INVESTIGATIONS ON SOME OPTO-ELECTRONIC TECHNIQUES FOR DIMENSIONAL METROLOGY

by

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1. Optical metrology
2. Measurement techniques

DEDICATED

to

My wife

Late Mrs. SAROJ CHAUDHARY

The inspiriting soul

CERTIFICATE

This is to certify that the thesis entitled, **"INVESTIGATIONS ON SOME OPTO-ELECTRONIC TECHNIQUES FOR DIMENSIONAL METROLOLGY"**, being submitted by **Mr. Krishan Pal Chaudhary**, to the Indian Institute of Technology, Delhi, for the award of the degree of **"DOCTOR OF PHILOSOPHY"**, is a record of the bonafide research work carried out by him under our supervision and guidance. He has fulfilled the requirements for submission of this thesis, which to the best of our knowledge has reached the required standard.

The material contained in this thesis has not been submitted in part or full to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

In the present era of globalization of trade, goods are crossing national boundaries. The metrology plays an important role in the trade. Dimensional metrology is highly dynamic subject for length measurement. The primary standard of length is based on optical phenomena and is defined in term of velocity of light. In the present era, the optical techniques have several advantages over the existing traditional one.

In the present thesis we have investigated various parameters of some opto-electronic techniques for dimensional metrology. With these investigations, the signal to noise ratio have been improved. The uncertainty of measurement has been reduced drastically.

Some of the techniques are based on existing instruments like coordinate measuring machine, surface roughness measuring device and optical coordinate measuring machine. The concept of image processing using wavelet transform has been introduced for measurements of wire-diameter and spacing of sieve. Optical technique based on CCD camera and image-processing systems have been investigated in the following chapters. We have also developed a graphical program in the Lab View environment to draw a line profile for analysis of the surface topography.

Chapter I pronounces the brief introduction of metrology, and its application in length and dimension measurement. Importance of length standard, different type of optical techniques and their applications are discussed.

Chapter II deals with the image processing and filtering using wavelet transform. New scheme of measurements based on symlet wavelet has been investigated and implemented to measure the wire diameter, aperture of wire mesh sieve using CCD

camera and image processing technique and an accurate analysis for defect detection have been given in this chapter.

Chapter III deals with the optimization of contact type and non-contact type of optical probes for their characteristics. Fiber optic probe characteristic to be used in configuration with optical CMM for blind-hole measurement has been investigated and data has been optimized. Autofocus probe and triangulation probe have also been used to make measurements and optimization of their optical properties with existing CMM.

Chapter IV deals with a new approach of measuring thermal expansion coefficient of different material using Perthometer (A surface roughness measuring device). Results have been presented which show a good correlation.

Chapter V deals with the some new approach for displacement measurement. A new concept has been presented for displacement measurement using coarse grating and incoherent source. In this chapter, a new application of optical sensor has been presented for measurement of length with an uncertainty of measurement better than $\pm 10\mu m$.

Chapter VI deals with the surface roughness measurement using optical method i.e. CCD camera and image processing. A new application of wavelet i.e. *conic kernel* has been presented to evaluate the three dimensional image.

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