INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Development of Kalman Filter based Algorithms for Fringe Pattern Analysis

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Thesis Submitted to the Department/ Center	:	Electronics and Electrical Engineering
Date of completion of Thesis Viva-Voce Exam	:	July 30, 2024
Key words for description of Thesis Work	:	Fringe analysis, fringe denoising, fringe pattern normalization, fringe pattern demodulation, phase estimation, speckle noise, Kalman filter, extended Kalman filter.

SHORT ABSTRACT

The purpose of fringe pattern analysis is to retrieve the phase from the fringe pattern. The phase retrieval is essential from the fringe pattern in order to derive the object information. Therefore, demand for the phase information has promoted the development of fringe analysis techniques. Spatial fringe analysis techniques typically involve different operations such as fringe denoising, fringe normalization, and fringe pattern demodulation for the phase estimation. In some cases, phase aberration compensation is also required to be performed. The thesis presents a number of spatial fringe processing algorithms based on the application of Kalman filter.

In the present work, different state-space formulation has been developed depending on the particular fringe processing operations. In doing so, different variants of the Kalman filter are utilized depending on the system and measurement models. In cases wherein the system and measurement models involve linear functions of the states, the standard linear Kalman filter is utilized. On the other hand, if system and/or measurement models involve nonlinear functions of the states, nonlinear version of the Kalman filter is utilized. The Kalman filter based spatial fringe analysis techniques have been developed for fringe pattern denoising, fringe normalization, and carrier modulated fringe pattern demodulation for the phase estimation. The challenging problem of closed fringe pattern demodulation has also been addressed. Numerous simulation and experimental examples have been provided. The salient features of the proposed techniques are robustness against the additive and speckle noise, good accuracy, low computational complexity, localized fringe processing, minimum or no user-defined algorithm parameters, performance independent of fringe density, ability to handle inherent fringe discontinuities, etc. The comparison of these techniques are provided with state-of-art methods to demonstrate their practical applicability.