Chapter 41
Adaptive Intelligent Systems for Recognition of Cancerous Cervical Cells Based on 2D Cervical Cytological Digital Images

Bernadetta Kwintiana Ane
Institute of Computer-aided Product Development Systems, Universitaet Stuttgart, Germany

Dieter Roller
Institute of Computer-aided Product Development Systems, Universitaet Stuttgart, Germany

ABSTRACT

To date, cancer of uterine cervix is still a leading cause of cancer-related deaths in women in the world. Papanicolau smear test is a well-known screening method of detecting abnormalities of the cervix cells. Due to scarce number of skilled and experienced cytologists, the screening procedure becomes time consuming and highly prone to human errors that leads to inaccurate and inconsistent diagnosis. This condition increases the risk of patients who get HPV infection not be detected and become HPV carriers. Coping with this problem, an adaptive intelligent system is developed to enable automatic recognition of cancerous cells from. Here pattern recognition is done based on three morphological cell characteristics, i.e. size, shape, and color features, and measured as numerical values in terms of N/C ratio, nucleus perimeter, nucleus radius, cell deformity, texture heterogeneity, wavelet approximation coefficients, and gray-level intensity. Through a supervised learning of multilayer perceptron network, the system is able to percept abnormality in the cervix cells, and to assign them into a predicted group membership, i.e. normal or cancerous cells. Based on thorough observation upon the selected features and attributes, it can be recognized that the cancerous cells follow certain patterns and highly distinguishable from the normal cells.

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INTRODUCTION

Cervix cancer is a malignant cancer of the cervix uteri or cervical area. This is considered as the second most common form of cancer in women in the world (Cotrans et al., 1999; WHO, 2010). In 2008, it is recorded 529,828 incidences and 275,128 deaths due to cervix cancer, with 68 per cent of the cases occurs in the poorest regions of the world; i.e. South Asia, sub-Saharan Africa, and parts of Latin America. The majority of cases are squamous cell carcinoma (WHO: Human Papillomavirus, 2007; Reproductive Health Technologies Project, 2008), while the adenocarcinomas are less common. This number is estimated to increase by 35.90 per cent worldwide in year 2025 with 720,060 incidences and 395,095 deaths (WHO: HPV and Related Cancers, 2010).

The pathogenesis of cervical cancer is pointed to Human Papillomavirus (HPV). Papillomavirus are icosahedral DNA viruses, non-enveloped with diameter of 52-55 nm. It belongs to the family of Papovaviridae. The viral particles consists of a single double-stranded DNA molecule of about 8000 base-pairs that is bound to cellular histones and contained in a protein capsid composed of 72 pentametric capsomers (WHO: Human Papillomavirus, 2007).

HPV infection is associated with malignancies of urogenital tract and anus. It is also related to disorder of skin and the upper respiratory system. To date, more than 100 HPV types are acknowledged to exist. There 15 types are classified as high-risk (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68, 73, and 82), 3 types as probable high-risk (26, 53, and 66), and 12 types as low-risk (6, 11, 40, 42, 43, 44, 54, 61, 70, 72, 81, and CP6108). Almost 85 per cent of invasive squamous cell cancer is infected by types 16 and 18, and less common by types 31, 33, 35, and 51 (Prayitno, 2006; Kumar et al., 2007).

Unlike many cancers, actually cervix cancer can be prevented. By providing women with proper screening tests and when necessary medical treatment, this devastating disease can be cured. Papanicolau smear, or so-called Pap smear, test is one of screening methods commonly used for detecting abnormalities in the uterine cervix cells, including the changes in the cells when they evolve into cancerous cells. The result of Pap smear test provides information on the characteristics of cervix cells, that valuable for cytologists to diagnose whether a cell is normal or cancerous.

Today, many parts of the world are still mostly doing the screening and diagnosis of Pap smear test conventionally. Due to scarce number of skilled and experienced cytologists, the screening procedure becomes time consuming and highly prone to human errors that leads to inaccurate and inconsistent diagnosis. Meanwhile, early cervical pre-cancers or cancers often have no physical signs or symptoms. In most cases, symptoms do not appear until the cancer is further along and has spread to nearby areas (American Cancer Society, 2010). This condition increases the risk of patients who get HPV infection not to be detected and become HPV carriers while the virus spread out and turns into malignant in the cervix uteri.

In order to overcome this problem, standardization and automation of the screening process seems to be a solution. As regards machines, we might say, very broadly, that a machine learns whenever it changes its structure, program, or data in such a manner that its expected future performance improves. Machine learning, as a branch of artificial intelligence, concerns with the design and development of algorithms that allow computing to evolve such behaviors based on empirical data. A major focus of machine learning is to automatically learn to recognize complex patterns and make intelligent decisions based on data. The goals in machine learning are primarily to make predictions as accurately as possible and to understand the behaviour of learning algorithms (Rasmussen and Williams, 2006).

Therefore, an adaptive intelligent system is being developed to enable automatic recognition of the cancerous cells from the Pap smear specimens.