

Chapter 10

Color Image Segmentation of Endoscopic and Microscopic Images for Abnormality Detection in Esophagus

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ABSTRACT

The study of medical image analysis encompasses the various techniques for acquisition of images of biological structures pertaining to human body using radiations in different frequency ranges. The advancements in medical imaging over the past decades are enabling physicians to non-invasively peer inside the human body for the purpose of diagnosis and therapy. In this chapter, the objective is to focus on the studies relating to the analysis of endoscopic images of lower esophagus for abnormal region detection and identification of cancerous growth. Several color image segmentation techniques have been developed for automatic detection of cancerous regions in endoscopic images, which assists the physician for faster, proper diagnosis and treatment of the disease. These segmentation methods are evaluated for comparing their performances in different color spaces, namely, RGB, HSI, $YCbCr$, HSV, and CIE Lab. The segmented images are expected to assist the medical expert in drawing the biopsy samples precisely from the detected pathological regions. Further, various methods have been proposed for segmentation and classification of squamous cell carcinoma (SCC) from color microscopic images of esophagus tissue during pathological investigation. The efficacy of these methods has been demonstrated experimentally with endoscopic and microscopic image set and compared with manual segmentation done by medical experts. It is envisaged that the research in this direction eventually leads to the design and production of efficient intelligent computer vision systems for assisting the medical experts in their task of speedy accurate diagnosis of diseases and prescription of appropriate treatment of the patients.

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1. INTRODUCTION

1.1 Medical Imaging

The study of medical image analysis encompasses the various techniques for acquisition of images of biological structures pertaining to human body using radiations in different frequency ranges. The image analysis is primarily influenced by the resolution and quality of the acquired images. The digital image processing techniques are employed to render such images amenable to more accurate and meaningful image analysis. In recent years, the improvement and the development of many image acquisition techniques, the enhancement of the general quality of the acquired images, advances in image processing and development of large computational capacities, have considerably eased this task. The acquisition of medical images in two (2D), three (3D), or higher dimensions, has become a routine task for clinical and research applications. The image acquisition techniques include magnetic resonance imaging (MRI), magnetoencephalography (MEG), 3D ultrasound imaging, computed tomography (CT), positron emission tomography (PET), endoscopy imaging, single photon emission computed tomography (SPECT), functional MRI (fMRI), and diffusion weighted imaging (DWI).

1.1.1 Medical Image Analysis

Medical imaging is an important mode of capture of anatomical and functional information and is helpful for the accurate diagnosis and treatment of diseases. Medical images are the basis for a large number of clinical tasks in the daily routine of healthcare. The sustained developments in the field of acquisition technology enable capturing the increasing amounts of high-resolution images that reveal different aspects of the human body's structure and function with unprecedented detail. In the clinical routine, such large amounts of data pose not only storage problems but also challenges for image analysis. Medical images, for example,

are analyzed for examining relationships between structural abnormalities and deformations and certain functional abnormalities and diseases. Adopting computational aid for medical image analysis is no longer an option, but a necessity (Silvia D. Olabariaga et al. 2007). Among the primary tasks of medical image analysis are image segmentation, registration, and matching.

1.1.2 Medical Image Segmentation

Segmentation of the object of interest is a difficult step in the analysis of digital images. Fully automatic methods sometimes fail, producing incorrect results and requiring the intervention of a human operator. This is often true in medical applications, where image segmentation is particularly difficult due to restrictions imposed by image acquisition, pathology and biological variation. Segmenting an anatomical structure in a medical image amounts to identifying the region or boundary in the image corresponding to the desired structure. In the classical approach of segmentation by image labeling, image features are extracted and used to obtain a sparse collection of locations and data, which are then interpolated to form a representation and possible segmentation. Desired regions are identified by labeling each volume element (voxel) in a 3D scan, or picture elements (pixel) in 2D, based on the anatomical structure to which it corresponds. In more recent approaches, an initial curve or surface estimate of the structure boundary is provided and optimization methods are used to refine the initial estimate based on image data. A fully segmented scan allows surgeons to both visualize the shapes and relative positions of internal structures better qualitatively and measure their volumes and distances quantitatively more accurately.

The output of manual segmentation of medical images, by knowledgeable medical experts, can sometimes be considered optimal. Unfortunately, expert segmentation is far from recommended in many clinical situations.

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