Pattern Recognition and Image Analysis

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Parallel Architectures for Multiresolutive Colour Image Segmentation

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Abstract

The present work focuses on the evaluation of parallel architectures for the implementation of unsupervised colour image segmentation. Multiresolution has been considered as segmentation technique. The results show that the combination of both strategies permits to speed up colour analysis.

Key words: Colour segmentation, Multiresolution, Parallel processing.

1 Introduction

Unsupervised colour image segmentation requires an excess of calculations to be implemented on systems that need to deal with high speed applications, such as quality control of natural objects in industrial processing. The using of an appropriated algorithm in conjunction with parallel architectures can be considered a key to the solution of the problem.

2 Multiresolutive Colour Image Segmentation Algorithms

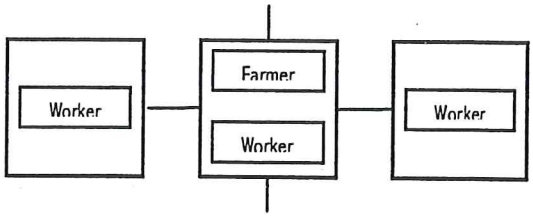
Many unsupervised methods for colour image segmentation (like *C-means*) are based on the use of clustering algorithms. In order to reduce the cost of this process, in [1] a previous histogram thresholding technique is introduced, giving information on the number of clusters to be formed and determining the histogram regions that clearly belong to each cluster. Some undetermined regions are left to be classified by *Fuzzy C-means* algorithm (FCM).

In the present work, two obvious variations of this algorithm are studied. First of all, a similar two-stage classification will be considered. *Scale Space Filtering* (SSF) [2] will be used as a tool to analyse the three colour components in a multirresolutive way; while a *minimum distance* (MD) algorithm will carry out a fine segmentation, classifying the undetermined regions. Secondly, it will be considered a one-stage algorithm based exclusively on SSF, without *a posteriori* refinement.

3 Hardware Development

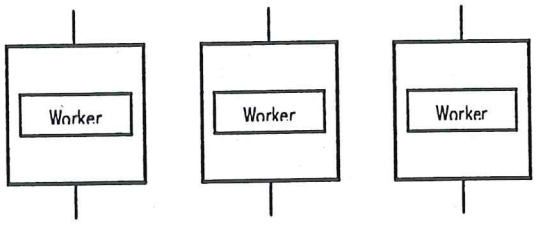
Two different configurations of *transputers* [3] will be analysed, taking into account its better or worse adaptability to the proposed algorithms, as well as their scalability.

3.1 First Configuration: Linear Cell



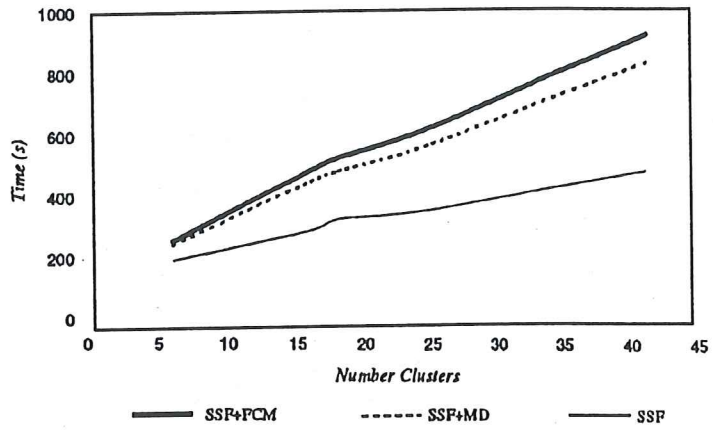
The *farmer* distributes the external information to the *workers*, co-ordinating communication between them and combining results. Each worker analyse a colour feature searching for clusters in the first stage and classifying one third of the total image in the fine stage.

3.2 Second Configuration: Pipeline Cell



This is the faster and more scalable configuration. It is simply three pipelined channels each one of them working on a different colour co-ordinate from the same image. It is only convenient to the one-stage algorithm since the workers are not allowed to communicate partial results. Consequently, there are no delays.

4 Evaluation



The sequential execution times of the proposed and the original algorithms are compared here. The test has been carried out with images leading to an increasing number of colour clusters. Time execution rates for algorithms using FCM and MD (minimum distance) strongly rely on the number of clusters. Total execution time only depends on the processor model used (transputer T805) and it must not be considered a characteristic.

To analyse parallelism, two performance descriptors are going to be used: *Time Acceleration* ($\mathcal{A}$), expressing the relation between sequential algorithm time T_S and parallel total time T_P; and *Efficiency* ($\mathcal{E}$), showing the use done of the N processors employed. They are defined as:

$$\mathcal{A}(N) = \frac{T_S}{T_P(N)} \qquad \Rightarrow \qquad \mathcal{E}(\%) = \frac{\mathcal{A}(N)}{N} \cdot 100$$

The sequential algorithms have to perform additional operations to combine results in the three-dimensional space that are superfluous in the parallel conception; consequently, $\mathcal{A}$ should be expected to be greater than the number of used processors (N), and $\mathcal{E}$ geater than 100%.

	$\mathcal{A}$	$\mathcal{E}$	
Linear Cell	3.88	129 %	**SSF + MD**
Parallel Cell	3.43	114 %	**SSF**

5 Conclusions

Second configuration is apparently faster, although there is a quality loss in the segmentation results. However, both configurations are widely superior to a conventional sequential structure. These results do not invalidate the FCM or the MD approaches as powerful tools in image processing, but they indicate there is a time penalty to be paid for using them.

6 References

[1] *On the color image segmentation algorithm based on the thresholding and fuzzy techniques.* Y.W. Lim, S.K. Lee. Pattern recognition, vol. 23, n. 9, pp. 935-952, 1990.

[2] *Scale space filtering: A new approach to multi-scale description.* A.P. Witkin. Image Understanding, 1984.

[3] *IMS D7314A IBM 386 PC ANSI C Toolset.* INMOS Limited. 1992.

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Estimado colega,

es un placer informarle de que - después de una cuidada revisión por los miembros del comité de programa - su artículo, número 89, titulado

Parallel Architectures for Multiresolution Colour Image Segmentation

ha sido aceptado para el VII SNRFAI para presentación Poster.

Cada artículo ha sido revisado de forma anónima por dos miembros del comité de programa. Para su información, le enviamos las copias de las revisiones de su artículo.

También se incluyen los detalles para formatear y enviar la versión final de su artículo. Por favor, considere que necesitamos recibir su versión definitiva antes del día **21 de Febrero de 1997**. Los artículos que lleguen fuera de plazo no serán publicados en los *proceedings* que se entregarán en el simposium.

Gracias por enviar su artículo al SNRFAI. Espero verle en Barcelona en Abril. Si tiene alguna pregunta no dude en contactar con el secretariado del simposium.

Atentamente,

P.O

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