Object Recognition in an Industrial Environment

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In fulfilment of the requirements for the degree of

Doctor of Philosophy (PhD)

Swinburne University of Technology

2010

Declaration

This thesis contains no material that has been accepted for the award of any other degree or diploma in any university or college of advanced education and to the best of my knowledge contains no material previously published or written by another person except where due reference is made.

Jane Michelle Dunn

Abstract

The use of automated visual inspection in industrial applications has to date been restricted to highly controlled environments. This places a limitation on the types of applications to which such systems can be applied. Increasing pressures upon manufacturing facilities in terms of cost and quality have led to an increasing demand for automated visual inspection systems. The objective of the research described in this thesis is to develop object recognition systems that are sufficiently robust to environmental variations to operate in poorly controlled industrial environments.

Local feature recognition has been identified in this research as a particularly suitable object recognition method for industrial applications due to its ability to handle occlusion, clutter and noise. However this research has identified two significant sources of variation that are common to industrial environments, namely complex illumination variation and viewpoint variation that have not been effectively addressed by the local feature recognition approach.

Two stages of the local feature recognition process were identified in this research as potential areas for improving the robustness to such variations: the descriptor stage and the putative interest point matching stage. Central to the improvement of the descriptor stage was the development of the Stepped Local Intensity Rank (SLIR) transform, which was designed as a potential means of providing invariance to complex illumination variation. Complex illumination invariant transforms were applied both in the forms of novel descriptors and of novel pre-processing operations to improve the system's robustness. The second area targeted for improvement was the putative interest point matching stage, an essential element of which is the distance metric. Distance metrics used in biological applications were identified as potential sources of improvement over the standard distance metrics conventionally used in computer vision and engineering applications. Analysis of these distance metrics led to the development in this research of several novel distance metrics that outperformed the existing distance metrics in relation to illumination and viewpoint variations.

The contributions of this research were evaluated against recognised benchmark descriptors and distance metrics using comparative feature recognition techniques that are commonly used throughout the literature. The novel feature recognition techniques developed in this research were found to provide significant performance improvements over the benchmarks in applications featuring complex illumination variation and viewpoint variation. Most importantly, the developed descriptors, pre-processors and distance metrics are not dependant upon characteristics that are particular to the industrial environment, and hence can be used in machine and computer vision fields in general.

Acknowledgement

This research was funded by the Australian Research Council (ARC) in collaboration with Ford Motor Company of Australia.

I would like to thank my primary supervisor Prof. Romesh Nagarajah for his continued guidance and constant support throughout the course of this research. I would also like to thank my second supervisor A/Prof. Alireza Bab-Hadiashar for his technical assistance, even while on the other side of the world.

Thank you to the Ford personnel: Mr. Matt Pickering, Mr. Andreá Cavallaro and Mr. Jim Politis, and to fellow team member Mr. Timothy Barry. Thank you especially to Tim for acquiring the images from the plant that were used in the experimental phase of this research.

I would like to gratefully acknowledge the generous assistance of my dedicated proof reading team of Dr. Kynan Graves, Mr. Stuart Hall and Mr. Mitch Hughes. In particular I would like to thank them for their thoroughness and the countless hours they spent reviewing this thesis.

I am also grateful for the support of the staff and students at IRIS who kept me motivated and helped me maintain my sense of humour, and to my parents who have always encouraged me to continue my education.

Finally, this research would not have been possible without the patience and support of my partner, Luke Dyson-Holland. I am eternally grateful.

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