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Automatic Indexing of Consumer Image Collections using Person Recognition Techniques

Peter Corcoran, Gabriel Costache and Rhys Mulryan
Dept. of Electronic Engineering, NUI Galway, Ireland.

***Abstract*--An evaluation of person recognition technologies for use in an automatic cataloging tool for consumer image collections is presented. Prototype implementations of the automatic cataloging tool and user search tools are described. A preliminary statistical analysis of the success rate of these tools is given.**

I. INTRODUCTION

Digital cameras continue to be one of the CE industry's recent success stories. However as users switch from conventional to digital photography they find themselves with rapidly growing collections of digital images. Few consumers have the time and personal discipline to manually catalog and organize their personal image collections. In this paper we present an evaluation of current state of-the art "person-recognition" technologies which allow us to build an automatic cataloging tool for consumer image collections.

The technologies assessed include face detection, face recognition, face region normalization and a number of color and texture-based analysis tools which allow a persons clothing, hair and other distinctive features to be incorporated into our image cataloging tool. We remark that the main system architecture is designed to support the cataloging of images within a digital camera as they are actually captured.

II. SYSTEM DESCRIPTION

The goal of our cataloging tool is to automatically analyze an image collection thus facilitating the sorting and retrieval of image associated with a specified person in a large collection of images. One of the principle challenges in implementing a workable cataloging system is the ad-hoc nature of consumer images. For example the quality of identified face regions is often poor and unsuitable for conventional face recognition techniques. Our approach is to incorporate additional techniques for analyzing the detected face regions and peripheral regions associated with them. This provides information related to a person's clothing, hairstyle, and appearance. Thus images can be more accuratedly sorted and browsed. The image processing techniques reviewed include:

A. Face Detection

The most important object in person tracking in an image collection is the face of the person. We evaluate a number of automatice face detection techniques, explaining some of the problems which can occur in consumer image collections due to the variable quality of images. However we have found that the latest detection algorithms are quite robust and accurate provided they are used correctly.

B. Face Normalization

After a face region is detected it is generally necessary to try and align and/or resize the region so that it can be subsequently analyzed by standard face recognition tools.

C. Face Recognition

As we are generally restricted to relatively small subsets of people in a consumer image collection standard recognition algorithms can be employed with a high degree of success. Evaluations are presented of PCA *(principle component analysis)*, ICA *(independent component analysis)*, DCT and wavelet based techniques [2, 3, 4].

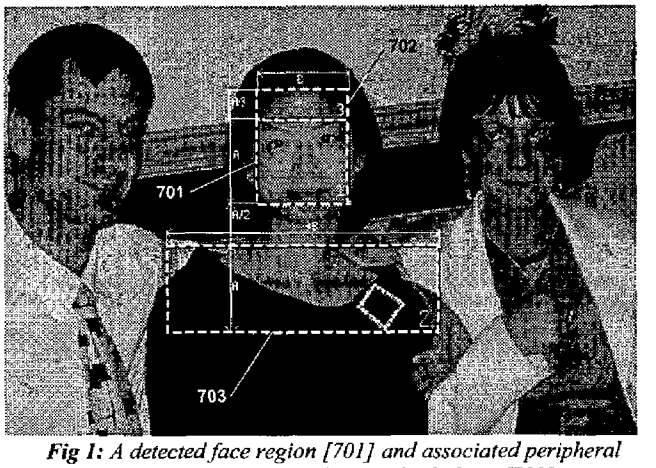

***Fig 1:** A detected face region [701] and associated peripheral regions for hair [702] and top-body clothing [703]*

D. Clothing Color & Texture Analysis

When browsing for person in a collection of images usually we want to find the person in a specific context, e.g. holiday photos , special events, public appearances, etc). Typically a person will wear the same clothing & hairstyle on a particular occasion. Thus image sorting can be improved by identifying particular ites of clothing & jewellery. Note too, that the color and texture of clothing is less influenced by light, focus or position than are the results of applying face recognition.

E. Hairstyle Color & Texture Analysis

A color & texture analysis of the hairstyle of a person can further enhance the sorting and retrieval of images. We further remark that the border region between the face and hair regions is more useful for differentiating between people than the bulk texture and color of a person's hair on its own.

Fig 1 illustrates the determined face region *[701]*, and its associated peripheral regions [702, 703] as used by the *main image analysis* module which we shall describe shortly.

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III. SYSTEM ARCHITECTURE

This is described in the subsections below and illustrated in ***Fig 2***.

A. Training Module

Before the image sorting & retrieval module can perform its main functionality it is first necessary to initiate a training process on an image collection. To simplify certain implementation aspects we assume that an image collection is a set of images contained within a subdirectory of the file system on a desktop PC. when a user switches into a subdirectory containing images our application loads a data file relating to this image collection and determines: (i) if it was previously trained are there images which have not yet contributed to the training process, and (ii) if the number of such unutilized images indicateds that an incremental training process should be initiated. Alternatively, if this image collection data file does not exist the application assumes that this image collection is "untrained" and will automatically initiate a full training process.

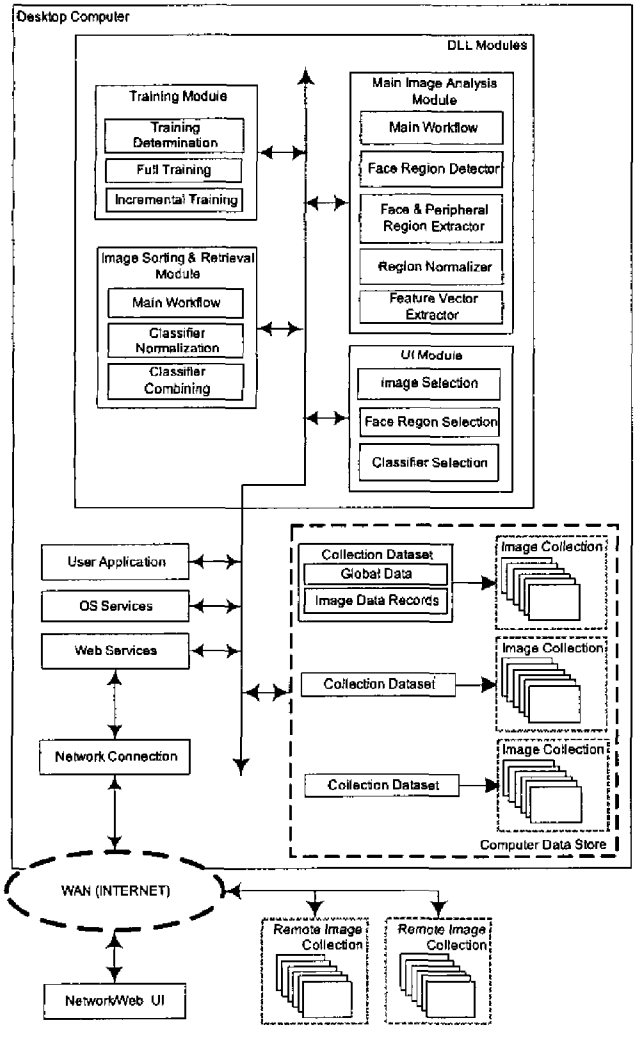

Fig 2: *Main System Architecture.*

B. Image Sorting & Retrieval Module

This module calls the *User Interface* module which allows a user to browse images in the current image collection. Once a user has selected a suitable master image the main workflowwill determine if there are marked face regions, or if an image was not previously marked it may decide to call the main image analysis module to search for face regions. The user then selects one, or more, face regions and selects the search mode, or classifiers to be used for this search.

C. Main Image Analysis Module

This module, hereafter referred to as the *main image analysis module* is used in both training and sorting/retrieval modes of the main system. It handles the actual process of cycling through a set of images and determining, extracting, normalizing and analyzing face regions and associated peripheral regions.

It is called from a higher level workflow and, in its normal mode of usage, is passed a set of images which must be analyzed. Where at least one face region is detected this module next extracts and normalizes each detected face region and, where possible, any associated peripheral regions. Finally it determines feature vector sets for a plurality of face and non-face classifiers and records this extracted information in an image dataset record.

D. UI Module

This module handels *user interface* aspects of the system. It is designed to be suitable for in-camera applications.

E. Image Collection Data

Data from an image collection is written into a main dataset which includes (i) global data relating to the image collection; (ii) a list of image data records associated with the analyzed data obtained from each image. These image data records further contain data relating to the extracted face & peripheral regions detected in each image and the feature vector data extracted from from each region.

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