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Determining Parameters for Images Amplification by Pulses Interpolation

Determinación de parámetros para amplificación de imágenes mediante interpolación de pulsos

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Abstract

This paper presents the implementation of a method for image samples interpolation based on a physical scanning model. It uses the theory to take digital image samples and to perform an implementation of such mechanism through software. This allows us to get the appropriate parameters for the images amplification using a truncated sampler arrangement. The shown process copies the physical model of image acquisition in order to incorporate the required samples for the amplification. This process is useful in the reconstruction of details in low resolution images and for images compression. The proposed method studies the conservation of high frequency in the high resolution plane for the generation of the amplification kernel. A new way of direct application of the physical model for scanning images in analytic mode is presented.

Keywords:

- interpolation
- image reconstruction
- expansion
- sampling
- scanning

Resumen

Este trabajo muestra la aplicación de un método para la interpolación de muestras sobre una imagen basado en un modelo físico de digitalización de las mismas. Se utiliza la fundamentación teórica de muestreo de la imagen digital y se realiza una implementación de dicho mecanismo a través de un software. Esto permite obtener los parámetros adecuados para amplificar las imágenes utilizando el arreglo de muestreo truncado. Se imita el procedimiento físico de obtención de la imagen y se incorporan las muestras requeridas para la amplificación. Este proceso es útil en la reconstrucción de detalles de imágenes de baja resolución y para la compresión de las mismas. El método propuesto estudia la conservación de las altas frecuencias en el plano de mayor resolución para la generación del núcleo de amplificación y presenta una nueva forma de aplicar directamente el modelo físico de escaneo de la imagen en modo analítico.

Descriptores:

- *interpolación*
- *reconstrucción de imágenes*
- *ampliación*
- *muestreo*
- *digitalización*

Introduction

This paper proposes a method for the construction of a pulse interpolation filter with maximum response amplitude at high spatial frequencies. This allows a better reconstruction of the details including the use of the characteristics of this type of amplification in order to achieve linear phase response in the edge transitions of the high resolution image. The preservation of edge information in an accurate frequency range gives a harmonious visual effect to the image and prevents the formation of blocks. This type of filter is used in the amplification, image reconstruction and simultaneously facilitates the compression process.

In some applications, as an imaging amplifier for Space-Multiplexed Optical Transmission (Ozdur *et al*., 2012) it is necessary to focus/collimate the light beam to the center of the bulk amplifier from the imaging systems (IS 1 and IS 2) of Figure 1 and then to couple back to the output fiber. The amplification effect of the bulk could be seeing as the electrical output of a more dense and sensible photo detector zone integrated over a period of time. During this period the light beam activates the resolution cells, and then the simulation of a photo detector sampling zone is useful to simulate the amplification effects.

The medical-image analysis requires an understanding of sophisticated scanning modalities, constructing geometric models, building meshes to represent domains, and downstreaming biological applications. These four steps form an image-to-mesh pipeline (Levine *et al*., 2012).

The proposed method could be used as an edge-preserving interpolation method after the denoise process for noisy images. In some cases the image is first decomposed using the bilateral filter into the detail and base layers which represent the small and large scale features, respectively. The detail layer is adaptively smoothed to suppress the noise before interpolation and an edge-preserving interpolation method is applied to both layers, it is effective to employ denoising prior to the interpolation (Jong *et al*., 2010).

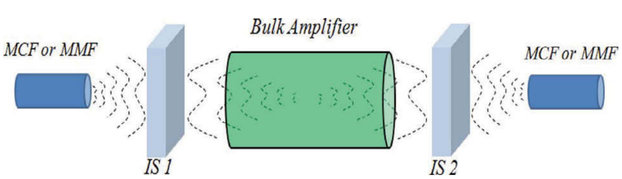

Figure 1. General schematic of the imaging amplifier. (MCF and MMF are the multicore and multimode fibers; IS is the imaging system

Some methods of interpolation, like the curvature interpolation method (CIM), study the edge composition of the low resolution image to interpolate the curvature to the high-resolution image domain. The CIM constructs the high-resolution image by solving a linearized curvature equation, incorporating the interpolated curvature as an explicit driving force (Hakran *et al*., 2011). Other regression-based image interpolation algorithms have been proposed in the literature, in which the objective functions are optimized by ordinary least squares (OLS). However, it has been shown that interpolation with OLS may have some undesirable properties from a robustness point of view: even small amounts of atypical values can dramatically affect the estimates (Liu *et al*., 2011).

This investigation tries to find the limits of quality in the high resolution image. The curvature content in the high-resolution image domain is studied using classical theory resources. A restricted interpolation system is made with spatial and window filters in order to increase the high frequency content. The proposed method constructs an interpolation kernel using the high frequency content at high-resolution image domain as an explicit driving force for the variation of the amplification kernel parameters. With this process, the optimal low-high resolution pair is found using the amplification kernel given by the Fourier transform of the truncated sampling arrangement (Papoulis, 1966). In the process filters as Butterworth (Pratt, 2001) and Canny (1986) are used in order to guide the construction of the interpolation kernel and to raise the high frequency content in the high resolution image.

Image sampling system

In a physical image sampling system the sampling arrangement should be of finite extent. The sampling pulses are of finite width and the image can be sub sampled with spectral overlap. Because of these, spurious spatial frequency components will be introduced into the reconstruction. This effect is called aliasing error (Brown, 1969; Helms and Thomas, 1962) and therefore it is necessary to explore the consequences of the non-ideal sampling.

In the example of Figure 2, a thin beam of light goes through a photographic transparency of an ideal image. Passing light is collected in a condenser lens and is sent directly to a photo detector. The electrical output from the photo detector is integrated over a period of time during which the light beam activates a resolution cell. In this type of system is considered that even lens

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