Computer-aided detection of early esophageal cancer using local texture and color features of HD endoscopic images

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Background and study aims: High Definition (HD) endoscopy has become a crucial tool for the detection of early cancerous lesions in Barrett’s Esophagus. These lesions can be endoscopically removed, increasing the survival chances of the patient significantly. However, the early identification of Esophageal Adenocarcinoma (EAC) is still difficult, hence many of these (pre-)malignant lesions are not identified as such by non-expert endoscopists. The aim of this study is to assess the feasibility of a supportive computer system that helps the gastroenterologist in the detection of EAC.

Methods: A novel algorithm has been developed for detecting deviating color and texture patterns that are associated with EAC in endoscopic images. Initial experiments have shown that Gabor-based texture features and simple color statistics are most suitable for capturing these deviating patterns in the esophageal tissue [1]. The system applies four basic steps: (1) it identifies the region of interest, (2) computes local color- and texture features of the original and the Gabor-filtered image, (3) classifies these features using a trained Support Vector Machine (SVM) and (4) applies additional post-processing techniques in order to annotate the image region containing early cancer. For this study we use 32 images from 7 patients with EAC and 32 images from 15 patients without signs of EAC. One expert gastroenterologists provided annotated ground truth images, which are used to train and test the detection system.

Results: After applying Leave-One-Out Cross Validation (LOOCV) on patient basis, a total of 36 out of 38 lesions are correctly detected by the proposed system. However, this high detection rate also resulted in 12 false positives, yielding a recall of 0.95 and a precision of 0.75. Based on system parameters, a trade-off can be made between recall and precision, where we consider precision is the most important. The delineations made by the system matched the annotations of the specialists with a pixel-based accuracy of 85.7%. In only 4 of the 32 images showing only non-cancerous tissue the system falsely detected a lesion. Figure 1 shows four annotations made by the proposed system (top row) and the corresponding ground truth annotations (bottom row).

Conclusion: Based on our results, we conclude that a computer-aided detection system that supports the gastroenterologist in the identification of early Barrett’s cancer is feasible. Further research is required for the development of such a system for real-time analysis of endoscopic video and increasing its robustness.