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ARTIFICIAL INTELLIGENT SYSTEM FOR DIAGNOSIS OF CERVICAL CANCER: A BRIEF REVIEW AND FUTURE OUTLINE

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Abstract: Cervical cancer is the fourth-most universal basis of cancer and decease from cancer in women. An estimated 528,000 cases of cervical cancer occurred, with 266,000 deaths. This is about 8% of the total cases and total deaths from cancer. About 70% of cervical cancers arise in developing countries. In low-income countries, it is the most common cause of cancer death. In the design of an artificial intelligent system, image processing and classification techniques are the most important techniques. This paper aims at reviewing the various algorithms and techniques required for diagnosis of essential features for the classification of cervical cancer into three different stages of normal, Normal, Low Grade Squamus Intraepithelial (LSIL), High Grade Squamus Intraepithelial (HSIL),

Keywords: Artificial intelligent system, Image processing, Feature extraction, artificial intelligent classifier, Multiple adaptive neuro-fuzzy inference system, Hierarchical Hybrid Multilayered Perceptron (H^2MLP) classifier.

I INTRODUCTION

Cervical cancer is the fourth-most common cause of cancer and death from cancer in women. An estimated 528,000 cases of cervical cancer occurred, with 266,000 deaths. This is about 8% of the total cases and total deaths from cancer. About 70% of cervical cancers occur in developing countries. In low-income countries, it is the most common cause of cancer death. In developed countries; the extensive use of cervical screening programs has dramatically reduced rates of cervical cancer. In medical domain, a rigorous research is being carried out to recognize cervical cancer cells and classify them into different stages so that a suitable treatment can provided.

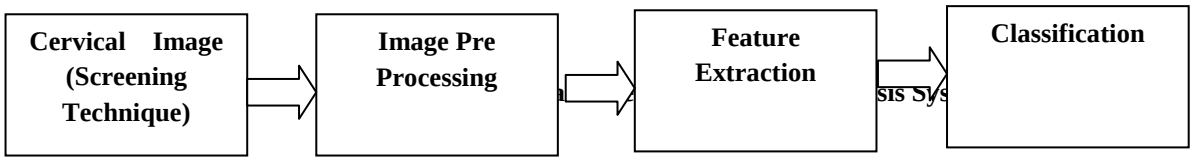
Recent rampant method used by pathologists for the diagnosis of cervical cancer is to manually observe the morphological changes in the cells by physical examinations; however, manual observation is very subjective and poses several problems [1]. In [2], the authors provide the progression from normal to invasive cervical cancer, the need for screening of cervical carcinoma, different methods of screening tests for cervical carcinoma and their advantages. The authors also provide information on different epithelial cell abnormality.

A major challenge for the countries of the third world is to formulate a screening program that is based upon available resources and which is easily available to a large section of society, particularly the rural populations. It is also important to set clear and realistic long term goals. With the active participation of medical personnel and emerging technology, a cost effective diagnosis system for cervical cancer needs to be formulated and implemented.

Many researchers [3-17] have worked in this direction since last decade and plenty of methods have been proposed in the area of automatic diagnosis of cervical cancer. However, there is a scope of improvement in all the three areas, i.e. image pre-processing, feature extraction and classification.

II. METHODOLOGY

In this system the cervical cancerous cells are collected through commonly used Pap smear test and image pre processing (noise rejection, de-blurring, image enhancement, edge detection) followed by feature extraction will be carried out. In the next stage, the obtained required features of the image is applied as input to intelligent system for classification of cervical images into three stages viz normal, Low Grade Squamus Intraepithelial(LSIL), High Grade Squamus Intraepithelial(HSIL).



Screening techniques: In [1], the author in brief reviews cervical screening techniques. Screening techniques for cervical cancer include 1) Conventional exfoliative cervicovaginal cytology i.e. the cervical (Pap) smear 2) liquid based cytology 3) Automated cervical screening techniques 4)Neuro medical systems 5) HPV testing 6) Polar probe 7) Laser induced fluorescence 8)Visual inspection of cervix after applying Lugol's iodine (VILI) or acetic acid (VIA) 8) Speculoscopy 9) Cervicography.

In this system the cervical cancerous cells are collected through commonly used Pap smear test method for sorting of cervical images into three stages viz normal, Low Grade Squamus Intraepithelial (LSIL), High Grade Squamus Intraepithelial (HSIL).

Fig 2: Pap Smear Test

The Papanicolaou test is a process of cervical screening used to distinguish potentially pre-cancerous and cancerous processes in the cervix (opening of the uterus or womb). Pap smear is performed by opening the vaginal canal with a speculum, then collecting cells at the outer opening of the cervix at the transformation zone (where the outer squamous cervical cells meet up the inner glandular endocervical cells). The collected cells are examined for abnormalities.

The data of the screening techniques are used as data for the computer screening arrangement as replaced in the specialist study. Four stages of the computer system are enhancement, features extraction, feature selection, and classification reviewed in detail.

Image Pre-processing: Pre-processing is a step to process raw image in such a way that they are ready to be used.

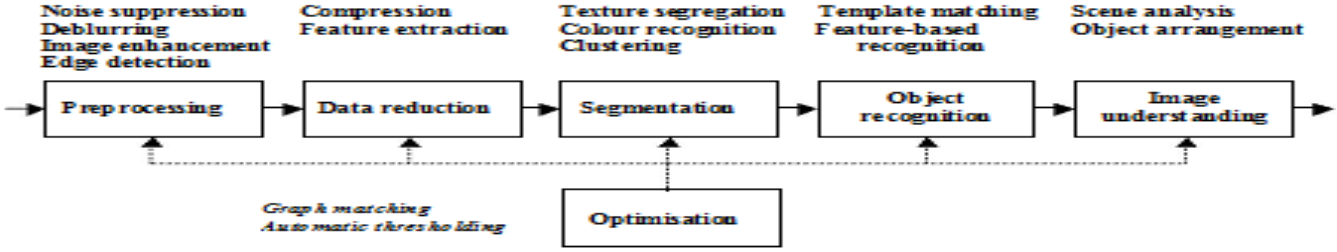


Fig. 3: The image processing chain [3]

In [5], the authors propose an algorithm for color intensity classification to classify cancerous and normal cell with minimum human error and improved accuracy. "Variation Level set Formulation of Curve evolution Without Reinitialization" is used to determine the range of color intensity and area of the cervical cells, but the abnormal cell cannot be further classified into different stages In [8], the author briefly reviews different approaches to Color Image Pre-processing and Segmentation. Recent techniques on neural networks, fuzzy logic, genetic algorithms and wavelet decomposition procedures were revisited.

Feature Extraction: Feature extraction is the method of extracting valuable information from the image. Features are characteristics of an image that are able to distinguish between different parameters like nucleus to cytoplasm ratio, shape, color intensity, nucleus area, eccentricity, nucleus perimeter etc. Most significant features (based on Doctor's advice) may be given more weightage in the proposed diagnosis system.

The obtained features through image processing is applied as input to the classifier (neural network, fuzzy system etc.) for classification of cervical cancer into three stages viz normal, Low Grade Squamus Intraepithelial (LSIL), High Grade Squamus Intraepithelial(HSIL). Mohammad Subhi Al-batah et al (2014)[12], discuss the automatic feature extraction (AFE) for features extraction process, a Neuro-fuzzy model called multiple adaptive neuro-fuzzy inference system (MANFIS) for classification. The proposed MANFIS produces

a good classification performance with 94.2% accuracy. The training accuracy produced by MANFIS was 96.3% and the testing accuracy was 94.2%. In [13], authors proposed a new features extraction algorithm called region-growing-based features extraction (RGBFE) is proposed to extort the cervical cells features. A new Artificial Neural Network (ANN) architecture called Hierarchical Hybrid Multilayered Perceptron (H^2MLP) network is proposed to envisage the cervical pre-cancerous stage.

Artificial Intelligent Classifiers: Artificial Neural Network (supervised or non supervised) or Fuzzy Logic system is used as classify different stages of cancer. Artificial neural networks are computational learning models inspired in the biology of the human brain. Fuzzy classification is the process of grouping elements into a fuzzy set whose membership function is defined by the truth value of a fuzzy propositional function. Seema Singh et al. (2015) [3] discuss morphological description of Cervical Cell images for the pathological recognition which can be used to develop a computer system which can help doctors in tracking the disease. The pre-processing step used are RGB-to-Gray Scale Conversion, Intensity Adjustment, Gray-Scale to Binary Conversion, Complementing and Filling Holes in the Image, Morphological Opening of the Image, Canny Edge Detection, Watershed Segmentation Perimeter and Labelling**.** Back-propagation algorithm of supervised training method is used for classifying the cancer slides based on six important features, i.e. nucleus area, nucleus perimeter, cell eccentricity, nucleus-to cytoplasm ratio, major axis-to-minor axis ratio and colour intensity of the cell. Accuracy obtained with proposed method is 79%.The software used for pre-processing and classification is MATLAB. Hierarchical Hybrid Multilayered Perceptron (H^2MLP) classifier can achieve accuracy of 94.29%, Sensitivity of 78.23%, Specificity of 99.48%, False Negative of 0.42%, False Positive of 0.52% [6]

In [7], authors developed a new learning algorithm called Modified Recursive Least Square (MRLS) for the Hybrid Multilayered Perceptron (HMLP) network. This research proved that the MRLS algorithm is stable and can provide faster convergence rate and better final convergence values of weights and thresholds for the HMLP network. The testing accuracy for Wisconsin Breast Cancer is 99.82% for the proposed HMLP with MRLS. Yung-Fu Chen et.al 2014[10] developed a semiautomatic PC-based cellular image analysis system for segmenting nuclear and cytoplasmic contours and for computing morphometric. Textual features to train Support Vector Machine (SVM) classifiers to categorize four different types of cells and to distinguish dysplastic from normal cells. An accuracy of 96.12% and 98.61% for four-cluster and two-cluster classifiers is obtained respectively. In [11], authors introduced a pattern classification method based on ANN, named HBG, in which a hybrid learning strategy is comprising back propagation and Gaussian weights. Babak Sokouti et al (2014[14] Levenberg–Marquardt feed forward MLP neural network (LMFFNN) is proposed to classify cervical cell. Based on the results, cervical cell images were classified successfully with 100 % correct classification rate using the proposed method. The rates of sensitivity and specificity were 100 % using LMFFNN method.

In [15], the authors have developed Support Vector Machine (SVM) and Adaptive Neuro Fuzzy Inference System (ANFIS) classifiers to classify the test Pap smear cell image into each normal or dysplastic cell image. Support Vector Machines are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis The output of classification obtained is found to be best for most of the images and the classification accuracy is 78%. M.Egmont-Petersena et al [17] discusses the importance of ANNs in image processing as either non-parametric classifiers, non-linear regression functions, or for (un)supervised feature extraction. This paper also gives a review on image processing using different artificial neural network algorithms. This paper provides information feed-forward ANNs, SOMs and Hopfield ANNs are the most frequently applied architectures.

III. DISCUSSIONS

This study has proposed an artificial intelligent system for cervical cancer diagnosis. It gives a clear review of the different algorithms employed in image pre-processing, feature extraction, intelligent classifier. Different algorithms employed at various levels have their own limitation in terms of accuracy, sensitivity, specificity, etc., which can be further improved. Researches are going on to improve the limitations in image pre-processing, feature extraction and classification of cancerous cells into different stages.

IV. FUTURE SCOPE

Due to limited number of skilled and experienced cytologists, the screening procedure becomes time consuming, costly and also prone to human errors leading to inaccurate and in consistent diagnosis. There is a need of an automatic diagnosis system which can assist clinicians and thereby reduce cost, time and expertise needed for cervical cancer screening. Therefore a system could be designed to produce a more accurate and faster screening and /or diagnosis. This system should be capable of updating itself with new and complicated cases of cervical cancer from time to time. With the active participation of medical personnel and emerging technology, a cost effective diagnosis system for cervical cancer needs to be formulated and implemented.

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