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# PERSON IDENTIFICATION BASED ON IRIS IMAGE ANALYSIS WITH SPECIAL EMPHASIS ON HARDWARE IMPLEMENTATION

Reviewer: **Professor Andrzej Napieralski**

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*The paper presents main results of PhD dissertation concerning authentication systems based on the analysis of iris pattern. The work presents the possibility of computing hardware acceleration of this process.*

## 1. INTRODUCTION

Biometrics is a field of study including person identification based on their physiological or behavioral features. Among different biometric features suitable for person identification one of the most promising is the human iris due to its relatively low error rates. However, current state of the art in the iris recognition field indicates that existing methods have a limited reliability when large populations are considered.

To identify a person based on their iris pattern, first, a photo of the eye must be taken. Next, the photo is processed. In all iris recognition systems this processing consists of three major stages. Firstly, the iris region is segmented, secondly, its features are extracted and finally, the features are compared with the signatures stored previously in the database of registered users. Basing on the comparison result the system recognizes the person standing in front of the camera.

## 2. HARDWARE IMPLEMENTATION OF IRIS IDENTIFICATION SYSTEM

After a detailed analysis it appeared that images of high quality are needed for a new approach to extraction of distinctive features in iris image – computational geometry [2]. In order to meet the requirements of highly repeatable and precise iris images a special acquisition device, called IrisStation, was developed. It consists of a dedicated camera placed on a movable platform, which can automatically take the best image of the iris using a specialized feedback. Such images of an eye contain a fair amount of distinctive features that must be effectively processed. For this purpose a hardware platform for biometric calculations was proposed by the author. One of the additional objectives was to make the analysis of other biometric samples possible, e.g. voice, fingerprints, etc.

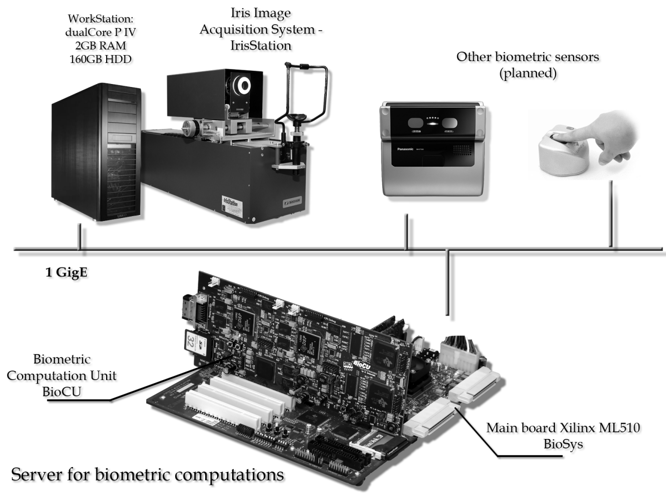


Fig. 1. Biometric system topology used for experiments

The proposed biometric computation server consists of two separate physical boards. The first one, a Virtex-5 FXT Xilinx ML510 Embedded Development Platform, is the basis for an embedded system, based on two PowerPC 440 microprocessors, called BioSys. The second one was designed from scratch at DMCS and is called BioCU (Biometrical Computation Unit) and its main components include four Digital Signal Processors, two of which are fixed-point (CPU0 and CPU1) and two of which are floating-point (FPU0 and FPU1), and a Xilinx Spartan 3AN FPGA. The BioCU board is inserted into one of the PCI 32bit slots on the ML510 platform. Data from distributed biometric sensors are provided to computation server through Gigabit Ethernet. Network topology used for experiments is presented in figure 1.

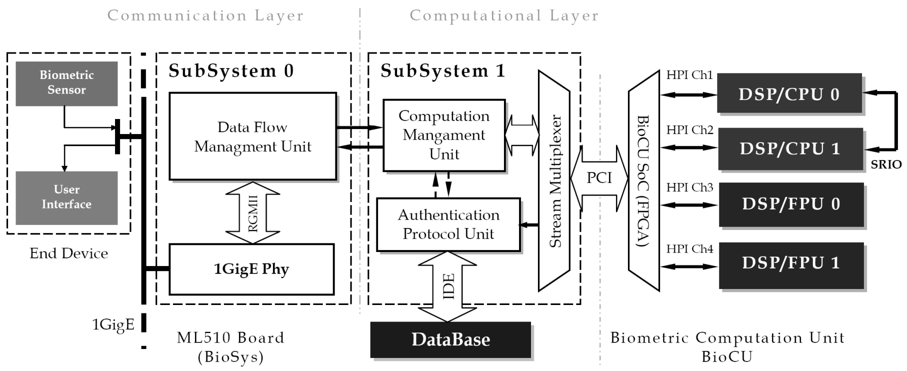


Fig. 2. Distribution of relative gradient of luminance on iris-pupil border

The server can be also divided into two logical parts – the communication layer and the computation layer – figure 2. A Gigabit Ethernet (1 GigE) connection is used to transfer data to and from the external sensor units. This data is then sent to the latter part of the system where the biometric data is initially divided into four separate streams associated with the DSPs. It has been assumed that operations dealing with images should be performed on CPU0 and CPU1 while the operations dealing with high-dynamic signals, such as voice data, should be performed on FPU0 and FPU1. Thus, the data is forwarded accordingly over the HPI interface. Additionally, the two fixed-point DSPs are connected using a RapidIO link, which enables them to exchange information with very low latency and high speed during the parallel data processing. External DDR2 memories, working with the frequency of 533 MHz, are available to both fixed-point DSPs and both PowerPCs (512 MB each) while the two floating-point devices can use 32 MB SDRAM memories each. After the DSPs have processed the data and have come up with a valid signature of the given biometric feature, it is transferred back to BioSys over the PCI bus where it can be checked against a database providing the client device with an identification answer or sent directly to the client module. However, the signature validation against the database of previously stored templates can be also performed in DSPs which, in the current software revision, are able to store the database in their memories (over 1 million records). In this case, the identification answer is sent back to the remote device. This mode of operation was used during tests. Several aspects of the proposed identification system have been tested. First of all, the influence of the paralleling of the authentication algorithm was examined when the work was distributed between two DSPs. Then, the time it takes for the authentication algorithm (database search) to complete was compared to those of the BioCU system and several commercially-available iris identification systems (fig. 3). As a feature extraction method texture analysis was used, as in the compared systems.

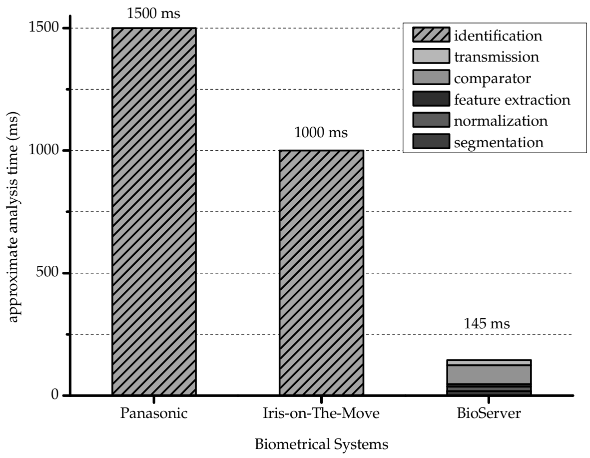


Fig. 3. Throughput comparison of commercial and the developed biometric systems

Finally, overall ROC curves of the developed biometric system were estimated and tested against commercially-available iris identification systems – figure 4. Biometric performance of the developed system is similar to the one obtained by the best commercial system – the LG IrisAccess3000 device. Test results of commercially-available systems can be found in an independent report [3].

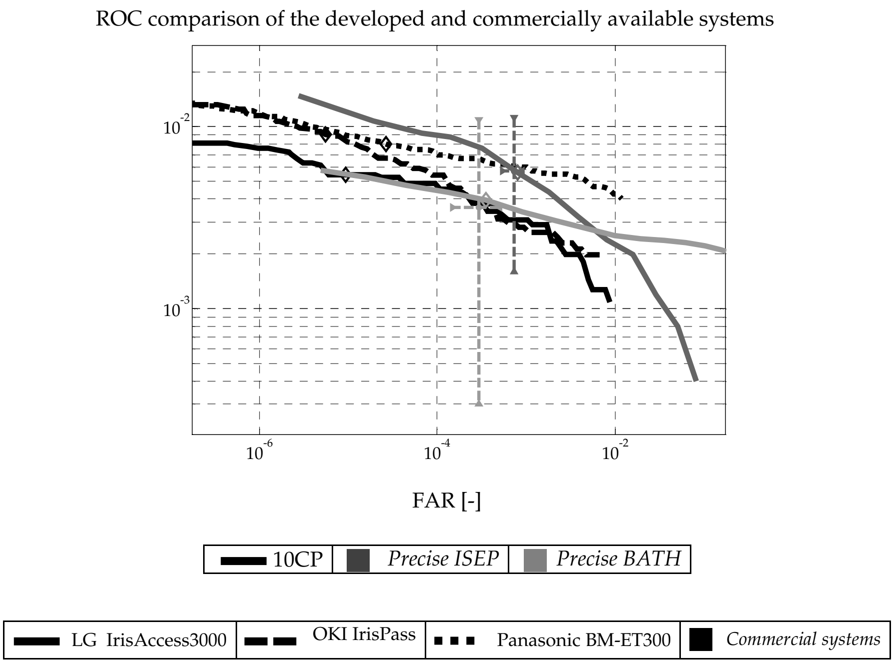


Fig. 4. Biometric performance comparison of the commercial and the developed biometric systems

# 3. CONCLUSIONS

The Research presented in [1] has shown that iris segmentation algorithm can be highly optimized for efficient hardware implementation. However, further experiments on iris feature extraction methods lead to the conclusion that a new approach to iris authentication process is indispensable. This method should extract distinctive features by using an iris structure model rather than a typical iris texture analysis. Nevertheless, such methods are much more sophisticated and require additional computation speed and optimization in order to keep such a system on the same throughput level as typical commercial systems. Therefore, special techniques for their implementation on Digital Signal Processors and Field Programmable Gate Arrays were developed.

The dedicated sophisticated algorithms can be implemented on the special extension card, fully designed by the author, with the functionality optimized for solving biometrical problems. Currently the dedicated hardware makes it possible to carry out the complete iris identification process within the time less than one hundred fifty milliseconds with a repository scan among ten thousand subjects. As it was presented in this paper, typical commercial systems need approximately one second to accomplish the same procedure.

To conclude, potential changes improving the efficiency of recognition systems were shown. Furthermore, a special hardware solution was proposed that is useful for implementation of high confidence algorithms. The analyses presented in the dissertation show a higher performance level of the designed system in comparison with the existing commercial systems.

# REFERENCES

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# IDENTYFIKACJA OSÓB NA PODSTAWIE ANALIZY OBRAZU TĘCZÓWKI OKA ZE SZCZEGÓLNYM UWZGLĘDNIENIEM MOŻLIWOŚCI IMPLEMENTACJI SPRZĘTOWEJ


## Streszczenie

W artykule przedstawiono główne rezultaty badań zawartych w rozprawie autora dotyczącej systemów uwierzytelniania osób na podstawie obrazu tęczówki oka. Zaprezentowano wątek sprzętowej implementacji systemu uwierzytelniania 1:N przy użyciu układów FPGA i DSP.


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