

Robust and Efficient Object Recognition for a Humanoid Soccer Robot

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Abstract. Static color classification as a first processing step of an object recognition system is still the de facto standard in the RoboCup Standard Platform League (SPL). Despite its efficiency, this approach lacks robustness with regard to changing illumination. We propose a new object recognition system where objects are found based on *color similarities*. Our experiments with line, goal, and ball recognition show that the new system is real-time capable on a contemporary NAO (version 3.2 and above). We show that the detection rate is comparable to color-table-based object recognition under static lighting conditions and substantially better under changing illumination.

1 Introduction

Color-based recognition of geometrically simple objects is a well known problem that has been extensively studied for over two decades [18,5]. Prominent examples for successful image processing methods are edge detection [2,10], region-growth algorithms [21,8], and histogram-based algorithms [12,19,14]. A popular approach is based on edge detection and subsequent Hough transformation [4] in which the authors show a method for line detection that can be used for more general curve fitting. Although the literature shows a broad range of variations and implementations of the mentioned approaches, only a few can be used for embedded systems that are constrained by limited resources such as time, memory, and/or CPU power.

The RoboCup Soccer environment demands efficient real-time object recognition. Many systems are still based on fixed color tables that are similar or based on the *CMVision* system [1]. It is well suited for static lighting conditions but lacks robustness when illumination varies. Röfer [15] improved the robustness by introducing ambiguous color classes and delaying hard decisions to a later processing stage. Reinhardt [14] uses different heuristics applied to color histograms to cope with variations in illumination.

We propose a new object recognition system where objects are found based on *color similarities*. As a first step, a subsampling is created considering the