Phase-Only Optical Information Processing

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Chapter 9
Project Summary

The work of this thesis has covered a broad but well defined area of study into phase-only optical information processing. Due to the scale of the project suggestions for future research are to be found in the relevent areas of this thesis where they shall prove of most benefit. After a general introduction to phase visualisation techniques in chapter one, chapters two and three develop an exact analytical tool for the computation of a Fourier series phase object spectrum. This technique encompasses the much simpler Taylor expansion technique usually cited in the explanation of phase visualisation and has shown detrimental convolution effects cannot be eliminated even at extremely low phase retardances.

Phase-only optical correlation relies on filters of greater complexity than those used in elementary phase-visualisation techniques. Practical filters - Spatial Light Modulators (SLMs) - are available for this purpose. Research within the Applied Optics Group at Edinburgh University is centred largely about novel VLSI design of SLMs, the simplest being the 16×16 pixel device of Underwood. Although much has been published on optical correlation, little of this concerns experimental implementation. Following research initiated by Ranshaw, a comprehensive program of research was initiated into optical correlation with the 16×16 SLM, experimental verification being paramount.

In chapter four the subject of correlation was introduced and chapter five detailed the operation of the 16×16 spatial light modulator used. Optical quality is of the highest importance for a phase modulating device and extensive investigation into improvement in this area was detailed in chapter six. The practicalities of the experiment (computer modelling parameters, fabrication details of target objects, etc.) are described in chapter seven. Finally, filter computation algorithms are discussed at length in chapter eight. To date, exceedingly few publications deal with filter computation for physical, pixellated spatial filters. Two algorithms were tested in both simulation and experimental situations and agreement between between the two was on the whole very good indeed. The 16×16 SLM has thus been shown capable of producing experimental results of high quality and the major objective of this project has thus been accomplished.
