Hardware Implementation of the Hough Technique for Irregular Colour and Grey-level Pattern Recognition

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Abstract.

Keywords

1. Introduction to the Hough Transform

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$$\rho \quad \alpha \quad = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \mathrm{I} \qquad \delta \ \rho - \qquad \alpha \ - \qquad \alpha$$

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$\rho = \qquad \alpha \ + \qquad \alpha$

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pixel counting

backprojection

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$\lambda \quad = \qquad \in \qquad\qquad =$

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$$= \left\{ \qquad\qquad = \right.$$

accumulation **accumulator** (

$\rightarrow$ $=$ $\times$ $\times\cdots\times$

$\subset$

2. The Binary Hough Transform for irregular objects

Basic definitions

digital images

$\rightarrow$ $=$ $\times$ $\subset$

object

$=$ $\in$ $=$

The Binary Hough Transform

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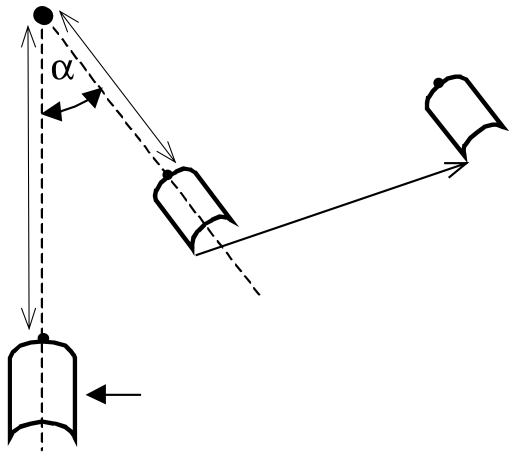

Figure 1. Scaling, rotation and translation of pattern with respect to an arbitrary point

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$$\begin{cases} {}' = \quad + \quad - \quad \alpha - \quad - \quad \alpha \\ {}' = \quad + \quad - \quad \alpha + \quad - \quad \alpha \end{cases}$$

$$\begin{cases} {}'' = {}' + \quad = \quad + \quad - \quad \alpha - \quad - \quad \alpha + \\ {}'' = {}' + \quad = \quad + \quad - \quad \alpha + \quad - \quad \alpha + \end{cases}$$

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$$\alpha \quad = \sum_{=} \qquad \alpha$$

$$\alpha \quad = \begin{cases} \qquad '' \quad '' \in \\ \end{cases}$$

$$= \quad \times \quad \times \quad = \qquad \times \qquad \times \qquad - \qquad \Delta\alpha = \frac{\pi}{}$$

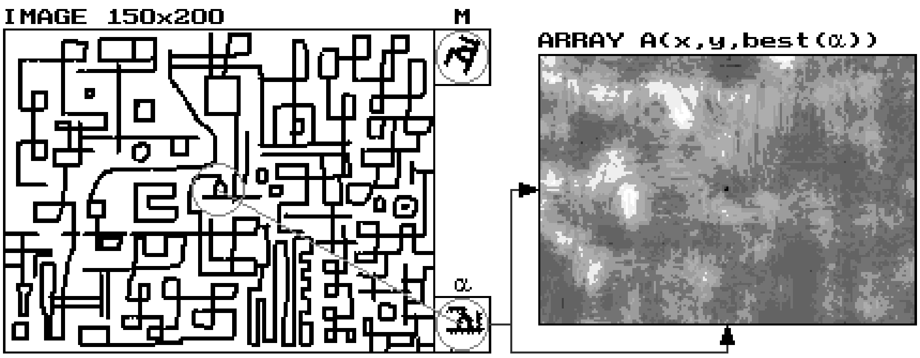

Figure 2. Hough Transform for complex image

3. Generalisation of the Hough Transform for grey-level images

$$\alpha \quad = \begin{cases} \quad \quad '' \quad '' = \\ \\ \end{cases}$$

$$\alpha \quad = \; -\left| \quad '' \quad '' - \quad \right|$$

Definitions

image with 256 grey levels

$$\rightarrow \qquad = \qquad \times \qquad \subset$$

Object

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Pattern $\times$

$$\rightarrow \qquad = \qquad \times \qquad \subset$$

Generalisation of the Hough Transform

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$$\alpha \quad = \quad \sum_{\in} \qquad \alpha$$

$$\alpha \quad = \quad -\left| \quad '' \quad '' - \quad \right|$$

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$$\begin{cases} ″ = \quad + \quad - \quad \alpha - \quad - \quad \alpha + \\ ″ = \quad + \quad - \quad \alpha + \quad - \quad \alpha + \end{cases}$$

Application of the histogram function

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<u>ALGORITHM</u> – histogram analysis

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$\Phi \quad \times$

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$\Phi \quad \Phi$

$$= \frac{}{\pi \cdot} \sum_{=} \left| \Phi \quad - \Phi \right|$$

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4. The Hough Transform and the scaling problem

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$= \times \times \times = \times \times - \times \xi \quad \xi \quad \Delta\alpha = \frac{\pi}{\;}$

$\xi \quad \xi$

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$\times$

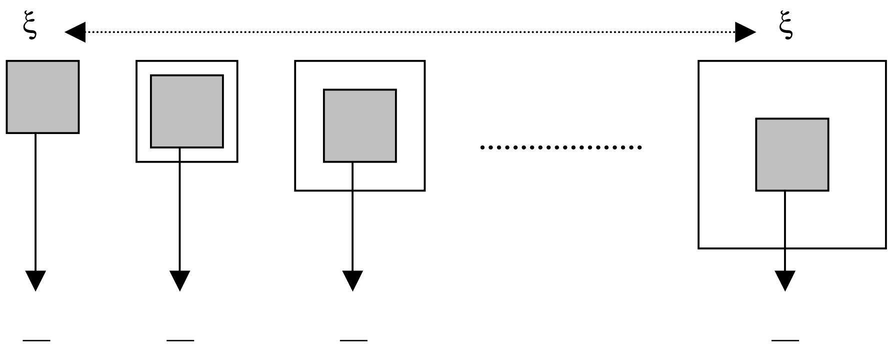

Figure 3. Graphical illustration of the process of patterns creation

5. Generalisation of the Hough Transform for Colour Images [18]

The first approach

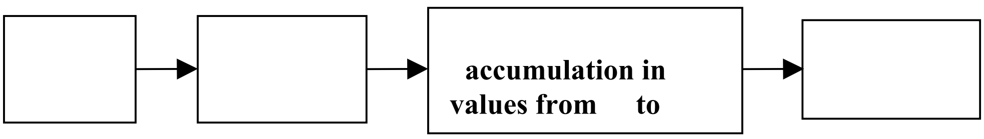

Figure 4. The simplest way of conduct with colour images

The second approach

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$$| \; ' \; ' - \qquad | = \sqrt{\; - \quad + \quad - \quad + \quad - \;}$$

The third, final approach

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$$| \; ' \; ' - \qquad | = \quad ' \; '$$

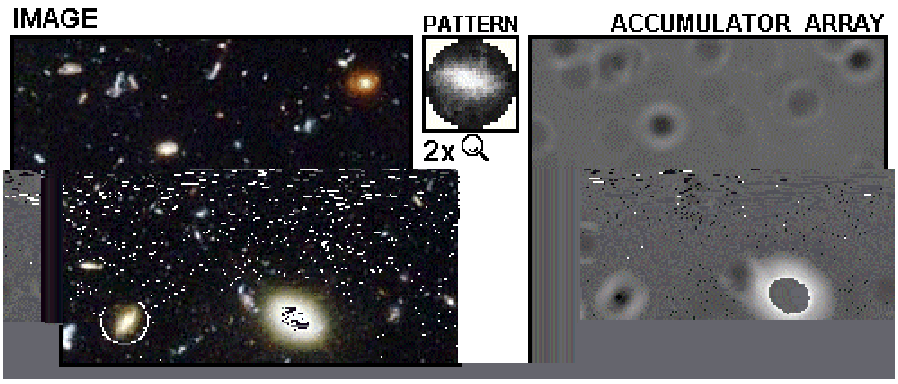

Figure 5. Object location in a colour image obtained from HST

6. Hardware implementation of the Hough technique [23]

Introduction to the Hardware [22]

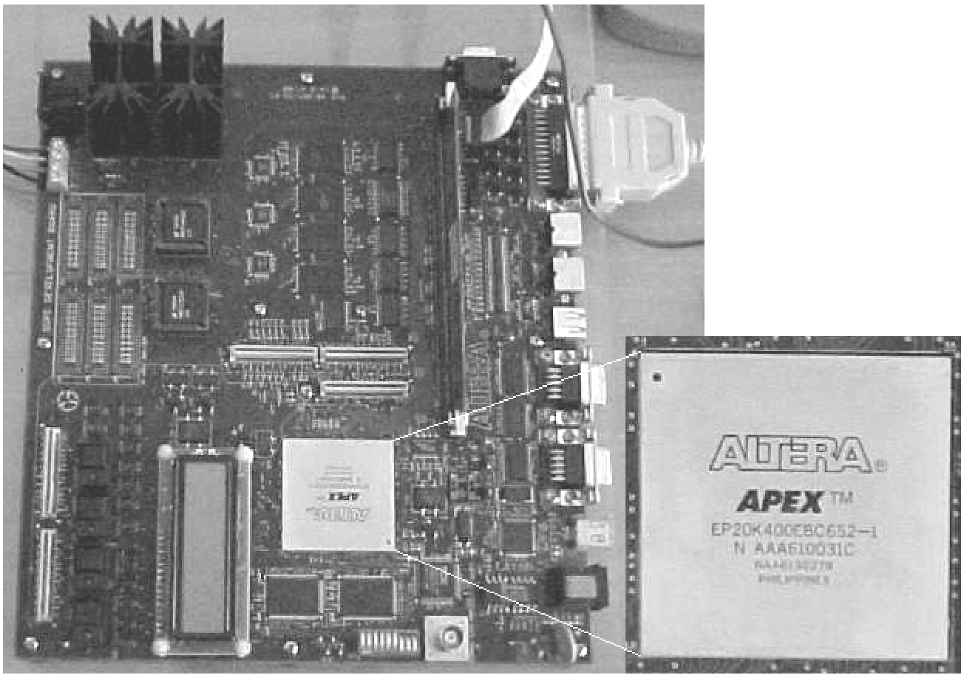

Figure 6. Altera SOPC board (the APEX device is zoomed in)

Technical Assumptions for the Project

- $\Delta\alpha =$ ^{o}
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sealing

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Implementation of function α

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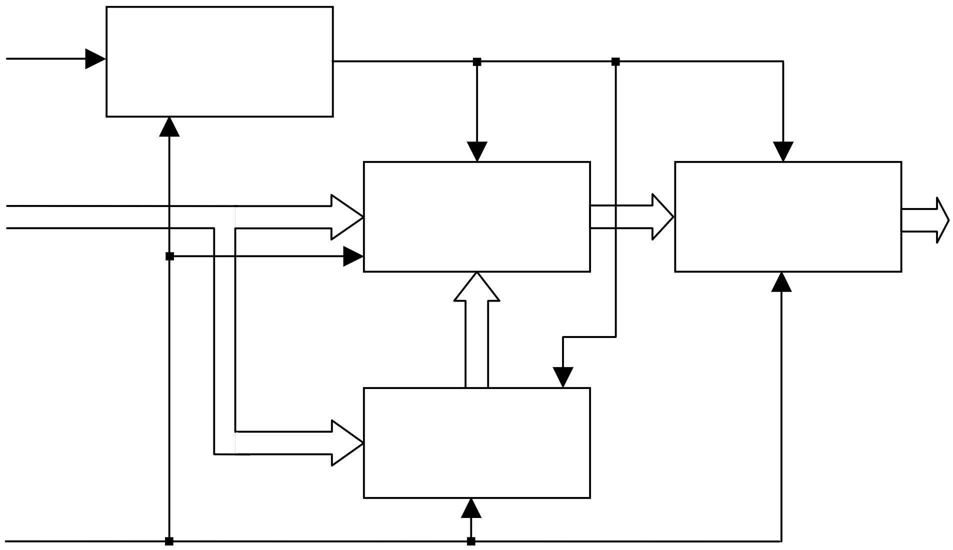

Figure 7. Block diagram of the structure implemented for function α

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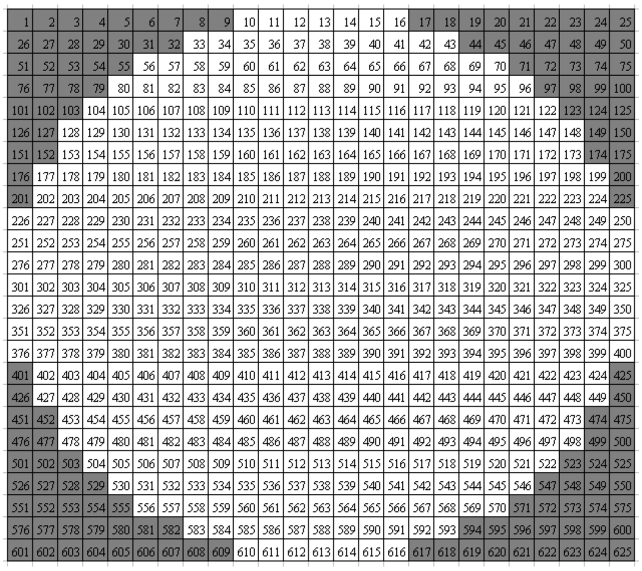

Figure 8. Indexed pixels of the pattern

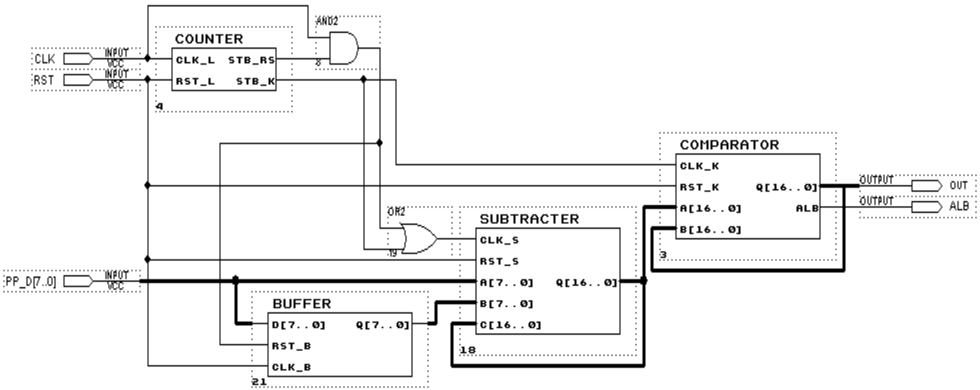

Figure 9. Technical scheme of the implemented structure

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Example results

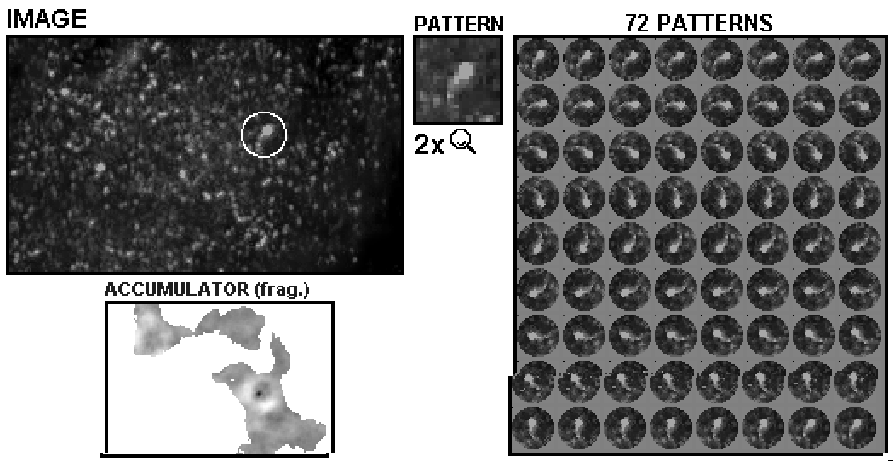

Figure 10. Example result with many similar elements in the input image

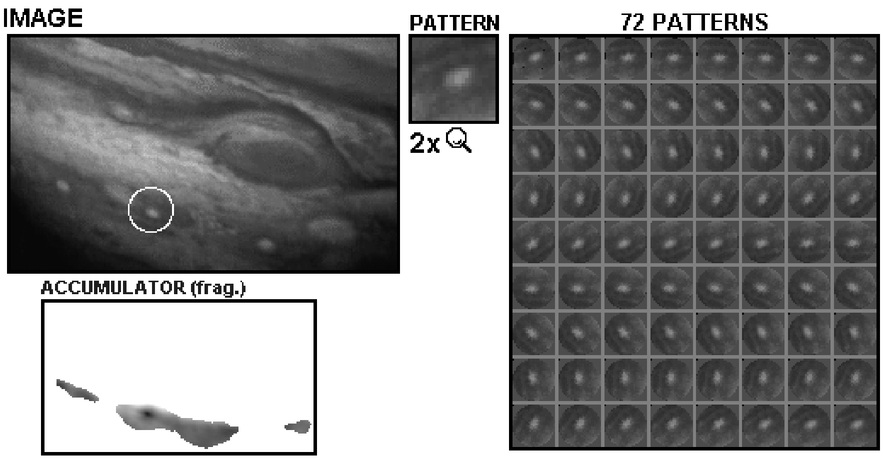

Figure 11. Example result with only three elements in the input image that are similar to the pattern

7. Conclusion

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Ż *Irregular Colour Pattern Recognition Using the Hough Transform*
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Ż *Irregular Pattern Recognition Using the Hough Transform* **9**

Ż *Pattern Recognition in the Case of Small Differences.*

Ż Ż *Hardware Implementation of the Hough Technique for Irregular Pattern Recognition.*

System-On-a-Programmable-Chip Development Board User Guide

Ż *Design of a hardware implementation of the Hough Transform* *Projekt sprzetowej realizacji transformaty Hougha*

Reviewed by Professor Włodzimierz Kwiatkowski

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