Face Detection Based on Skin Color Modeling and Modified Hausdorff Distance

Table of contents

ABSTRACT

This paper presents a new face detection approach which is capable of detecting human faces from complex backgrounds. A new skin color modeling process is applied to the face segmentation process. Image enhancement is then used to improve the features of face candidates before feeding to the face object classifier which is based on a modified Hausdorff distance. The overall performance of the face detection system is evaluated and achieved a success rate of 87.5 %.

INTRODUCTION

Face detection is a necessary first step in face recognition systems with the purpose of localizing and extracting the face region from the background. The human face is a dynamic object and displays a high degree of variability in appearance. In real life situations, different illumination, distance from the imaging device, occlusion, and rotation of the head in different planes are bound to happen, which poses a significant challenge to face detection. Most systems assume a specific orientation of the face such as frontal or near frontal face orientation to simplify the problem [1]-[3].

Face detection techniques can be classified into two schools: (i) image based techniques and (ii) feature based techniques. Image based techniques address face detection as a general recognition problem whereby pattern recognition is applied to the whole image. The face knowledge is therefore implicit to the users and mapping and training schemes are utilized to achieve what is known as recognition. Feature-based techniques build in explicit knowledge where features representing face as defined by the designer are first extracted from images [4]. Face detection is thus achieved by verifying that a certain degree of confidence that features extracted from images represent a face.

Color analysis on images has long been used as a technique which can give additional dimension to image compared to grey scale image. Classification is easier to handle in color space compared to gray scale. It is a known fact that the skin color of different races tend to cluster in close proximity in the normalized color space or chromaticity space. Using this skin color model, a skin candidate region is identified based on certain threshold value. Image matching methods can be well used to find correspondence between a template and given portion of an image having the most partial similarity [5].

Skin color has long been used for detecting skin color region and even in head detection system for searching head region. The major problem with using skin color model however is that it is subject to variation in illumination and hence not robust enough in detecting head candidate. One more prominent problem is that most of the time, object which appears to have skin color is not necessarily the human face, worse, it may not even be part of the human skin. It is therefore impossible to rely solely on skin color alone as an effective face detection strategy.

The use of variants of the Hausdorff distance has recently become more and more popular in image matching applications [5]. It has the advantage of being scale invariant, illumination invariant and robust in complex background. The Hausdorff distance is a robust technique used in image matching problem [6]. Traditionally, it

has always been used in gray scale image to locate image candidate which is a closest match to an object. In order to search for the possible image candidate, the system generally needs to scan through the whole image until it reaches the targeted candidate. As the image size grows, so does the computing power needed to locate the image candidate. It is therefore believed that using skin color filter along with Hausdorff distance will target the shortcomings of both these strategies. Skin color filter will help identify the image candidate so that Hausdorff distance will be able conserve computing power on the image candidate while Hausdorff distance will verify the validity of the image candidate which is not possible by using skin color filter alone.

In this paper we present a framework based on feature-based approaches where low level features are derived prior to knowledge-based analysis. In this instance, color information is used as the low level features to differentiate between face candidate and non face candidate where face candidate comprises human skin color pixels. A second low level feature which is the edges of the face candidate region and any facial features it may contain are then used. The last step of this approach is generalized measure analysis where distance between face candidate region and face template is calculated to decide if the face candidate region is really a face. The classical Hausdorff distance is simple, but it is sensitive to degradation, such as noise and occlusions. Therefore, a modified Hausdorff distance which is more robust to degradation is used instead. Modified Hausdorff distance [7] between the edges of face candidate region and that of the face template is calculated. The face candidate region is then considered a face if the modified Hausdorff distance measure is smaller than a threshold value predetermined.