Simple Mathematical Models in Biometric Image Analysis

Dr. Khalid Saeed, DSc, PhD, MSc, BSc Engg

Faculty of Physics and Applied Computer Science
AGH University of Science and Technology
Cracow, Poland `saeed@agh.edu.pl, khalids@wp.pl`
`http://home.agh.edu.pl/~saeed/`

Abstract. Biometrics is a science that deals with human identification on the basis of our biological features. Therefore, Biometrics belongs to Pattern Recognition and is part of it. Biometric examples are all features we are born with like facial image, finger-prints, iris of the eye, . . . or the features we learn in our life like the way we write (signature), the way we walk (gait) or any of the behavioural characteristics. One of the basic steps in the procedure of pattern recognition for the right decision taken with high success rates of identification and verification is the way we furnish the characteristic points of the human biometric images. Once the biometric image is represented by the actual description, easy for implementation in the available popular computing systems, the recognition results will then be more satisfying. The characteristic points should cover all the essential information carried by the selected features that are necessary and in high percentage sufficient for human identification and/or verification.

A general study of all biometric categories will be discussed with examples. The methods of biometric image preprocessing will also be given in order to show the biometric image preparation for classification and recognition. The worked out algorithms with their mathematical approaches and models represented by the feature vectors will be shown. During the talk, the author will present a method for image description derived from the theory of analytic functions. The original mathematical importance of Toeplitz matrices, which are positive definite, is in the theory of the classical Caratheodory coefficient problem, proved independently by Toeplitz and Caratheodory in 1911. Caratheodory investigated power series which are analytic in the unit circle and have a positive real part in the unit circle. This will take us to Caratheodory and Schur theorems [1], to their modified and developed assertions used in Electric Circuit Theory – Network Synthesis and applied by the author to the Digital Filter Realisation and then to Image processing [2]. The contribution of Toeplitz and his matrices to the subject will also be discussed with examples on the use of the theory in Image description for the sake of their object recognition. The main idea is based on employing the mentioned above classes of analytic functions to build a mathematical model for image description for classification by either the determinants or matrix lowest eigenvalues. Both the matrix lowest eigenvalues and their determinant approaches will be discussed. How to construct the

image feature vector by the aid of the matrix determinants sequence will be shown as a new method of image description. The matrices, in turn, are shown how to be formed from the geometric features of the object image, the object being one of the human biometric feature images or, as a general case in recognition systems, any other object under testing for recognition.

References

1. I. Schur. Methods in Operator Theory and Signal Processing I. Gohberg, ed., Birkhäuser, 1986, 31–89.
2. Saeed K.. A mathematical model on Töeplitz lowest eigenvalues in signal and image processing. Accepted for presentation at IMACS 2011, Morocco 2011.