Intelligent Information System for Interpretation of Dermatoglyphic Patterns of Down’s Syndrome in Infants

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Abstract. The paper describes design of an intelligent information system for assessment of dermatoglyphic indices of Down’s syndrome in infants. The system supports medical diagnosis by automatic processing of dermatoglyphic prints and detecting features indicating presence of genetic disorders. Application of image processing and pattern recognition algorithms in pattern classification of fingerprints and prints of hallucal area of the sole is described. Application of an algorithm based on multi-scale pyramid decomposition of an image is proposed for ridge orientation calculation. A method of singular points detection and calculation of ATD angle of the palm print is presented. Currently achieved results in dermatoglyphic prints enhancement, classification and analysis are discussed. Scheme used in classification of dermatoglyphic prints is described. RBF and triangular kernel types are used in the training of SVM multi-class systems generated with one-vs-one scheme. Results of experiments conducted on the database of Collegium Medicum of the Jagiellonian University in Cracow are presented.

1 Introduction

Early detection of genetic disorders in infants, allowing for making therapeutic decision and starting a treatment, is largely dependent on the ability of carrying out fast and reliable observations and obtaining results of these observations. One of the methods of detecting genetic disorders is dermatoglyphic analysis carried out by an anthropologist. Dermal ridge patterns on fingers, palms and soles used in this method become visible at about three months and are completed by the sixth month of prenatal development. Factors disturbing normal development of fetus may also influence formation of dermal ridges structures. Down’s syndrome (trisomy 21), one of the most common chromosome disorders and Turner’s syndrome can be detected using dermatoglyphic patterns analysis [6] [8]. Dermatoglyphic patterns of infants with genetic disorders differ from normal patterns found in healthy population. Determining the presence of genetic disorder requires a simultaneous analysis of dermatoglyphic prints of fingers,
palms and soles. The presence of a single pattern typical for the particular genetic syndrome in any of the considered areas is not indicative of Down’s or Turner’s syndrome. Many of these patterns can be found in healthy infants. However, when several, or all, of the patterns characteristic for a genetic disorder are present together, they are indicative of its presence. For the detection of Down’s syndrome a diagnostic index was developed called dermatoglyphic nomogram [7]. Diagnostic index used in screening tests for Turner’s syndrome’s presence was also developed [5]. Both of these indexes rely on a correct recognition of dermatoglyphic patterns by the anthropologist.

2 The Aim of the Work

Problem of pattern recognition and pattern understanding of genetic traits of infants with Down’s syndrome is a difficult and complex issue. Available data estimate that around 60000 people living in Poland were diagnosed with Down’s syndrome. Development of modern telecommunication networks and Internet in particular, enables creation of the telemedical system localized in Collegium Medicum of the Jagiellonian University in Cracow. Clinique of Jagiellonian University has many years of experience as a centre of genetic disorders diagnostics in neonates. Scientific faculty of the Clinique of Jagiellonian University provides substantial support in realization of the project. Conception of the project assumes development, in the Clinique of Jagiellonian University, of a prototype of the telemedical system, in which data in the form of dermatoglyphic images is transferred through the telecommunication networks from the distant hospital database centers and processed. The aim of the telemedical system is screening analysis of incoming data. Another goal is a support of the diagnosis process conducted by medical personnel in cases of ambiguous classification of the telemedical system.

The aim of the research conducted is the creation, based on gathered data and domain knowledge described in medical literature, of an automatic system supporting the diagnosis process and detecting infants’ genetic disorders, as follows:

1. The system recognizes characteristic combinations of particular patterns of soles, palms and fingers and on that basis, infers the occurrence of genetic disorders. It is expected that the application of this system improves treatment’s effectiveness, i.e. the number of complications caused by the treatment in the later years of infants’ life is going to be lower.
2. The system supports doctor’s work by the analysis of large amounts of patients’ data and decreases the probability of a mistake in strenuous biometric analysis such as counting the number of ridges, determining ridge width or calculating the ATD angle.