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A Novel Interactive Biometric Passport Photograph Alignment System

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Abstract. A novel framework for interactively acquiring images is developed in which uses real-time visual and audio cues to assist in guiding the user into correct alignment for compliance with European biometric passport regulations. Users pose in front of a camera using visual feedback from a monitor to approximately position themselves prior to an iris detection scheme used to calculate their roll (z-axis) alignment. Audio instructions are then provided to refine the posture. Blink detection is also used to ascertain the user's readiness to having their passport image taken.

1 Introduction

One of the stumbling blocks of Face Recognition (FR) is the issue of misalignment. Many approaches have been taken towards minimizing its effects on FR from acquired images. The approach taken here is to minimize the amount of misalignment error as part of the acquisition process itself by creating software that interactively guides the subject into the optimal position to acquire a normalized image.

The ISO/IEC 19794-5 standard's second corrigendum [1] and the British Home Office's Guide for Professional Photographers [2] were used as handbooks to creating a software interface for acquiring biometric passport compliant images.

The main aims of this project were to create an accurate iris detection algorithm which could be used to detect the user's roll (z-axis) alignment, a blink detection method which would be used to receive feedback from the user and an intuitive interface similar to a passport photograph booth which would guide the user's alignment through audio and visual cues.

The following sections explain the system in more detail. Section 2 covers the Graphical User Interface itself. Sections 3 and 4 give details of the algorithms used for Roll Alignment Calculation and Blink Detection respectively. The test methodology and results obtained are explored in Section 5 and finally Section 6 contains some conclusions and thoughts on further work.

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2 The User Interface

On execution the software would initialize, display the user interface and remain idle until the Start button was pushed. It would then give the user a brief tutorial as shown in Fig. 1.

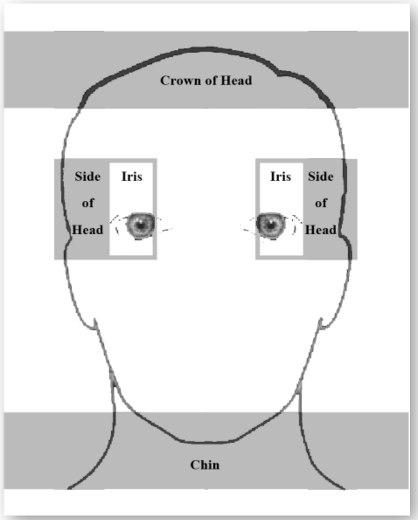

Fig. 1: Tutorial: The user was given clear instructions on how to position their head within the blue guides and their irides within the outlined boxes.

It would then assess their roll alignment. If the user was aligned and a blink was detected it would display their selected image and ask if they would like to print the photograph or continue with the alignment process.

On the other hand if their alignment was off by ±8° [1] then they would be instructed to "Tilt Left" or "Tilt Right" as required. Fig. 2 shows the basic behaviour of the software.

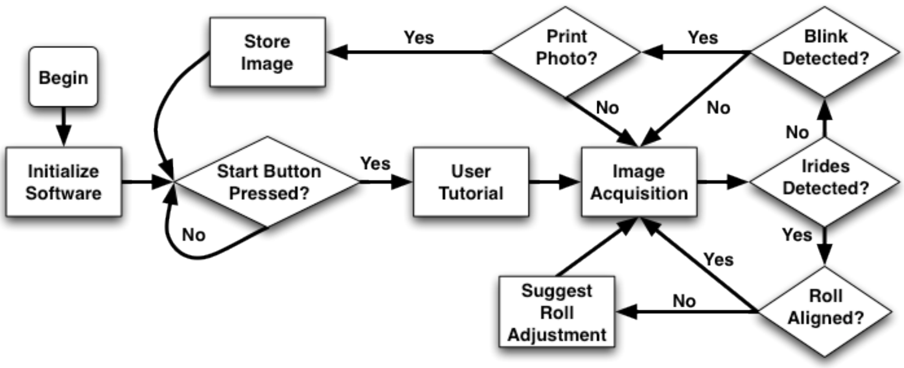

Fig. 2: GUI Flowchart: An overview of the entire system.

3 Roll Alignment and Iris Detection

3.1 Roll Alignment

The roll angle of the user's face was determined by measuring the inclination of the BB line which is the line intersecting the centres of the eyes [1]. If the BB line was over ±8°, a suggestion was given to the user to adjust their pose. The flowchart in Fig. 3 shows the processes involved.

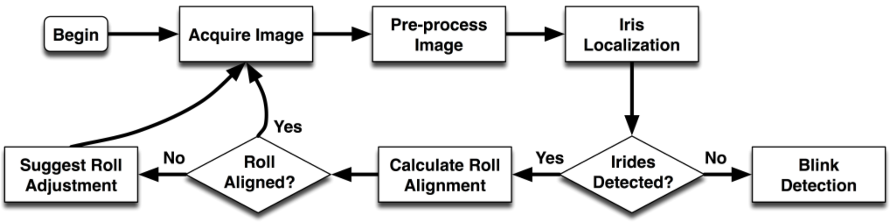

Fig. 3: Roll Alignment Flowchart.

The images were acquired from the webcam in RGB space using the Image Acquisition Toolbox for MATLAB® before being converted to the Value channel of HSV (Hue, Saturation, Value) space.

3.2 Iris Detection

A wealth of study has been done on iris detection for many different reasons from face tracking [3], to personal identification and security [4-6], to monitoring driver fatigue [7], to human-computer interfacing [8].

In this system functions developed by Peter Kovesi [9] were used to pre-process the images before localization. These consisted of Edge Detection [10-12] weighted for vertical edges, Gamma Adjustment, Non-Maxima Suppression and Hysteresis Thresholding. This left only the vertical limbus edges on which an Adaptive Hough Transform [12-16] was applied to detect the iris centres and radii.

4 Blink Detection

IR often overlaps with studies on blink detection [18-19] and blink detection itself is often used as a means of human-computer interaction [18-20]. So it is hardly surprising that there are a number of different approaches that could be taken [21-24]. The method chosen for this implementation was Frame Differencing [20,25]. See Fig. 4 for details. This is a very common technique which, due to its speed, is often used in combination with other techniques as a first stage approximation. Here the eye regions and iris locations are already known and this data could be reused to confirm the frame differencing results.

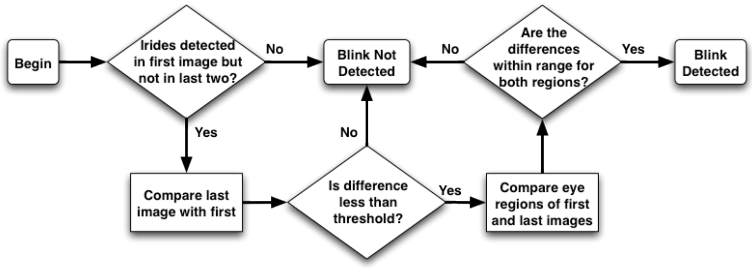

Fig. 4: Blink Detection Flowchart.

5 Test Methodology and Experimental Results

The following results were collated from data obtained from five participants during two sessions. Over one hundred images were stored from each participant.

5.1 Iris Detection Results

To test iris detection ten images were chosen randomly from each participant, ensuring that at least one each of roll angles > 8° and < -8° were selected. This gave a total of fifty iris pairs.

The results are shown in Fig. 5. More than 92% of the irides' radii were found within 1 pixel of their true radius, 83% of the irides' centres were found within 1 pixel of their true centre on the y-axis and 93% within 1 pixel on the x-axis.

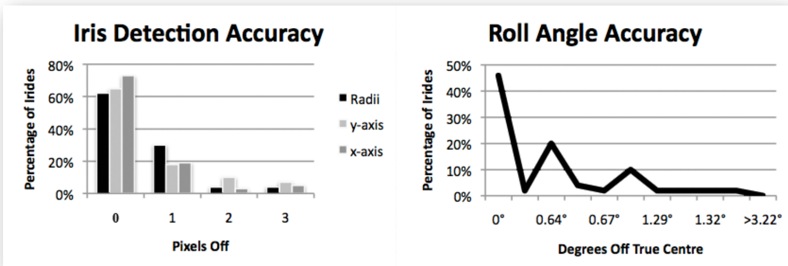

Fig. 5: Iris Detection Results: Over 80% of irides were found within 1 pixel of their true centre and 86% of iris pairs were within 1.3° of their true roll alignment.

5.2 Blink Detection Results

For the blink detection tests a complete set of images from three participants was used. The results are shown in Fig. 6. In the blink category, blink sequences correctly classified totaled 93.75% and those that went undetected totaled 6.25%. 97% of the data was in the non-blink category. 99.06% of these were classified correctly as non-blink sequences and a further 0.94% were classified as blink sequences.

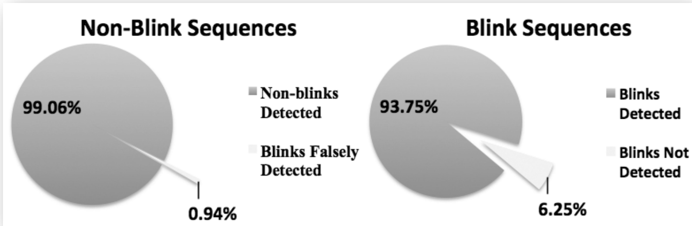

Fig. 6: Blink Detection Results: Almost 94% of blinks were detected and over 99% of non-blinks were detected.

6 Conclusion

An intuitive framework was developed which interactively supported the user in capturing a biometric passport image through audio and visual feedback. The system assessed the user's roll alignment while giving visual guidance for head position. Test results show the system to be quite accurate.

The next step would be to assess the user's pitch (lateral axis) and yaw (vertical axis) alignment. Other improvements worth considering would be to assess the user's facial expression and distance from the camera.

Much of the false detection and inaccurate segmentation of the irides was caused by poor quality images. Motion blur and specular/diffuse reflections were particularly common. This has led to the work now being done on image quality assessment and adaptive feature extraction as part of the Nomad Biometric Authentication project (NOBA). NOBA is an international collaborative project whose goal is to produce an iris recognition system for mobile devices. In such circumstance image quality is generally poor. Noise detection and categorization using neural networks may help to improve the reliability of such systems. Not only by improving segmentation and removing non-iris data but by allowing intelligent selection of features for matching.

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