Chapter 6
Virtual Magnifier–Based Image Resolution Enhancement

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ABSTRACT

To obtain high resolution images, some low resolution images must be processed and enhanced. In the literature, the mapping from the low resolution image to the high resolution image is a linear system and it is only enlarged by an integer scale. This paper presents a real scaling algorithm for image resolution enhancement. Using a virtual magnifier, an image resolution can be enhanced by a real scale number. Experimental results demonstrate that the proposed algorithm has a high quality for the enlarged image in the human visual system.

INTRODUCTION

For image analysis, we often want to investigate more closely a specific area within the image. To do this we need to enlarge the specific area. In the video sequence, for a specific area within an image frame, we can *zoom* in on it by enlarged it. The enlarged area can be recognized efficiently.

Image resolution enhancement refers to image processing algorithm which produces a high quality and high resolution image from a low quality and low resolution image. It includes two procedures. The first is the problem for finding a mapping between high resolution image and low resolution image. The second is the problem for calculating all the pixel values of the high resolution image from its low resolution version. In the literature, the mapping between them is always chosen by a linear mapping system. However, for the CCD (charged-coupled devices) camera, the resolution of enlarged images is produced by the lens. The linear mapping system is not suitable. In addition, due to the linear mapping system,

the scale of the image to be enlarged is always an integer scale once. Thus, in this paper, we will focus on the design of the mapping system and the mapping system can enlarge the image by a real scale. In the second procedure, image interpolation addresses the problem of generating a high resolution image from its low resolution version. Conventional linear interpolation schemes (e.g., bilinear and bicubic) based on space-invariant models fail to capture the fast evolving statistics around edges and annoying artifacts. Linear interpolation is generally preferred not for the performance but for computational simplicity. Many algorithms (Algazi, Ford, & Potharlanka, 1991; Carrato, Ramponi, & Marsi, 1996; Early & Long, 2001; Lee & Paik, 1993; Li & Orchard, 2001; Nguyen, Milanfar, & Golub, 2001) have been proposed to improve the subjective quality of the interpolated images by imposing more accurate models.

The magnifier is a perfect optics tool. It is easy to enlarge the resolution of images by a real scale. In this paper, a virtual magnifier is constructed and simulated. Using the virtual magnifier, the mapping between high resolution pixels and low resolution pixels is obtained. Further, a traditional interpolation algorithm (Gomes, Darsa, Costa, & Velho, 1999) is applied into the mapping of the high resolution image and low resolution image. Under three real images, experimental results demonstrate that the proposed algorithm has a high quality in the human visual system.

The remainder of this paper is organized as follows. In the next section, we describe the imaging model by using a magnifier. The proposed algorithm is then presented, followed by experimental results illustrated to demonstrate the advantages of the proposed algorithm. Finally, some conclusions are addressed.

IMAGING MODEL

In the optics, the trace of a ray of light is a straight line. When the ray passes through a medium, the rule of the refraction is followed by the Snell's Law (Jenkins & White, 1976; Meyer-Arendt, 1989; Pedrotti & Pedrotti, 1987) and the Snell's Law is defined below.

Law of Refraction (Snell's Law) (Pedrotti & Pedrotti, 1987): When a ray of light is refracted at an in θ_1 and θ_2 denote the incident angle and the refraction angle, respectively, n_1 and n_2 denote the two media with refractive indices. Figure 1 shows a ray of light passing from medium n_1 into a optically denser medium n_2, where *N* is a normal line. According to the Snell's Law, an object *M* with height *h* is located at the left side of the lens and passes through the lens, then the imaging object M'' with height h'' is formed on the right side of the lens (see Figure 2). In Figure 2, L_1 and L_2 denote the left spherical surface and the right spherical surface of the lens, respectively.

Image resolution enhancement refers to image processing algorithm which and θ_2 denote the angles of the incidence and refraction, respectively. Angles of the incidence and refraction are positive when the angle from the normal line to the ray must be rotated counterclockwise. φ_1 ($.\varphi_2.$) denotes the angle of the axis and the inci-

Figure 1. Refraction of light
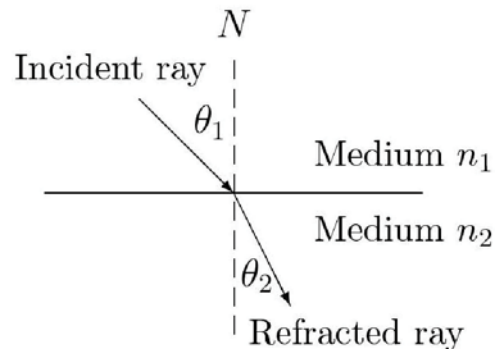
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