DETECTION OF SPECULARITIES IN COLOUR IMAGES USING LOCAL OPERATORS

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ABSTRACT

Areas of spectral reflectance, or highlights, can be analyzed for a wide range of information or clues that they give us about a scene. This paper presents a local algorithm for analyzing a moderately unconstrained color image to determine the areas of spectral reflectance. The algorithm is based on the separability of the diffuse and spectral reflection components by differential methods.

The location of specular reflectances are marked by finding zero-crossings in concave down regions for two-dimensional arrays of intensities representing the color image. These zero-crossings correspond to the centers of the highlight regions. The highlight centers are then expanded to highlight regions by region growing in a direction orthogonal to the local orientation of the highlight. Thus, at the conclusion of the algorithm, the information known about each highlight includes location, size and direction.

INTRODUCTION

Computer Vision is often perceived as something that should be trivial. The reason for this perception is that we are ourselves so good at vision, we take the whole process of vision for granted. In fact, the interpretation of our three dimensional world, as portrayed in a two dimensional array of intensities, is anything but trivial. While humans bring a vast amount of 'intrinsic' information to bear on the problem of image analysis, the computer does not have the capacity, at the current time, to perform the same feat. Therefore, to permit any useful analysis of an image whatsoever, we tend to limit, or constrain our image world such that analysis becomes feasible with respect to the limited amount of knowledge we can impart to the computer.

A particularly useful and efficient task that we practice every day, however unwittingly, is that of distinguishing between objects made from different materials. An important prerequisite for such perception is the ability to discern the quality of an object's appearance. Various qualities of appearance are apparent in the world around us, such as texture, color, shine, luster, etc. all of which give us important clues as to an object's composition. This paper will concern itself with the quality of surface gloss.

Glossiness, in general, is correlated with specular reflectance [Beck 72]. By looking at picture 1 we can easily determine which objects are shiny by the presence of areas of spectral reflectance.

Surface sheen, shine, gleam, etc. (see [Wyszecki 75] for a discussion of these terms) is a very important aspect in material discrimination. We regard metals as having a shiny appearance, whereas plastics, while they may have as smooth a finish, appear somewhat dull in comparison. Other surfaces may be altogether matte. These differences are caused by the presence, or absence, of local mirror-like or specular regions of reflected light, henceforth called highlights. If we can detect these highlights within an image, we can glean information that will help us to identify materials.

Some other consequences of finding highlights are that; (i) they would aid in constraining the size, color, and location of a light source; (ii) they would simplify object recognition or matching by identifying the regions so that some of the effects of the illumination could be 'factored out' and (iii) they also would enable constraints to be placed on object size and location [Thrift 82]. Perhaps a more basic or fundamental reason for wanting to locate highlights is that computer vision is concerned with modeling human vision, of which an inherent feature is the ability to locate highlights.

The detection of highlight regions proceeds by examining the stimuli that creates the sensation of a highlight. Horn's [Horn 75] model of surface reflectivity describes the two basic reflection components from a surface, specular and diffuse, as being separate quantities. Forbus [Forbus 77] used this information to generate a series of one dimensional profiles of intensity for curved surfaces, to see what parameters are relevant to the perception of highlights in archomatic images. Forbus noted that both the specular and diffuse reflection components must be present to create the sensation of a high light. Using this information, in conjunction with the expected sinusoidal shape of the specular reflection