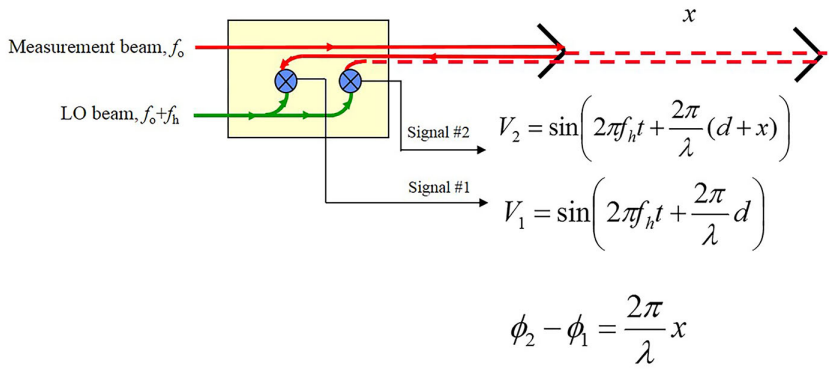


National Aeronautics and Space Administration

NASA

TECHNOLOGY SOLUTION

Sensors

Swept-Frequency Laser Metrology System

A laser metrology system capable of providing real-time platform motion information at high precision and accuracy

NASA's Jet Propulsion Laboratory has developed a precision coordinate metrology system for aligning and monitoring large deployable structures and telescopes. Conventional laser metrology systems are capable of micron-level absolute and sub-nanometer-level displacement measurements, but they require complicated hardware-stabilized lasers, calibrated and stabilized frequency sources, and optics and electronics with tight tolerance limits, plus there is a large degree of ambiguity in the measurement. JPL's laser metrology system is likewise capable of sub-micron-level absolute and sub-nanometer-level displacement measurements but is far simpler than conventional systems because it requires only a swept-frequency laser source and a calibrated reference cavity.

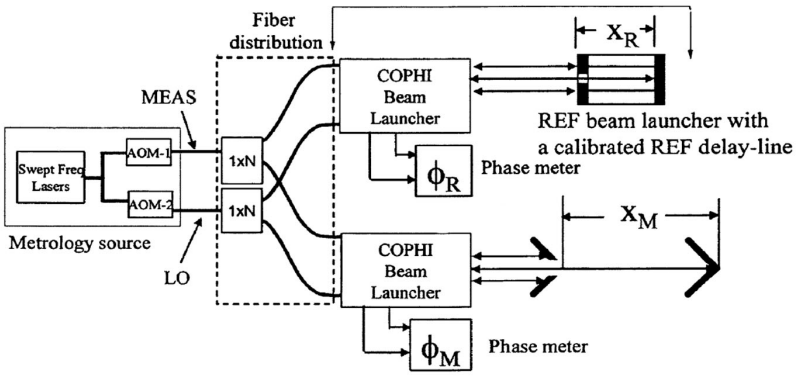
BENEFITS

- Simple system with reduced hardware overhead as well as reduced calibration and stabilization requirements
- Capable of sub-micron-level absolute and sub-nanometer-level displacement measurements
- No ambiguity in distance measurements because the measured phase change is directly proportional to the distance under measurement
- Precalibrated reference delay-line made from highly thermally stable materials makes the system less susceptible to environmental influences

THE TECHNOLOGY

JPL's swept-frequency laser ranging system employs a swept-frequency laser and multiple common-path heterodyne interferometers, one of which is coupled to a calibrated delay-line for use as an absolute reference for the system. This reference delay-line is the only absolute reference needed in the metrology system and comprises two optical-grade mirrors held with a stable spacer to impose a known distance between them. This distance is precalibrated to a high degree of accuracy. The reference delay-line can be made from highly thermally stable materials to make the system less susceptible to environmental influences. There is no ambiguity in distance measurements made by this system because the measured phase change is directly proportional to the distance under measurement.

In operation, the metrology system uses the two heterodyne interferometers to create two laser beams at two different frequencies to measure distance and motions of targets. The system can be used in absolute mode by tuning the laser frequency and in relative mode (for displacement measuring) by using the laser in stationary mode.



Functional block diagram of JPLs swept frequency laser metrology system.

APPLICATIONS

The technology has several potential applications:

- Metrology tools - semiconductor, automobile, and surveillance industries
- Aerospace - planetary protection, deep-space communications and navigation, precision control of spacecraft and payloads, and astronomical interferometry

PUBLICATIONS

Patent No: 7,764,384

F. Zhao, Development of high-precision laser heterodyne metrology gauges, Proc. SPIE, vol. 5634, pp. 247-259 (2005).

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More Information

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