Haar Filter Hardware Architecture for the Accuracy Improvement of Stereo Vision Systems

Cheol-Ho Choi[1,o], Younghyeon Kim[1], Jiseok Ha[1], and Byungin Moon[1,2,*]
[1] Graduate School of Electronic and Electrical Engineering
[2] School of Electronics Engineering
Kyungpook National University, Daegu, Korea
E-mail: [o]qwe0725@knu.ac.kr, *bihmoon@knu.ac.kr

Introduction

- **Semi-global matching (SGM) is widely used to compute the disparity map** for stereo vision systems
- However, **mismatching can occur frequently by noise and high-frequency components**
- To overcome this problem, we **proposed the preprocessing method based on Haar filter**

Proposed Method

Input Images

2-D Haar Filter

$$I_{freq} = \sum_{\substack{k=0 \\ l=0}}^{N-1} h(i) I(x+k, , y+l)$$

$h(i)$: **Transformation function**
$I(x+k, y+l)$: **Input** image
k **&** l : Data point
I_{freq} : Image of **Frequency component** (**Low-High, High-Low, High-High**)

Weighting Factor Multiplication

Pixel Calibration

$$I_{desire} = I_{org} - I_{LH} - I_{HL} + I_{HH}$$

$I_{desired}$: **Output** image, I_{org} : **Input** image
I_{LH}, I_{HL} *and* I_{HH} : Images **of frequency component multiplied by weighting factor**

Experiment Results (KITTI Dataset)

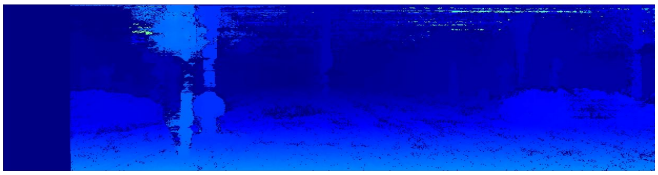
< Table 1. Performance Comparison >

	Non-Occlusion		Occlusion	
	MP	MER	AMP	MER
Gaussian	104704	22.48%	111007	23.83%
Proposed	**101015**	**21.69%**	**107383**	**23.06%**
Improvement	**3.52%**	-	**3.26%**	-

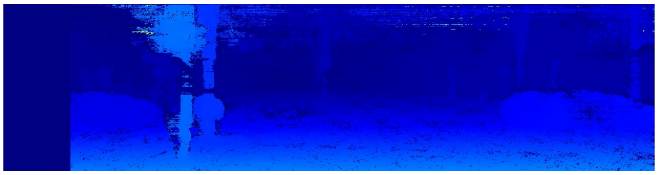
MP: Mismatching Pixels, MER: Mean Error Rate

Proposed method improve the MER of non-occlusion and occlusion by 3.52% and 3.26%, respectively

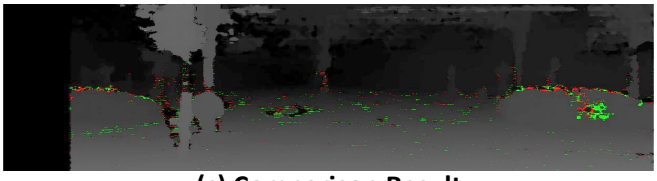
< Figure 1. Results of Disparity Map >



(a) Gaussian Filter



(b) Proposed Method



(c) Comparison Result

Green color indicator : Improvement
Red color indicator : Deterioration

< Table 2. Hardware Resource Usage >

Resource	Gaussian Filter	Propose Method
Slice LUTs	110	**137**
Slice Registers	180	**191**
BRAMs	2	**1**

Conclusion

- Proposed method **improve the matching accuracy with reasonable hardware resource usages**
- It is **suitable for embedded stereo systems that require high matching accuracy**