People suffering from a medical condition known as Barrett’s Esophagus have an over 30-fold increased chance of developing esophageal cancer. Therefore, these patients undergo periodic endoscopic inspection to identify signs of developing cancer at an early stage, for which endoscopic treatment is still possible. However, these early cancers are very hard to identify visually and the current biopsy protocol suffers from sampling error. Hence, a considerable number of these developing cancers are detected at a later stage of the disease, for which the treatment involves drastic surgery and radiochemotherapy. This leads to a poor prognosis, with a five-year survival rate of approximately 15%, whereas for early detection, this figure is close to 100%.

This thesis demonstrates the promise of automated image analysis methods for detecting Barrett’s cancer at an early stage. Together with medical experts, quantitative image features are developed to capture the subtle color and texture patterns in the tissue that are associated with early cancer. These features are combined with machine learning algorithms to automatically distinguish cancerous tissue from normal Barrett’s tissue.

The presented Computer-Aided Detection (CAD) system achieves detection rates that rival those of top specialists. Furthermore, for scans acquired with a newly developed device that allows imaging of the subsurface tissue layers at micrometer resolution, the proposed CAD algorithms even surpasses expert performance.

The investigated methods and presented algorithms in this thesis will enable better detection of esophageal cancer, leading to a greatly improved prognosis for patients and a significant reduction of the associated healthcare costs.