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Recent developments in the field of frequency scanning interferometry

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Two questions for which people ask for help from NPL are: 'How good is my instrument?'and 'what are the uncertainties associated with my measurements?'At NPL we felt an instrument was needed which would inherently answer these questions with every measurement. Therefore we have built a coordinate measurement system that is self-calibrating with compensation for systematic errors, calculates in-process uncertainty estimates, has continuous traceability to the SI metre, and makes rapid coordinate measurements. These attributes are achieved using frequency scanning interferometry which is used to make absolute distance measurements and multilateration which is used to calculate target coordinates with uncertainty estimates.
In our measuring system, multiple sensors each measure the distances to multiple targets, simultaneously. Using a minimum of four sensors and six targets, the location of both the targets and the sensors can be determined without prior information about the system. Increasing either the number of sensors or targets leads to data redundancy, which can be used to infer uncertainty estimates for the coordinate measurements. By including systematic effects (associated with e.g. the measuring sensors) into the multilateration model they can be compensated for within the solution.
With our current implementation, each sensor head can measure multiple targets simultaneously out to a radial range of 10 m and angular range of ± 35°. Traceability and scale reference are obtained using a HCN gas cell as a frequency reference. Distance measurement uncertainties of 1 ppm are achieved and by correcting for systematic errors in the multilateration model it is possible to retain this uncertainty through to coordinate measurement uncertainties.

Summary

At the previous PACMAN conference in 2015 we presented a novel optical coordinate measurement system operating over a (1 x 1 x 0.75) m3 volume. The system utilises frequency scanning interferometry (FSI) to determine the absolute distance between targets and sensors and multilateration to calculate target coordinates. This presentation will cover the developments we have made at NPL over the last year in order to extend the measurement volume up to (10 x 10 x 5) m3.

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