CHAPTER 1: INTRODUCTION

In this chapter, a brief introduction to the cancer detection from microscopic biopsy images considered in this thesis and basic concepts studied has been presented. Related work, the main contributions of the thesis and the organization of the thesis has also been stated.

Section 1.1, presents the background of medical imaging system for cancer detection, the motivation and problem description for the present work in detection of cancer from microscopic biopsy images has been discussed in section 1.2. In section 1.3, thesis objectives have been described. Section 1.4, present the main contributions of the thesis. Finally, Section 1.5 highlights the organization of the thesis.

1.1 Background

Cancer is one of the leading causes of the death around the world. It is the uncontrolled growth of abnormal cells anywhere in the body. The abnormal cell is considered as either a malignant cell or tumor. The cancer is nothing but an advance stage of tumor. Cancer is easier to treat and cure if it has been diagnosed at early stage. This chapter provides the basic cancer detection techniques as well as advanced cancer diagnostic methodology with new and accurate techniques for detection of cancer from microscopic biopsy images. A Microscopic biopsy is the removal of a small amount of tissue with Fine Needle Aspiration (FNA) for examination under a microscope.

Biopsy will strain with H&E fluid to obtained blue (cell and nuclei) and pink tissues of microscopic biopsy images**.** Visual appearance of microscopic biopsy images after H&E straining is shown in Figure 1.1.

Figure 1.1: Visual appearance of microscopic biopsy images taken from University of Iowa in 1995

About 200 type of cancer have been concurred according to national cancer institute (www.cancer.gov). These are broadly categorised as follows:

Carcinoma: These types of cancer begin on surface of the body. Cancer arises from the cells that cover external and internal body surfaces. Lung, breast, and colon are the most frequent cancers.

Sarcoma: This type of cancer begins in the soft tissues like, bones, Cartilage, fat, mussels and blood vessels or other connectives or supportive tissues.

Leukemia: This type of cancer starts in blood forming tissue, such as bone marrow and causes large number of abnormal blood cells.

Lymphoma and Myeloma: This type of Cancer begins in cell of immune systems.

Central nervous system cancers: This type of cancer begins in the tissues of the brain and spinal cord.

Thus, there is a need of an automatic cancer diagnosis system based on microscopic biopsy images using image-processing tools. Therefore, the cancer and its type will be detected in a very early stage for complete treatment and cure. This system helps pathologists to improve the accuracy and efficiency in detection of malignancy and to minimize the inter observer variation. In addition, the method may help physicians to analyze the image cell by using classification and clustering algorithms by staining characteristics of the cells. The various image processing steps involved for cancer detection from biopsy images include acquisition, enhancement, segmentation, feature extraction, image representation, classification, and decision-making as shown in Figure 1.2. With the help of image processing tools the sizes of cells, nuclei, and cytoplasm as well as the mean distance between two nearest neighboring nuclei are estimated by the system.

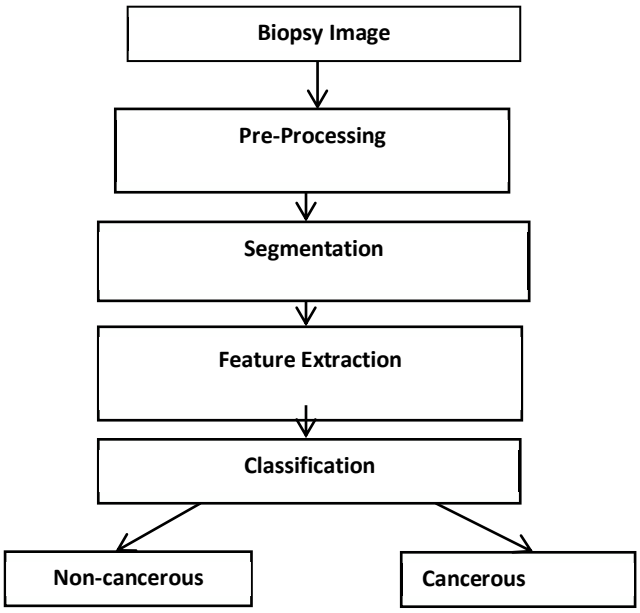

Figure 1.2: Block diagram of automated CAD tool for cancer detection from microscopic biopsy images

1.2 Motivation

The motivations behind presented work in this thesis are design and development of a computer aided diagnosis (CAD) tools for cancer detection from microscopic biopsy images. The other technique used for cancer detections are, invasive, painful, rate of malignancy will increase due to rays illuminated by scanning devises, it does not provide the level of accuracy that required for diagnosis and treatment. The pathologists and medical practitioners required only definite system for the confirmations of presence or absence of disease. Most of the image modalities used deal with grey level images. While microscopic biopsy images needs to be process the color images. The manual evaluation of microscopic biopsy for cancer detection leads to subjective, time consuming and varies with perceptions and level of expertise of pathologists. To overcome these challenges automated cancer diagnosis is needed for objective, fast, accurate and quantitative results. In this chapter, a systematic survey on computational steps for detection of cancer from biopsy images using image processing and pattern recognition tools is presented. These steps involve image pre-processing, enhancement and restoration, segmentation, feature extraction to quantify properties of local area, and classification of sample image into normal and abnormal categories e.g. benign and malignant ones.

1.3 Objective of the thesis

The major objective of the present work is to develop framework for detection of cancer from microscopic biopsy images. The success of design and development of cancer detection model for microscopic biopsy images depends on the development of an appropriate segmentation, feature extraction, and pattern classification techniques. Moreover, the success of the design and development of

the CAD tool for cancer detection from microscopic biopsy images heavily depend on the design and development of suitable segmentation methods. In this thesis, apart from suggesting the efficient available methods for each step in the design and development of the CAD tool, the major emphasis is laid on the development of efficient segmentation approaches. Here, two cases are considered. Firstly, the segmentation of microscopic biopsy images having no intrinsic or external noise and secondly the segmentation of microscopic biopsy images in presence of intrinsic Poisson noise and external additive noise.

To summarize, in this thesis, following important problems of cancer detection from miscopy biopsy images are investigated:

1. A brief description about the cancer detection techniques and process and detection of cancer from microscopic biopsy images.
2. Study and implementation of existing approaches for each design step namely pre-processing, segmentation, feature extraction, and classification of the overall CAD tool for detection and classification of cancer from microscopic biopsy images into four fundamental tissues type.
3. A brief description of measuring matrices used to evaluate the segmentation and classification approaches are also described.
4. Design and development of incremental and hybrid color k-means approach for segmentation of microscopic biopsy images.
5. Design and development of an adaptive fourth order PDE based FCM segmentation approach for segmentation of microscopic biopsy images corrupted with poison noise.

1.4 Contributions

The main contributions of this thesis are as follows:

- A detailed literature review on computer aided diagnosis (CAD) tools for detection of cancer from microscopic biopsy images are investigated and presented.
- Clinically significant set of features extracted from microscopic biopsy images are illustrated and implemented for cancer detection from microscopic biopsy images. Based on experimental results and comparative analysis, a suitable approach for each design step is recommended for the design of the CAD tool.
- A hybrid color k-means segmentation approached is proposed, implemented and compared with other popular approaches for segmentation of breast tissues of microscopic biopsy images and its region of interest (ROI) segmented ground truth images.
- A fourth order partial differential equation (FPDE) based nonlinear filter adapted to Poisson noise (AFPDE) with fuzzy c-means (FCM) segmentation method is proposed. This method is capable of handling Poisson noise removal while performing segmentation of the microscopic biopsy images. The proposed approach is tested on breast cancer microscopic data set with ROI segmented ground truth images. The microscopic biopsy data set contains 31 benign and 27 malignant images of 896×768.

The methods proposed in this thesis may aid researchers and medical practitioners of the area of cancer detection to go through the state-of-the-art methods for recent development in cancer detection and segmentation from microscopic biopsy images. The results obtained from the above approaches are

very helpful to the doctors and pathologists. The proposed approaches automatically determine whether the microscopic biopsy images are cancerous or not. If the cells are cancerous, the biopsy results can tell the doctor where the cancer originated and the type of cancer which may help guide treatment planning options.

1.5 Organizations of the thesis

The overall thesis is organized into six chapters as follows:

Chapter 1 provides the introduction, background, motivation and problem description for the present work including thesis objectives, and contributions. Finally, this chapter concludes with the organization that illustrates the coverage of chapters in the thesis.

Chapter 2 provides Introduction and survey of each design steps of a computer aided diagnosis (CAD) tools for detection of cancer from biopsy images using image processing and pattern recognition techniques. These design steps involve image pre-processing, where enhancement and restoration is first step, segmentation is most important second step, feature extraction is used on third step to quantify properties of image, and finally classification of sample image into normal and abnormal categories e.g. benign and malignant ones.

In **Chapter 3**, a framework for automated detection and classification of cancer from microscopic biopsy images using clinically significant features is proposed and examined. The comparative analyses of the existing methods used for the design of the said CAD tool based on experimental analysis are presented. Based on results and analysis suitable approaches are recommended for the design and

development of the said CAD tool. Further, the proposed approach is performing better in comparison to other methods.

In **Chapter 4**, a hybrid combination of color k-means and marker control watershed based segmentation approach is proposed to be applied for the segmentation of cell and nuclei of microscopic biopsy images. The proposed approach is tested on breast cancer microscopic data set with ROI segmented ground truth images.

Chapter 5, present a fourth order partial differential equation (FPDE) based nonlinear filter adapted to Poisson noise (AFPDE) with fuzzy c-means (FCM) segmentation method. This method is capable of effectively reducing the blocky artifacts while achieving good trade-off between Poisson noise removals with edge preservation of the microscopic biopsy images. The proposed approach is tested on breast cancer microscopic data set with ROI segmented ground truth images.

In **Chapter 6,** we summarize main findings of this thesis and give future perspectives of the research in this thesis.