In: Hammwöhner, Rainer; Wolff, Christian; Womser-Hacker, Christa (Hg.): Information und Mobilität, Optimierung und Vermeidung von Mobilität durch Information. Proceedings des 8. Internationalen Symposiums für Informationswissenschaft (ISI 2002), Regensburg, 8. – 11. Oktober 2002. Konstanz: UVK Verlagsgesellschaft mbH, 2002. S. 79 – 83

Object Segmentation Using Colour for Security Applications on Mobile Devices

Maurice Danaher, Lennon Hopkins

Edith Cowan University
Perth, Western Australia 6050
m.danaher@ecu.edu.au, l.hopkins@ecu.edu.au

Abstract
This paper presents research-in-progress on a colour based method of object segmentation for use in biometric security methods on mobile devices. The limited processing capability of mobile devices has restricted the computational complexity of security algorithms that can be used. The purpose of our system is to use a colour based method to reduce the amount of information that must be processed by biometric algorithms. This is accomplished by creating a mug shot of a target individual from an image with an unknown background and unknown target/camera positions. Specific security algorithms can then be applied to the generated mug shot. An overall reduction in data processing will allow more efficient biometric security measures to be implemented.

1 Introduction

Our work is concerned with the development of a security application for preventing unauthorised access to mobile devices. We are researching an image recognition approach that uses colour to segment the image. Current methods of biometrics such as facial detection/recognition are based heavily on facial geometry and edge detection. Despite the accuracy of these methods, the amount of computational resources required for processing is still too great for mobile devices to process efficiently. In comparison to shape-based biometric methods, it has been suggested that colour be used as a method of identifying and segmenting possible target locations as it is far less computationally intensive [Wu et al 00]. Based on previous experimentation by researchers in the field of computer vision and image processing, the consensus

on colour-based methods of recognition is stated by Gonzalez and Woods (2002) “Colour is a powerful descriptor that often simplifies object identification and extraction from a scene.”

In this work a reduction in processing requirements is accomplished by restricting the area of the image on which computationally intensive processes, such as shape/edge based recognition algorithms, are applied. Current methods of facial/feature recognition are based on algorithms that make use of geometric shapes and must be applied to the entire image. The use of colour as a segmentation method has been based on the assumption that a “discontinuity in colour between two regions of an image implies different surfaces” [Maxwell 00).

2 Method

A mug shot is an image of a target object with controlled scale, lighting and background (which is usually a constant colour) [Bichsel & Pentland 94]. Control of these variables is not always possible in the natural environment. Our system generates a mug shot from an image with unknown camera/target positions and unknown lighting conditions. Biometric algorithms are then used to process the generated mug shots.

A region-growing algorithm is applied to the acquired image to determine which area(s) can be defined as skin colour. The image is then segmented according to the areas defined by the region-growing algorithm. These segments are then analysed to determine if holes exist. The holes correspond to the location of the eyes. These segments are then weighted according to their location from the centre of the image and output individually.

A number of system parameters must be set prior to image analysis. These parameters include setting the colour range that is defined as skin tone colours, the number of initial seed pixels to be used by the region-growing algorithm and the boundary parameters used for region segmentation. The parameter determining the number of initial seed pixels provides the foundation of the region-growing algorithm. Currently, experimentation with the number of pixel seeds is being conducted to determine the optimal number of seed values. If the seed value is too high the amount of overall processing required increases. Inversely, if the seed value is too low, the accuracy of the system decreases.

The colour threshold parameter determines the variance of pixels surrounding the seed pixels. This parameter has a significant impact on the performance of the region-growing algorithm. If the colour threshold parameter is too low, larger regions will be segmented increasing the processing required. Conversely, if the colour threshold value is too high, smaller (possibly incomplete) regions will be segmented and the accuracy of additional recognition/detection algorithms will decrease.

Following is a simplified version of the method that is used by our system (Figure 1):

1- A target image is acquired using a web camera at a high resolution (1024 x 768). Images can also be acquired using a digital camera.
2- Using a colour-based region-growing algorithm, the image is processed to determine which area of the image contains possible locations of a human head. A number of seed pixels are used to determine the colour regions.
3- Once the colour regions are determined and the extremity of the regions established, a border is defined to accommodate hair. The border is then used to segment the regions for further image processing.
4- To reduce the number of false positives identified by our system, an algorithm is applied that determines if there are holes within a colour region. If the system detects two holes in a single colour region (corresponding to the location of the eyes) the segment is designated as a potential head image. This is done as follows. An average colour for the segmented image is calculated. The colours of the pixels are compared to the average colour of the segment. If the colour deviance from the average is greater than a threshold value it is defined as a hole pixel. A ratio, based on the size of the segment, is calculated to determine the number of adjacent hole pixels that must be present in a segment. If the number of adjacent hole pixels is greater than or equal to the ratio value then the segment is defined as a potential head segment.
5- The potential head segments are weighted according to the distance they are located from the center of the image (it is assumed that the target is near the center of the image).
6- The head segments are then output as mug shots or passed on to other algorithms for facial/feature detection according to the weightings they have been assigned.

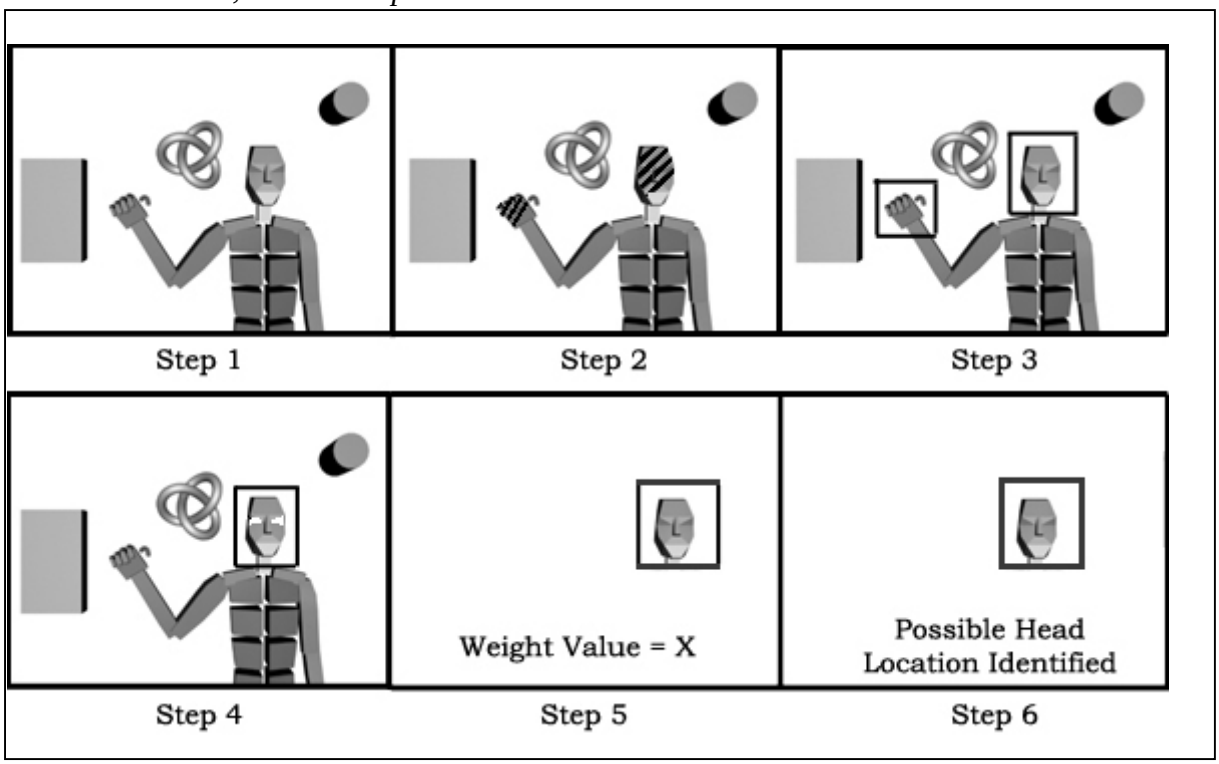

Figure 1: Graphical representation of the developed system.

3 Future Work

Preliminary experimentation with our system has revealed a number of flaws in the identification of potential head locations. The majority of flaws observed in our system are associated with background objects in the image and the parameters associated with them including colour threshold values and boundary values. Coloured illumination has also presented a problem for our system where non-skin coloured objects are illuminated with coloured lighting and exhibit colouring similar to skin tones. Our system has been developed with the assumption that the acquired images are taken with natural or white lighting.

The value of the colour variance threshold that is used by the region-growing algorithm becomes problematic if the background of the target is also skin-tone coloured or if it contains skin-tone coloured objects. Currently our system will identify an object of skin tone colour that contains holes regardless of the positioning of the identified holes. Further tests and experimentation with our system will include:

- Varying the range of colours that have been defined to be skin tone to reduce the number of false positives detected.

- Modifying the number of initial seed pixels to determine the optimum number required for maximum accuracy while keeping computation to a minimum.
- Modifying the algorithm for hole detection in a single colour region to prevent further processing of false positives e.g. if holes are aligned vertically disregard colour segment.
- Increasing the borders of the located target to prevent cropping an incomplete head region.
- Experimenting with the resolution of the initial image to minimize associated data processing.
- Experimenting with the threshold values of the average colour deviance within a segment.
- Experimenting with the ratio used to define the number of pixels that are part of a hole.

In conclusion the system we are developing supports the use of colour as its primary method of image segmentation. This approach may allow a greater variety of security applications, particularly methods based on biometric security, to be implemented on mobile devices.

4 References

[Wu et al 00] Wu, Y. et al. "An Adaptive Self-Organizing Color Segmentation Algorithm with Application to Robust Real-Time Human Hand Localization", Intl. Proc. Asian Conf. On Computer Vision, 2000, Taiwan.

[Gonzalez & Woods 02] Gonzalez, R.C. and R.E. Woods, Digital Image Processing, 2002, New Jersey: Prentice-Hall Inc.

[Bichsel & Pentland 94] Bichsel, M. and A.P. Pentland, "Human Face Recognition and the Face Image Set's Topology", Image Understanding, 1994, 59(2): p. 254 - 261.

[Maxwell 00] Maxwell, B.A., "Segmentation And Interpretation Of Multicolored Objects With Highlights". Computer Vision And Image Understanding, 2000, 77: p. 1 - 24.