IRIS IMAGE SEGMENTATION BASED ON INDUSTRIAL VISION TOOLS

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Abstract: In the last few years biometric data acquisition and processing systems for person identity verification and / or identification started to be increasingly used. This is done both in military applications for person identification in military operations and war theatres, but also in civilian applications for personal identity verification, accounting systems, etc. Depending on the organization policy, such systems must be secured and customized, for application enhancement, and to fulfil the organization requirements. Such systems which allow customization and enhancement are not available for source code modification and feature enhancement. This paper presents a software image processing development environment IPDE based on vision tools, which is able to run vision projects but also allow the user to develop stand alone applications in a short amount of time, applications which are based on customized vision tools. The IPDE is used to exemplify the process of creating an iris recognition application where a set of vision tools were used in order develop a customized iris image segmentation routine. The paper is structured on three chapters presenting the IPDE architecture, the vision tools, the application development stages, and ends with some experimental data and conclusions.

1 INTRODUCTION

In the last years, the identification and verification of the identity of persons has become an increasingly important factor (Zhai, 2009; Patnala, 2009; Araghi, 2010; Matschitsch, 2008). A special place is held by systems for person identity verification / identification based on the iris, which were accepted and used especially in military applications (L-1 Identity Solutions Inc., 2010).

The biggest advantage of using the iris as a biometric verification and recognition method is the accuracy and reliability (Daugman, 2004) estimated to be ten times more accurate than methods using fingerprint, iris-based methods produce a false match rate (or false acceptance rate – FAR) of 1/1-2 million samples, while fingerprint-based methods produce a false match rate close to 1/100000 samples (Cao, 2005; Ganeshan, 2006;). Due to this aspect some countries have initiated the procedures to integrate the iris biometric data into the population identification cards.

While fingerprints are constantly exposed and are likely to deteriorate, the iris is naturally protected by the cornea (a transparent membrane covering the eye) and its model seems to remain unchanged for decades, being only affected by some eye diseases which are more frequently found to elders, population which is less probable to be involved in such identification process.

Unlike fingerprint scanners, which require direct contact and must be kept extremely clean, iris scan can perform safely and hygiene at some distance from the eye. Disadvantages include the iris scanning higher initial cost (few thousands of dollars) and the fact that it is still a relatively new technology that has not been tested enough.

Also to implement this technology some organizations require special software products developed "in the house". In order to do this in the shortest time, an IPDE which allow rapid application development is needed.

This paper gives some solutions to the issues presented and offers a rapid implementing solution for acquiring and processing iris information. In the

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next sections the software architecture of the proposed solution is described, followed by the presentation of the vision tools used and examples.

2 THE SOFTWARE ARCHITECTURE

In order to rapidly develop an iris recognition application which can be customized by the organization, the image processing subsystem must be accessible for modifications. Only few IPDE have this property, and have been considered for implementation, in the end the chosen system was AdeptSight from multiple reasons:

- The vision system have high performances in object localisation: 1/40 of a pixel in position, and 0.01 degree in rotation (which allow a precise iris, pupil and eyelid localization)
- The system has the possibility to train and edit object models based on non connected contours (this is the case of the iris, which in most situations is partially occluded by the eyelid)
- The programming interface is based on visual tools (visual programming) for rapid development, and has also the possibility to be integrated with high level programming languages (C#) for complex applications.
- The system can be easily integrated with other systems by using Ethernet, serial, or I/O lines. (Fig. 1)

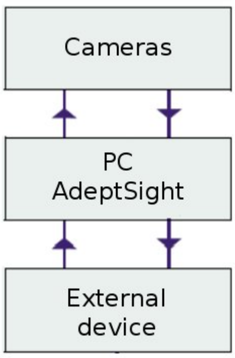

Figure 1: External device - Vision System integration.

AdeptSight uses up to four FireWire cameras connected directly to the PC where the AdeptSight software is installed.

The development of vision applications is based on vision projects which have the following structure: The vision project is separated in two main parts, the first part handles the hardware and the communication environment and is composed by communication routines and configuration of system devices like cameras (Basler, Direct Show or Emulation – virtual camera), and other hardware devices. The second part is represented by the vision sequences, which compose the principal part of the project. The sequences are composed by vision tools connected together and which are executed step by step in a sequence defined by the programmer. In addition the user can develop C# programs which interact with the AdeptSight project and extend his functions regarding the communication with other devices and other functions which are not implemented in AdeptSight.

3 VISION PROJECT IMPLEMENTATION

The vision is calibrated using a dotted pattern which is placed in front of the camera at a distance which approximates the distance to the subject eye. The calibration is executed using a 2D camera calibration wizard which guides the user step by step through the calibration process. The single information which the user must supply is the Dot Pitch of the calibration pattern, the rest of the process is handled by the wizard. After the 2D camera calibration the following information's are obtained:

- Average Pixel Width/Height
- The lens distortions are corrected
- The perspective distortion is also corrected

After the 2D camera calibration, the sequence can be loaded into the project, and for this application the sequence is very simple and consists on the following vision tools, an acquisition tool which obtain the image from the camera, a set of two localization tools named Locator(s) which have the role to recognize the pupil and the iris boundaries, and a set of two locators which will detect the eyelid boundaries, which are required in order to obtain only the iris valid image date.

In this application the difficulty is to detect the correct boundaries of the iris disregarding the outer irregularities which are generated by the contrast between the iris and sclerotic membrane and the eyelids.

Fig. 2 presents the interface for model editing. The system, based on the contrast threshold, and the outline and detail levels detect the contours and proposes the user a set of contours for model building. The outline level provides a coarser level of contours than the detail level. The location

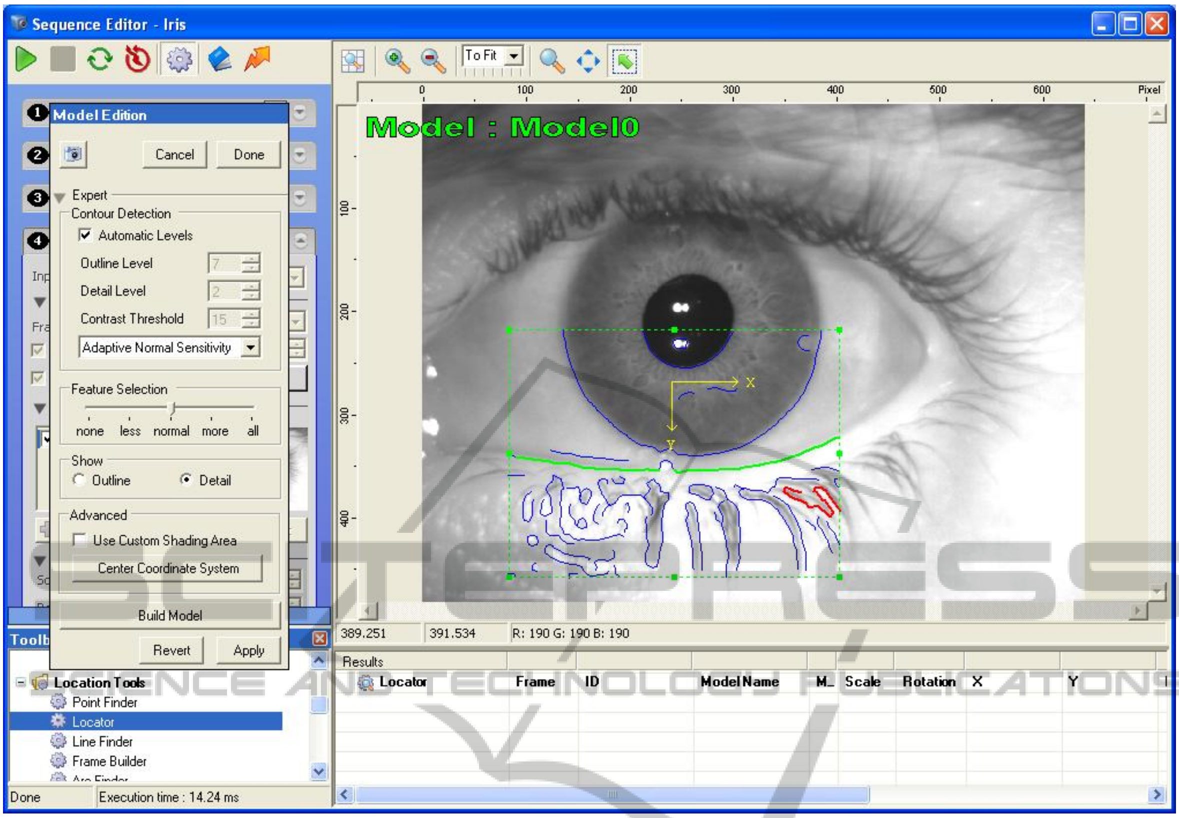

Figure 2: Editing the model for the lower eyelid.

process uses outline level contours to rapidly identify and roughly locate potential instances of the object, then, the location process uses the detail level contours to confirm the identification of an object instance and refine its location within image.

The user can modify the selected contours by deleting/adding contours, or select only parts of the proposed contours (Adept, 2001, Adept, 2007). In Fig. 2 the red line is selected for deletion, the blue contours are marked as deleted (will not be used for model building) and the green contours are valid contours. After all contours have been selected, the model can be build and used for recognition.

4 CONCLUSIONS

The proposed IPDE is a software development environment for image processing which allow rapid application development and in the same time allows the developer to customize the vision tools which the IPDE offers by default.

The AdeptSight IPDE is a fast solution for developing “in house” customized iris recognition applications for organizations which require a high level of personal identification system customization and optimization. The IPDE offers a set of default vision tools which can be customized by changing the parameters in the vision project but also allows the developer to write applications in which those tools can be used and moreover modified to satisfy the application necessities.

In our case the application demonstrates the rapidity of image processing of the vision tools (all 5 tools – 1 acquisition tool, and 4 locators, have been executed in less than 30 milliseconds). Also we demonstrated the reliability of the vision tools 98% of the images which had the iris in the centre of the image have been correctly segmented (the pupil, iris, and eyelids have been correctly and accurately detected) (the tests have been conducted on Bath Iris image database) (University of Bath, 2009). In the rest of the images where the iris was not centred the system have problems in detecting the eyelids due to the angle which the axis of the camera makes with the eye, the eyelids borders being masked by the hair on the eyelid.

Figure 3 presents some results in detecting the pupil, iris and eyelids basic features in iris segmentation. The used method can be as good as

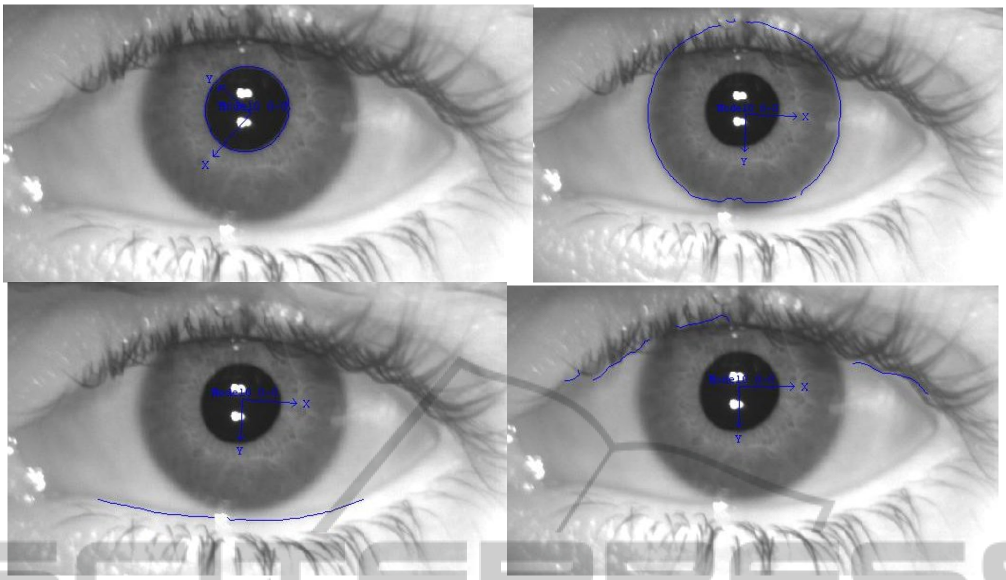

Figure 3: Results in detecting the pupil, iris, and eyelids for iris image segmentation.

other classic segmentation methods (sobel filters, Gabor and long Gabor filtering) (Daugman, 2007; Popescu-Bodorin, 2010).

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