The effect of window mask shape on algorithm design in pipeline architectures

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Abstract

Due to the large amount of data and the speed requirement of many vision applications, parallel architectures are increasingly being used. Recently, there has been much research in algorithms for Pipeline Architectures. In this paper, we discuss how we can take advantage of the shape of the masks and the spatial relationships between the data points in designing algorithms for pipeline architecture. This design methodology allow individual fast algorithm to be designed for different local window masks. We shall illustrate this concept by giving several algorithms for different masks for median filters. The classes of median filters considered in this paper are cross shape, X-shape, all samples median filter and the separable median filter. The correctness of these algorithms are also proven.

KEYWORDS: median filters, window mask shape, algorithm design, parallel computation, pipeline architectures.

A cause du grand nombre de donnees et de la vitesse requise par plusieurs applications visuelles, les architectures paralleles sont de plus en plus utilisees. Recemment, beaucoup de recherches sur les algorythmes pour architectures en pipeline ont ete effectuees. Cet article examine la facon de tirer avantage de la forme des masques de meme que des relations spatiales entre les points de donnees dans le design d'algorythmes pour architecture en pipeline. Cette methodologie permet le design d'algorythmes individuels rapides pour differents masques en fenetre locaux. Nous illustrerons ce concept par des algorythmes pour differents masques pour filtres medians. Les filtres medians en forme de croix, ceux en forme de X, les filtres medians separables et tout autre echantillonage de filtres medians constituent les differentes categories etudiees dans cet article. Nous avons egalement fait la preuve de l'exactitude de ces algorythmes.

MOTS CLES: filtres medians, forme des masques en fenetre, design d'algorythmes, compilation parallele, architectures en pipeline.

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I. Introduction

Computer based image analysis have a wide range of applications. These include industrial applications such as automatic visual inspection and robotic vision. Biomedical applications include computer tomography, X-ray imaging, and Electron Microscopic imaging. Due to the large amount of data and the speed requirement, parallel architectures are often being used. Recently, several vision systems have been proposed using pipeline architectures [Petkovic, 86], [Persoon, 88], [Sanz & Petkovic, 88]. Pipeline architectures have fast performance and are commercially available, allowing applications to be tested before dedicated equipment need to be built. Currently there are much research interest and publications in parallel algorithms using pipeline architectures, including various geometric features [SHD, 87], [Sanz & Dinstein, 87], polygonal masks [SDP, 87], [Sanz & Petkovic, 88], projections [Sanz & Hinkle, 88], local maximum and minimum [Dinstein & Fong, 88], and non-linear hybrid filters [Fong, 89] In this paper, we propose a new approach for algorithm design for this type of parallel architectures.

In image processing applications, many operations are defined based on a local window. The window is often square in shape, sometimes rectangular, and the data points chosen within the window may vary as well. There has been a large amount of literature on image enhancement filters, where properties and utilities of filters of various size and shape are studied. In this paper, we shall consider the best known nonlinear order-statistical filters, the median filter. It was first introduced by Tukey[TU, 74], and has been observed to be very effective for removing noise, especially impulse noise, for one or two dimensional signals, while satisfying the usually conflicting goal of preserving information-bearing edges [GW, 81], [H, 81]. The properties of the median filters had been studied in details [AAW, 81], [AG, 82], [KW, 81], [NG, 84], [BHM, 87], [B, to appear]. They have been successfully applied to many signal and image processing tasks.

In standard median filters, the median is taken over all samples inside the window. When the number of samples is large, the ordering procedure is computationally intensive. Masks for the median filters other than the entire window have been proposed. These include the cross-shape and the X-shape windows, the separable median filters, and the multilevel median filters [NHN, 87]. In this paper, we propose an algorithm design methodology by taking advantage of the