

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

by

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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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Conventions

Typesetting

This thesis is typeset in Times New Roman and Sans-Serif using L^AT_EX2_ε. 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, Malaysia: 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 5th IEEE Conference on Industrial Electronics and Applications (ICIEA2010), 15-17 June 2010.

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