TECHNICAL UNIVERSITY OF CRETE

# Efficient Color Recognition Under Varying Illumination Conditions For Robotic Soccer

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*"The more you know, the more you realize you know nothing."*

Socrates

# *Abstract*

**Visual perception is a central problem in robotics because of the richness of information in color images, but also because of the difficulty in coping with image variations due to illumination conditions. In the RoboCup competition (Robot Soccer World Cup), where robots act autonomously using mainly visual cues, the objects of interest are characterised by unique colors and their recognition relies on the correct identification of image areas corresponding to the same color. This thesis addresses the problem of color recognition under varying illumination, namely the classification of any image pixel to the correct color class of the corresponding object, even when illumination conditions vary. The proposed approach is based on labelling by hand a representative set of images from the robot camera and training a classifier which generalises over the entire color space. The illumination problem is addressed either by including special illuminant features (average color values from a large region or from the entire image) in the classifier, or by transforming the input to an appropriate reference illumination level through histogram specification before classification. These procedures have been integrated into the Kouretes Color Classifier ($KC^2$) graphical tool, which provides intuitive means for labelling images (regions, clusters), selecting features (neighbourhood, illuminant), training classifiers (Decision Trees, Support Vector Machines, Neural Networks), and generating code for efficient execution on the robot. The $KC^2$ tool minimises the user time required and delivers excellent color classifiers using only a few images. The proposed method has been tested successfully on the Sony AIBO and the Aldebaran Nao robots and can be used in a wide range of applications beyond RoboCup.**

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