Performance Estimation of Oversampled Bio-inspired Velocity Estimator Based on Reichardt Correlator

by

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Thesis submitted for the degree of

Master of Engineering Science

in

School of Electrical and Electronic Engineering
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May 2010

Typeset in LaTeX 2ε

Bin Guo

to my parents

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Abstract

Inspired by the insects' incredible visual capabilities, many vision motion detection systems were proposed and developed. The Reichardt Correlator, as a bio-inspired vision motion detector is commonly used for velocity estimate of objects. Traditionally, the received signals in receptors in a Reichardt Correlator are digitised at bit depths of 8 or greater and sampled at Nyquist rate. Its implementation requires relatively complicated arithmetic units to cope with the processing of the samples. This is considered as bringing heavy computation burden to the motion detection system.

In this thesis, a new approach for using oversampled, low bit depth representations for velocity estimation using the Reichardt Correlator is developed. This is achieved by considering the trade-off between oversampling ratio and bit depth, commonly found in oversampled data converters. After using real images as stimuli to the Reichardt Correlator, it was found that using lower bit depths and oversampling can retain the accurate velocity estimation performance, and at the same time, reduce the system arithmetic complexity. As a result, a sigma-delta conversion was proposed to pre-process the input signals to the Reichardt Correlator. In this approach, the image information is encoded as 1-bit oversampled representation. The long term aim is to have a scheme whereby the required system arithmetic complexity can be made simpler. In this step, three different panoramic images were used as the stimuli in simulations. The core contribution of this thesis is an investigation between the trade-off in performance and arithmetic complexity using the Reichardt Correlator as a velocity estimator in vision system, rather than elaborating the Reichardt Correlator, which can result in a more complex arithmetic implementation.

The performance of the proposed approach is evaluated by comparing oversampled results with traditional representations. The comparisons results show that the proposed approach can achieve better performance in terms of optimal velocity detection,

under reduced system arithmetic complexity. Because of the image contents, small oscillations and a slight loss in velocity estimation accuracy was observed. Since the approach can reduce system arithmetic complexity are the primary considerations, small oscillations and inaccurate velocity detection can be tolerated.

Statement of Originality

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Acknowledgments

This thesis could not have been completed without the help and support of a number of people. I would like to take this opportunity to thank them.

First, I would like to thank my supervisor Dr Said Al-Sarawi whose many ideas, guidance and enthusiasm have been a source of motivation to me. He showed me different ways to approach a research problem and the need to be persistent to accomplish any goal. Many thanks must also be given to my co-supervisor Dr Brian Ng, who provided continued support and motivation for my research. It has been so important to get his academic advice and understanding in our regular meetings. In the final step of writing thesis, his unfailing support and guidance gave me the confidence and helped me successfully accomplish my project.

This research has been carried out in the School of Electrical and Electronic Engineering School in University of Adelaide. I would like to acknowledge everyone who made available their assistance, support and advice. I would like to acknowledge Dr Tamath Rainsford for providing some of the images used in this thesis. I would like to thank my colleagues at the room of EM419, Omid Kavehei, Robert Moric, Kiet To, Kyukjin Lee, Ying Sun, for their general moral support throughout my time here, and their willingness to answer questions. I would like to express appreciation to Associate Professor Cheng Chew Lim, Mr. Matthew Trinkle, Zhonghao Hu, Ruiting Yang, Yuexian Wang, Lifang Lu for their valuable help and support.

I would like to thank my friends in Australia, Annie, Celeste, David, Chloe, Cindy, Zifang Liu, Peiqiong Lai, who provided valuable support and companionship in my time in Australia and without whom I would be much lonely in Australia.

Last but not least, I would like to thank my parents for their support throughout my degree, their consistent financial support and encouragement is the basis of my study in Australia. Their love and understanding are always the force which drives me forward.

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Conventions

Typesetting

This thesis is typeset in Times New Roman and Sans-Serif using LaTeX2e. Referencing and citation style are based on the Institute of Electrical and Electronics Engineers (IEEE) Transaction style [1].

Spelling

English spelling in this thesis is based on Australian English.

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Publications

Conferences

[1] B. Guo, B. W.-H. Ng, and S. Al-Sarawi, "Using sigma-delta conversion for velocity estimation in bio-inspired detection system." Kuala Lumpur, Malaysis: 2010 International Conference on Electronic Devices, Systems and Applications (ICEDSA2010), 11-13 April 2010.

[2] B. Guo, B. W.-H. Ng, and S. Al-Sarawi, "Performance estimation of oversampled low bit depth, bio-inspired motion detection system." Taichung, Taiwan: The 5^{th} IEEE Conference on Industrial Electronics and Applications (ICIEA2010), 15-17 June 2010.

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