Interpolation of Images Based on Contour Line Representation

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By the development of the multimedia devices in recent years, opportunities for image processing on computers have increased very much. One of such processes is to magnify or to shrink images by an arbitrarily specified scale. The present main method has a problem that images are blurred, when the magnifying power is high. Therfore, we propose a method using the computationl geometric technique by the contour line expression of images.

A digital image is represented as a 2 dimensional array of intensity levels of the pixels on the square grid. When an image is magnified, the number of pixels increases. So we need to interpolate pixels. Interpolation method is roughly divided into two. One is the method using intensity levels of local pixels neighboring one to be interpolated. Bi-liner and bi-cubic methods are such ones. However, these methods have a problem that images are blurred. Another is the method to treat images as free curved surfaces or terrain maps. In this method, pixels are interpolated by using global character of an image. The interpolation based on contour line represntation used in this thesis is related to this method.

Intensity levels of pixels can be regarded as height at the corresponding locations. A contour line of an intensity level i is a boundary line between the domain in which an intensity level of each pixel contained is i or more and the domain in which it is smaller than i. By finding such contour lines, an image can be represented as a terrain map, and pixel interpolation finds to be global. In the traditional contour line representation, contour lines pass through the center of pixels. However, in this thesis, contour lines pass through between pixels. If contour lines pass through the center of pixels, the area of a region enclosed by a contour line may happen to be zero. And it causes a problem when the image is magnified.

Contours of an image consist of only horizonal and vertical segments. If they are magnified keeping their original shapes, straight lines can be jaggy lines and jaggy is visible in the result image. Therefore, it is needed to approximate contour lines smoothly. However, it is required to keep from self unintersection among approximate contour lines and preserve containment relation of the original contours because of the nature of contour lines. In this thesis, I propose a method for approximating a contour line by a spline curve which passes through a limited domain. In this method, approximate spline curve is obtained by solving the CHANNEL problem to obtain a path between two polygons.

It is hard to obtain a spline pass that is a solution to the CHANNEL problem. However, we can obtain it by using an envelope of spline curves. The envelope consists of two polygons, one above the spline curve and one below it. When the envelope stays between the input polygons, the spline curve also stays between them. To approximate a contour line, we solve the CHANNEL problem twice once for to the horizonal components and secondly for the vertical one.

We have implemented the above algorithm. First we have observed that when we approximated one contour line the resulting approximated curve was smooth. There were some vibrations, but we could improve them by changing parameters. We compared magnified images by proposal method with those by conventional ones. We have implemented nearest neighbor method, bi-linear method and bi-cubic method as the conventional methods. And magnified images are of gray scales. The resulting images were not so blurred, but there were stripe patterns. This is considerd to be because intensity levels were not approximated.

In this study, two problems are left to be solved. One is to approximate not only the shape of contour lines but the height, so that differences of intensity levels do not appear as stripe patterns. Another is to define areas where approximated contour lines stay, to keep its containment relation.