Image Segmentation Using Colour

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Abstract: *This paper presents research-in-progress using colour as a means of image 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 effective biometric security measures to be implemented.*

Key words: *Mobile devices, security, algorithms.*

INTRODUCTION

Mobile technology has provided numerous advantages to the information technology industry. These advantages include greater communication abilities and a physically dynamic workplace environment. The portable nature of mobile technology can also be considered to be one of its drawbacks. Problems associated with the portability of mobile technology are theft and unauthorized access of the stolen devices.

A proposed security solution is biometric based methods. 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 resources required for efficient processing on mobile devices is still too great.

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 [1]. Based on previous experimentation by researchers in the field of computer vision and image processing, the consensus on colour-based methods of recognition is provided by Gonzalez and Woods [2] "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. By reducing computation required by visual biometric methods further developments in mobile security using biometric methods can be made.

BACKGROUND

The purpose of the system we have developed is to reduce overall time, storage and computation costs associated with facial/feature detection algorithms. Current methods of facial/feature recognition are based on algorithms that make use of geometric shapes and must be applied to the entire image.

By using colour-based methods to reduce the image area on which recognition algorithms are applied less computational resources are required [3]. 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) [4]. In the natural environment, a discontinuity between colours does not always imply a discontinuity between surfaces. The system we have developed is based on the assumption of colour continuity. Research conducted by Maxwell [4] specifically addresses the issues of colour and surface discontinuity.

Wu et al [3] in previous experimentation with human skin colour concluded that "there is a large variation of skin colour for different people" [1]. Similarly Zarit et al [5] conclude that "skin tones vary dramatically within and across individuals". Based on our preliminary experimentation, the range of skin colours for different people has been constrained to a

very small range of available colours.

IMPLEMENTATION

A mug shot is an image of a target object with controlled scale, lighting and background (usually a constant colour) [6]. Control of these variables is not always possible in the natural environment and our system attempts to replicate a 'mug shot' with unknown camera/target positions and lighting conditions. Biometric algorithms can then be 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 first parameter(s) is directly related to the range of colours that are defined as skin tone colours. It is possible at this stage to define the colours that are to be identified as colours other than skin tone. The system will then attempt to find colour regions matching the parameters in the target image [7].

The parameter determining the number of initial seed pixels must also be set. This value 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 will increase. Inversely, if the seed value is too low, the accuracy of the system will decrease.

The colour threshold parameter that determines the variance of pixels surrounding the seed pixel(s) must be set. 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 [2]. 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.

The following is a simplified version of the algorithm that is used by the system (Figure 1):

1. A target image is acquired using a web camera at a high resolution (1024 x 768). Similar images can 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.
3. The extremity of the identified colour regions is established and 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.
5. The potential head segments are weighted according to the distance they are located from the centre of the image (it is generally assumed that the target is near the centre of the image).
6. The head segments are then output or passed on to other algorithms that specialize in facial/feature detection according to the weightings they have been assigned.

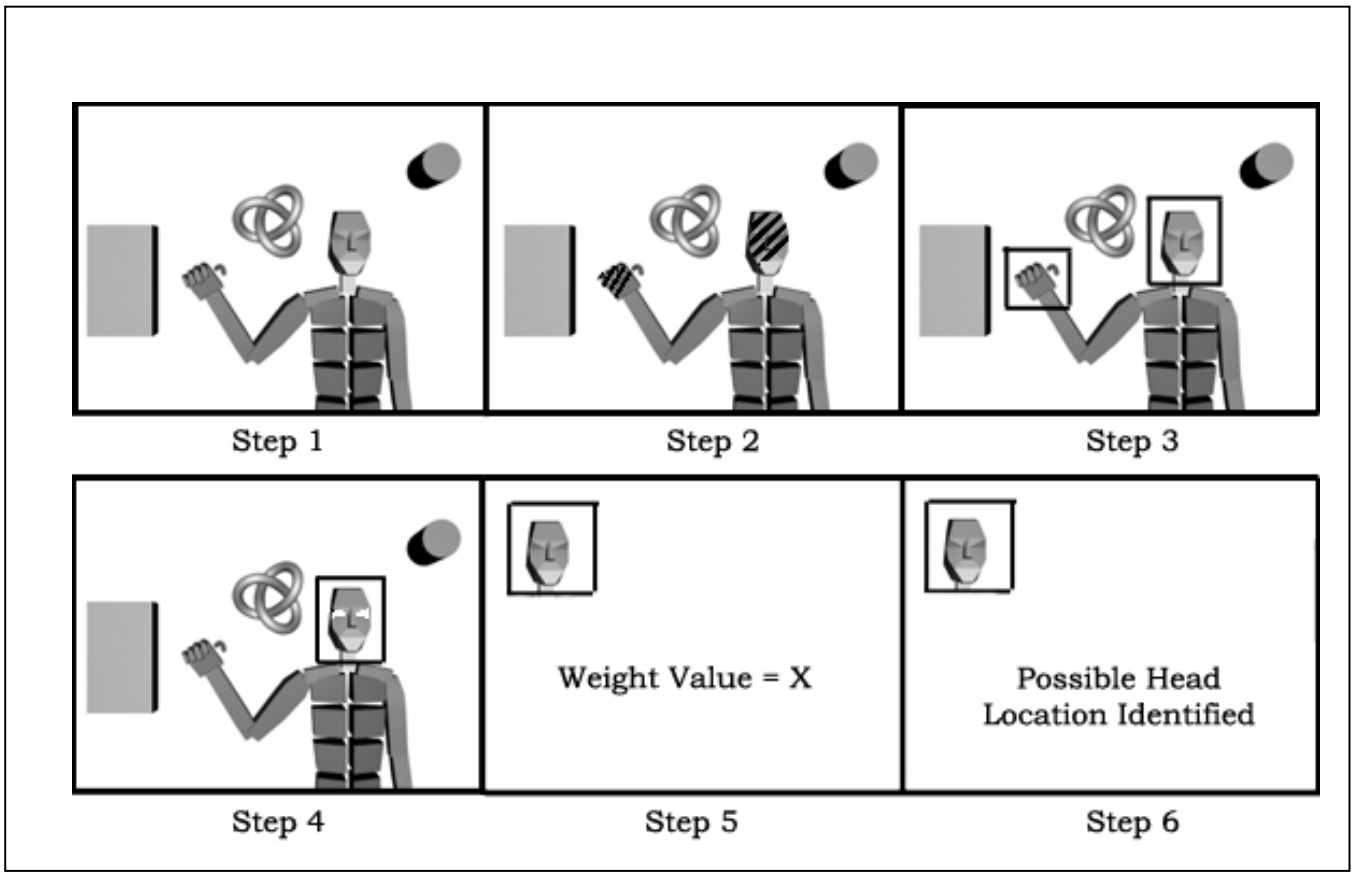

Figure 1 – Graphical representation of the system

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 is 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. Research conducted by Maxwell (2000) [4] specifically addresses the issue of coloured illumination and colour continuity.

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:

(1) Restricting the range of colours that have been defined to be skin tone to reduce the number of false positives detected.

(2) Modifying the number of initial seed pixels to determine the optimum number required for maximum accuracy while keeping computation to a minimum.

(3) Modifying the algorithm for 'hole' detection in a single colour region to prevent further processing of false positives i.e. if 'holes' are aligned vertically disregard colour segment.

(4) Increasing the borders of the potentially located target to prevent cropping an incomplete head region.

Experimenting with the resolution of the initial image in an attempt to minimize associated data processing

CONCLUSIONS

The system we have developed supports the use of colour as its primary method of image segmentation. The usage of colour can reduce the overall processing required in biometric security methods. The reduction in processing will allow a greater variety of security applications, particularly methods based on biometric security, to be implemented on mobile devices.

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