Identification of Carcinoma in Situ from Segmented Squamous Cervical Cells

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Abstract — This paper presents an identification approach for an early-state cervical cancer called carcinoma in situ (CIS). Size of nucleus and cytoplasm of a squamous cell in the Pap (Papanicolaou’s) smear image is related to the cancer in CIS state. Segmentation techniques for the single squamous cell and the combined squamous cells are proposed. A proportion of the segmented nucleus area and the segmented cytoplasm area is computed and used as an indicator of the normal cells and the abnormal cells. To evaluate a performance of the proposed approach, 20 Pap smear images with 30 cells, 10 abnormal cells and 20 normal cells, have been tested. Experimental study with real ground-truth-known images demonstrated the feasibility and promising of the proposed techniques in discriminating between normal cell and abnormal CIS cell. The results reveal 80% accuracy approximately.

I. INTRODUCTION

Cervical cancer is the second most common cancer in women worldwide, exceeded only by breast cancer [1]. The mortality related to cervical cancer can be reduced if this disease is detected at its carcinoma in situ (CIS) state, known as squamous intraepithelial lesion (SIL) [2].

Currently, the primary screening tool for detection of cervical cancer and its precursor is the Pap (Papanicolaou’s) smear test [3]. In the Pap test, a large number of cervical cells obtained by scraping the cervical epithelium are smeared onto a slide which is then fixed and stained for cytologic examination. Each smear is then examined under a microscope for the presence of neoplastic cells [4]. Figure 1 shows an example of the Pap smear test [5]. The Pap smear is unable to achieve a concurrently high sensitivity and high specificity [6]. The accuracy of the Pap smear is limited by both sampling and reading errors [7]. Approximately 60% of false-negative smears are attributed to insufficient sampling, while the remaining 40% are due to reading errors. Because of the monotony and fatigue associated with reading Pap smears (50,000–300,000 cells per slide), the American Society of Cytology has proposed that a cyto-technologist should be limited to evaluating no more than 12,000 smears annually [8]. As a result, accurate Pap-smear screening is labor intensive and requires highly trained professionals.

However, Pap smear test is popular at this time even though the accuracy is limited. Because, it can be a final decision of pre-cancer and carcinoma in situ, while another method can not make these decisions.

Figure 1. Pap smear test [5].

Carcinoma in situ is the cervical cancer in the first stage, which is an abnormal deep-basal cell. This cell is a class of squamous cell. Therefore, if a final decision can be made accurately at the moment stage, the physician can be protect patient in due time. The incidence of cervical cancer mortality will be dramatically reduced. Figure 2 shows examples of Pap smear images with squamous cells.

From histological knowledge, the cytologist can make a final decision of carcinoma in situ by comparing between nucleus and cytoplasm in the cell.

There were some research works trying to find the comparison. For instance, Bak et al. [9] proposed an efficient segmentation method that exploits local information for automated cell segmentation. This method is proved to be resistant to the heavy noise and is not restricted to a particular noise environment represented by specific noise distribution form. Luck et al. [10] proposed the model and segmentation algorithm for reflectance confocal images of in vivo cervical tissue. Lassouaoui and Hamani [11] proposed genetic algorithms and multifractal segmentation of cervical cell image. Alan et al. [12] proposed segmenting cervical epithelial nuclei from confocal images by using Gaussian Markov random