper reference signal. The phase difference between the reference signal and the measured signal using the Mach-Zehnder interferometer is obtained by mixing those two signals. The phase error is used to detect the frequency deviation error from the target value, which is then fed back to the driving current of the laser to compensate for it. The frequency sweep error from the ideal linear frequency waveform will degrade the spectral linewidth of the target spectrum and will degrade the maximum range performance of FMCW LiDAR. Therefore, the spectral linewidth measurement of frequency modulated laser is very important to evaluate the performance of the LiDAR system. However, it is impossible to apply the conventional self-homodyne or self-heterodyne method with a long delay line to evaluate the spectral linewidth of the frequency-modulated laser because the beat frequency generated by the long delay line is too high to measure with a high bandwidth frequency modulated laser. In this article, the spectral linewidth of the frequency-modulated laser is measured by using the newly proposed self-heterodyne method with a short delay line. The theoretical derivation for the proposed linewidth measurement method is provided in this article. The laser's spectral modulation bandwidth and linewidth are measured as 2.91GHz and 287kHz, respectively. LiDAR.

Keywords : FMCW, LiDAR, spectral linewidth, self-heterodyne

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