Abstract

In this thesis, we study and exploit two approaches to building up robust classification and detection methods, namely embedding a reject option into classifiers and designing multi-stage (or cascaded) classification/detection structures. The reject option embedding enhances the classification robustness through inclusion of an effective rejection rule for potentially misclassified samples. The multi-stage methods incorporate multiple classifiers/detectors to jointly and robustly address classification/detection tasks. Based on these two approaches, this thesis investigates ways to propose robust classification/detection methods with real-world applications of biomedical images.

Classification and detection of biomedical images usually hold a premise of further biological and medical analyses, e.g., disease treatment. Manual classification/detection of biomedical images is prone to subjectivity and suffers from inefficiency due to high-throughput production of images in practice. Hence, it is greatly demanded for automating the process of biomedical image classification/detection. In general, miss classification or false detection of biomedical images is high-cost especially for certain diagnosis processes, e.g., cancer prediction. Also, automated biomedical image classification/detection could confront the challenges of high level noise, image blur, illumination variation and complicated geometric correspondence among various categorical biomedical patterns. Therefore, it is valuable to propose robust classification/detection methods in real-world applications related to biomedical images.

Firstly, the thesis proposes a novel method which embeds a reject option in twin support vector machine (RO-TWSVM) through the Receiver Operating Characteristic (ROC) curve for binary classification. The proposed RO-TWSVM can achieve robust classification by rejecting both ambiguous and outlier samples.

Secondly, the thesis investigates a two-stage classification method based on a cascade of an SVM with a reject option and subspace analysis. Such method is formulated to robustly classify biomedical images with different geometric correspondence.

Thirdly, the thesis proposes a novel two-stage method for automated detection of ring-like endosomes in fluorescent microscopy images. The proposed method firstly roughly localizes candidate targets using local feature information. Then, it refines the detection results by ruling out endosome-like background patterns from a classification perspective based on global information of training patches. These two stages jointly produce robust detections in real-world microscopy images.

Overall, this thesis contributes two types of novel methods to enhance robustness of classification/detection models: (i) Embedding a reject option in in twin support vector machine (RO-TWSVM) through the Receiver Operating Characteristic (ROC) curve; (ii) Proposing multi-stage methods which exploits complementary feature information to address image classification/detection tasks. The superiority of the proposed methods in this thesis is shown in the specific applications of real-world biomedical images.