Corneal modeling and Keratoconus identification

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This study aims to create a diagnostic system for early Keratoconus (KTC) identification. Keratoconus is a progressive ocular pathology that may lead to gradual corneal deformation, and might cause decreased quality of vision. KTC is easily identified at advanced stages by means of clinical parameters, measured by non-invasive devices. Meanwhile identification of early KTC is still a big challenge for practitioners. This work proposes a mathematical model of normal (N) and KTC eyes. Furthermore, a hybrid machine learning algorithm was implemented as a clinical support tool for ophthalmologists to reach a correct diagnosis.

A gaussian-sphere mathematical model was considered to model both N and KTC corneas. 145 N and 312 KTC anterior and posterior corneal maps (layers), were collected at the Antwerp University Hospital (UZA, Belgium). The maps were fitted to the gaussian-spherical model in order to extract potential meaningful parameters to help identify early KTC. Moreover, extracted data were statistically analyzed and used to train a hybrid machine learning algorithm, which applies a probabilistic strategy to support vector machine (SVM) and multilayer perceptron (MLP) algorithms. Cross-validation techniques were used to validate and evaluate the accuracy of the diagnostic system.

The mean squared error (MSE) of the gaussian-spherical model amounted to $MSE \leq o(10^{-3})$ mm, $MSE \in [0.002, 0.004]$ mm in the center, and $MSE \simeq 0.02$ mm on corneal borders. The highest accuracy in classifying early KTC versus N eyes from the extracted parameters was 94% during the validation and 99% in the training step.

The implemented diagnostic system results in an accurate tool for early KTC detection. Further work is needed to improve this system to model the progression of KTC.