A CDSS For Annotation And Interpretation of Cervical Cells Using Image Analysis Techniques

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ABSTRACT: This work mainly focuses on development of a classification algorithm for segmentation of fluorescent image of cervical cells and classification of them as normal or abnormal. A GUI has been developed for a meaningful interaction between the user and the system and the results of the algorithm have been presented to the Clinician in a meaningful way to enable annotations and hence collate and build on the data base together with expert knowledge.

Keywords: CDSS, Cervical cells, GUI

I.   INTRODUCTION

Clinical decision support systems (CDSS) have been used for several decades and it has the potential to significantly improve patient care and patient safety [1]. A CDSS is of clinical value to physicians, improves the quality of care and decrease costs of health care delivery. There are some criteria for a successful deployment of a CDSS which includes: (i) The data entry and the decision algorithms; (ii) The human-computer interaction, which includes both the data acquisition, and the manner in which information is to be requested from the system; (iii) The output of the CDSS, which includes the format and type of information supplied. So in this study we focus on developing one of such components of CDSS for cervical cancer.

Cervical cancer is the second most common type of cancer for the women worldwide, but because it develops over time, it is also one of preventable types of cancer. The algorithm used in this work which is written in Mat lab coding recognizes the individual cervical cells from a cluster of cells and delineates them from the background. Morphological feature such as area of the nuclei were used to identify whether a particular cell is normal or abnormal. It may be noted that the nucleus morphology of the cervical cell harbors the most significant information about the changes in precancerous and cancerous cells when compared to the normal cells [4]. Hence identifying the nucleus automatically was one of the most important steps to detect abnormal cells in cervical smears. The Graphical user interface (GUI) for expert intervention was developed to present the automatically classified date for annotation of the expert [2]. The inputs provided by the expert were used in building or creating data / knowledgebase. The raw data was presented to the medical expert so that he or she could verify with his or her expert knowledge and hence allow development of ground truth knowledge. These external annotations were also automatically stored to the data base together with the images as needed. The Database contains a collection of cervical cells images in the raw form. These images when annotated, the algorithm creates another file tagged with the image containing the annotated data. Further when the algorithm compares the annotations with the clinical trials data and the case data as the case may be, the results generated out of such a comparison can also be stored in the data base. Thus the data base serves as both storage of raw data and the knowledge base.

1. Image Acquisition

For the purpose of the detection of cervical cells, fluorescent images of the cervical cells were used[5]. Fluorescent cervical images were taken from well known libraries, such as www.olympusmicro.com, www.invitrogen.com , and www.calit2.net. Fluorescent cervical images unlike other cervical images show the nuclei very prominently simplifying the image based detection.
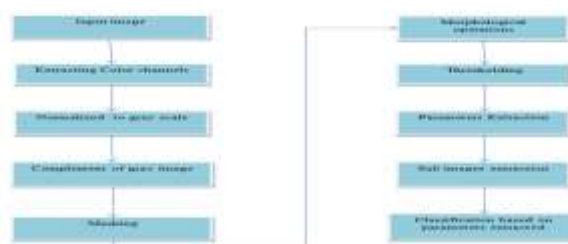
1.1 Image Analysis

Fig 1.1.1: Image analysis steps

The Image Analysis was done in Matlab R2012a. The input fluorescent image which was in the RGB form was taken.The color channels were then splitted. Each color channels were then normalized to gray scale image in the range of 0 to 255.The complement of the normalized gray scale image was taken after which masking was performed between the complement image and the original input image. [6] The morphological operations using structuring elements, dilation and erosion was performed on the masked image. Thresholding was performed to get the binary image. The work uses global thresholding with the normalized threshold value. The morphological parameters were then extracted, which includes areas, eccentricity, etc.[3] Using the morphological parameters, sub-images were then extracted using bounding box. Further classifications were done on the basis of areas obtained as normal and abnormal cervical cells.

II.   GRAPHICAL USER INTERFACE

The GUI was developed in Microsoft Visual studio 2008 comprising of three windows form [7]. It helps in the easy interaction between the computer and the expert. The segmentation done in the Image Analysis was presented in more easy and meaningful way using GUI. The forms created include various components taken from the toolbox. It comprises of buttons, combo box, picture boxes, combined image box, task bar, timer etc. Such forms are easy to use because the clinician can the verify the segmentation result by just clicking the appropriate button of the GUI.

The raw image was stored in the database as a separate file folder. The input image was processed in the classification algorithm comprising of various steps. In order that the classification algorithm can be accessed by the GUI, the Matlab code of the image processing algorithm was converted into an executable file using MCR (Matlab Compiler Runtime) which are available in the Matlab software itself. The proposed GUI was created in windows using Microsoft Visual studio 2008 (MVS2008). The executable file, of the algorithm and other functions of the GUI were linked in the MVS 2008 internally. On calling a function, say for example 'import image' or 'NEXT' which are presented as a button, the images were then displayed in the GUI for annotation by the physicians. The images were then annotated by the physicians and the annotated images were stored on by clicking the 'OK' button.

The annotated images were stored in the database with separate file tag as normal and abnormal. These data's from the database can again be used by the physicians for their future references.
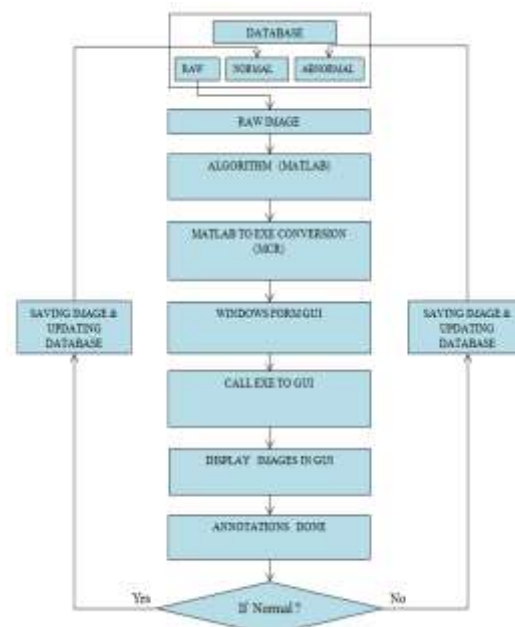

Fig 2.1: Flowchart of the GUI implemented

III.   DATABASE

The Database consists of the collection of cervical cells images in the raw form. These images when annotated, the algorithm creates another file tagged with the image containing the annotated data. Further when the algorithm compares the annotations with the clinical trials data and case data as the case may be, the results generated out of such a comparison were also stored in the data base. Thus the data base serves as both for the storage of raw data and the knowledge base.
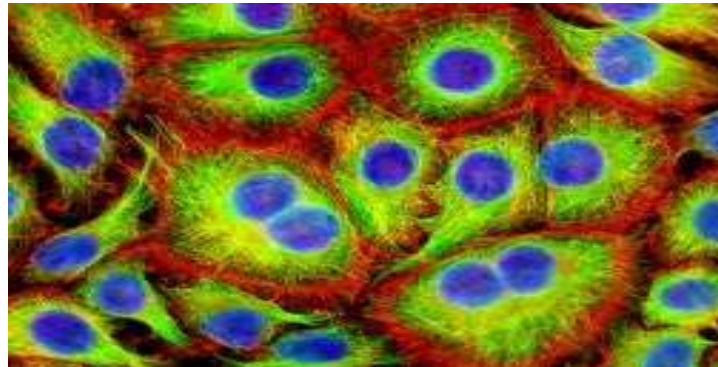
IV. RESULTS AND ANALYSIS
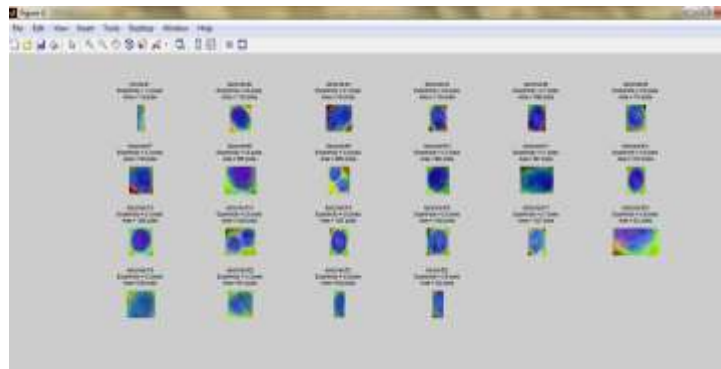

Fig4.1: Original Image

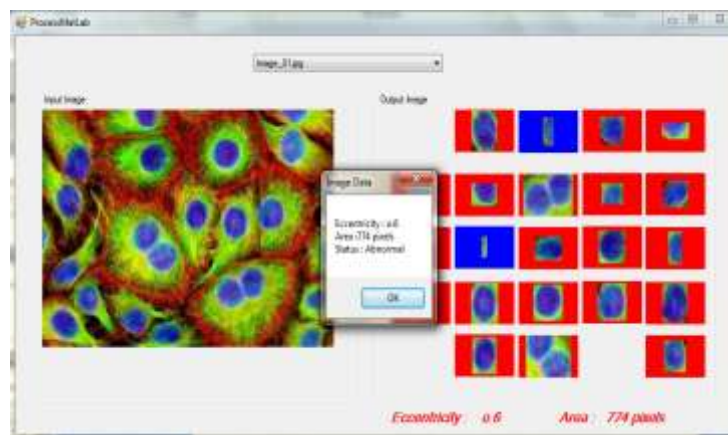**Fig4.2:** Segmented image with classification

Fig 4.3: Segmented image in GUI showing eccentricity and area

The results of the algorithm and GUI are presented. Fig. 4.1 shows original image of cervical cell highlighted by fluorescent dye and Fig.4.2 shows the corresponding nucleus of the cells of original image segmented and their classification as normal or abnormal. Fig 4.3 shows the original image side by side with their segmented form in the GUI. The parameters such as eccentricity and area were also displayed on the GUI saying it as a normal or abnormal one.

Around 25 images were processed by the algorithm and were classified as normal and abnormal depending on the parameters such as eccentricity and area. Out of which, 23 images were segmented accurately and were classified. The normal cells were found to have small area

and eccentricity compared to the normal one. Here the algorithm was found to extract the uniquely colored nuclei of the cervical cells due to fluorescent dye. It was found that the segmentation of nucleus was excellent and easy on account of using fluorescent image when compared to non fluorescent image. The annotation data and expert input provided through the GUI were stored in database as a separate file tag which can be used in future verification too.

V. CONCLUSION

In this work, a concept of CDSS for cervical cancer has been proposed. The three main components of the CDSS namely the Classification algorithm, the GUI and database were developed. The GUI was implemented in Windows form but in different platform. The interaction between the two different platforms, here Matlab and Visual Studio was itself a tedious job which was done successfully.   The results of the work were demonstrated and found to be establishing a process of concept. A fully implementation of cervical cancer CDSS is definitely a huge task which can be carried out as future work. Also the system created in this work can be easily extended to incorporate larger database with appropriate resources. It is believe that the current work is intended to just lay the foundation for cervical care CDSS and such a system should be of immense use in order to improve the cervical cancer care in specific and woman health in general.

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