IMAGE SUPER-RESOLUTION FROM LOW-RESOLUTION IMAGES USING CONTINUOUS MOMENTS

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Abstract

Recently, there has been a growing interest in using functions that can reproduce polynomials for the analysis of signals like signals with finite rate of innovation (FRI) [1]. These functions, which must satisfy Strang-Fix conditions [2], can be of various types like Spline or wavelet scaling functions.

In this paper, we describe a novel approach of image super-resolution using a large set of very low-resolution images. The point spread function of the lens in our image acquisition system is modeled with a function that can reproduce polynomials. By using such sampling kernels, we are able to retrieve the *continuous geometric moments* of the original observed image from its sampled version only.

In particular, we focus on the case where the sampling kernel is a cubic B-spline. Indeed, for order as low as 2, the shape of B-splines is already very close to a Gaussian curve which is often used for modeling real camera lenses [3]. In addition, B-spline signal processing offers an excellent framework in which Dual B-splines and Cardinal B-splines are well defined in the continuous domain as well as in the discrete domain [4].

More importantly, cubic B-spline also allows to retrieve enough continuous moments so that the disparity existing between images can be retrieved accurately up to affine transformations [5]. Since we are considering the moments of the original observed image, we are able to do a very precise registration of the different sampled images even though these images can have a very low-resolution. This moment-based approach of registration also avoids the usual stages of control points extraction and correspondence whose efficiency decreases as the resolution gets lower [6].

We implemented a complete image super-resolution algorithm using this registration technique and which operates on real images. Figure 1 illustrates the results obtained with our approach in case of unknown translations between sensors. Each acquired image is a different low-resolution sampled version (see Figure 1(b), 65x65 pixels) of a high-resolution image (see Figure 1(a), 2000x2000 pixels). We are assuming that a fairly large number of sensors is available (*e.g.* 100 sensors). By using

(a) Original image. (b) One sampled image. (c) Super-resolved image.

Fig. 1. Image super-resolution from 100 sampled images using continuous moments for registration (original image: NASAs Earth Observatory).

traditional techniques for interpolation and restoration, we obtained super-resolved images with a good level of details although few information was originally available from the sensors (see Figure 1(c), 2000x2000 pixels).

In future works, we want to take advantage of the fact that each sampled image is the dual representation of the orthogonal projection of the original image in the shift-invariant spline space, [7], in order to optimize the interpolation and restoration steps of our image super-resolution algorithm.

1. REFERENCES

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