

Chapter X

Colored Local Invariant Features for Distinct Object Description in Vision-Based Intelligent Systems

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Abstract

This chapter addresses the problem of combining color and geometric invariants for object description by proposing a novel colored invariant local feature descriptor. The proposed approach uses scale-space theory to detect the most geometrically robust features in a physical-based color invariant space. Building a geometrical invariant feature descriptor in a color invariant space grants the built descriptor the stability to both geometric and color variations. The comparison between the proposed colored local invariant features and gray-based local invariant features with respect to stability and distinction supports the potential of the proposed approach. The proposed approach is applicable in any vision-based intelligent system that requires object recognition / retrieval. At the end of this chapter, we present a case study of a local features-based camera planning platform for smart vision systems.

Introduction

Distinct object description is a common goal for most vision-based intelligent systems. Robotic vision, driver support systems, visual tracking, panoramic vision, camera self-calibration, and camera planning are few out of many examples of the applications and intelligent systems that need robust object description and recognition methodologies. However, object description and matching is not an easy task in the presence of variations in real imaging conditions. Several kinds of variations can affect the image of an object. These variations are categorized into two main types: geometric and photometric. The geometric variations include changes in translation, rotation, scaling, and affine and / or projective transformations, whereas the photometric variations include changes in illumination direction, illumination intensity, illumination color, and highlights. Therefore, the challenge for any approach to object description is to build a feature descriptor that is invariant to both the geometric and photometric changes simultaneously.

Color is valuable information in object description and matching tasks. Many objects can be misclassified if their color contents are ignored. Nevertheless, most of the existing approaches use gray geometric-based feature extractors. Contrastingly, color-based image retrieval approaches neglect the geometrical characteristics of objects. Combining both geometrical and color information in object description has been growing rapidly. In most cases, the approaches that combine color and geometric contents are stronger either at one of the geometry side or the color side.

In this chapter, we address the problem of distinct description of objects using local invariant features. Particularly, we focus on embedding the color information in traditional geometrical feature descriptors and its impact on the performance of different types of vision-based intelligent systems.

Problem Statement and Chapter Overview

The problem of object description can be looked at as a transformation between two spaces. The first space is the object image, either gray or color, where the object is represented as a 2D signal. The other space is the feature space in which the object is represented by a reduced vector representation whose length varies depending on the feature extraction approach used.

In contrast to the image space, the object representation in the feature space should not be affected by the variations of the imaging conditions. In other words, for perfect object description, the multiple representations of the object in the image space, under different imaging conditions, should be mapped to a unique representation in the feature space. This condition is called “feature invariance.” Feature invariance represents the biggest challenge for any object description approach.

In the background section of this chapter, we review some of the existing approaches in feature extraction. In sections “Geometrical Invariant Features” and “Photometric Invariance”, we explain well-known approaches for geometrical and photometrical / color invariant techniques, respectively. In these two sections, we highlight the advantages and

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