Systems and Methods for High-Precision Long and Short Distance Length Measurement

Advantages
- Allows precision measurement of lengths within a range over 9-12 orders of magnitude, resulting in significantly enhanced accuracy
- Suitable for measurement over large distances with enhanced degree of precision

Invention

Background
Traditional length measurement can be categorized by two general methodologies. The first approach uses incoherent detection of light pulses to determine time-of-flight information, which is then converted to distance. While this approach is suitable for long distance measurements, high-precision measurements are generally unavailable due to hardware performance limitations. The second methodology uses detection of optical coherence, also referred to as interference fringes, to perform length or distance measurements with high precision. This technique is suitable for the precise incremental measurements. However, it is not suitable for measurement over large distances where an absolute measurement is required. In an effort to overcome the aforementioned limitations, methods have been developed that use a separate fast detector to determine time of flight and an optical spectral analyzer to perform fringe-resolved cross-correlation to increase the measurement precision. These methods, however, are complex and require significant hardware resources. Thus, a need exists in the industry to address the aforementioned deficiencies and inadequacies.

The present invention provides an absolute length metrology at arbitrary distances with a resolution better than that provided by optical fringe. This technology uses spectral interferometry, and mode-locked lasers, which are able to produce pulses of light of extremely short duration, on the order of picoseconds or femtoseconds. By using optical pulses generated at a specific frequency, the distance between each of the pulses is known and thus the distance to a target can be determine with a high degree of precision over large distances. Measurements can be made over a span of more than 10 kilometers away with an accuracy of less than 1 micron by utilizing this invention.

Application
Applications for this technology range from automotive self-positioning and tracking, to military and commercial imaging systems using synthetic aperture, such as space-borne synthetic aperture imaging. These imaging modalities could utilize this technology to significantly increase the resolution of their products.

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