Computer-Aided Design of Medical Devices Based on Deep Learning Model

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The abnormal growth of tissues in the small, lower portion of the uterus, known as the Cervix, which connects the uterus's main body to the vagina or birth canal, is known as cervical cancer. One of the most prevalent forms of cancer among women worldwide is cervical cancer. Reducing the severity level and death rates can be achieved through early detection and appropriate diagnosis. In this paper, we offer an automated cervical cancer diagnosis method based on MRI scans and the CRBNN (Convolutional Radial Basis Neural Network) Classifier. The MRI pictures are first pre-processed to get rid of unwanted sounds and other impacts. Following pre-processing, the region of interest is obtained by segmenting the picture using the DT-CWT method. The split region's texture features are extracted. A segmented area's nearly 13 attributes are taken, and the classifier is then used to determine whether or not the image is malignant. The suggested methodologies' outcomes yield useful classifications of malignant and non-cancerous images.

Keywords: Cervical Cancer; MRI Images; Multiclass SVM Classifier; Region growing segmentation; Texture features.

1. Introduction

There are trillions of live cells in the human body. Regular body cells go through a systematic process of development, isolation into new cells, and eventual death. Most cells divide after an individual reaches adulthood only to replace worn-out or dying cells or to heal wounds. When cells in a particular area of the body start to go mad, cancer is born. Cancer can take many different forms, but it all starts with the aberrant growth of abnormal cells. Compared to normal cell growth, cancer cell development is distinct [1]. Cancer cells do not die; instead, they continue to proliferate and divide into new, abnormal cells. Moreover, cancer cells have the ability to target many tissues, something that normal cells cannot [5]. A cell becomes a cancer cell when it starts acting erratically and attacking different tissues. Damage to DNA causes cells to develop into cancerous ones. Every cell contains DNA, which carries out all of the functions. Cancer cells frequently migrate to various bodily parts, where they begin to grow and form new tumours that replace healthy tissue. We refer to this process as metastasis. It occurs when cancer cells enter our body's lymphatic or circulatory systems [2].

The World Health Organisation (WHO) data indicates cross-national variations in the occurrence and mortality rates of cervical cancer [11]. The third most common malignancy among women worldwide, cervical cancer claimed 275,000 lives in 2008. Of those deaths, 159,800 occurred in Asia and 88% occurred in developing countries. It is usual to describe cervical cancer as a particular type of infection [14]. This is due to verified discrepancies in cervical cancer mortality and frequency between the created and creating worlds. The Crisis Card indicates that Africa has the highest death rate [4].

The following sections provide the paper's organisation: The cervix is discussed in Section 1 of the introduction. The suggested work is presented in Section 2. The results analysis is presented in Section 3, and the work's conclusion is presented in Section 4.

2. Literature Review

The disease known as cervical cancer is characterised by abnormal and uncontrollably proliferating cervix cells that frame tumours [6]. The lowest part of the uterus is called the cervix (belly). It is sometimes referred to as the uterine cervix. The upper portion of the uterus is where the baby develops. The cervix serves as the interface between the uterine body and the vagina (birth trench). The term "endo-cervix" refers to the portion of the cervix that is closest to the uterine body. Squamous cells (on the exo-cervix) are one of the two main cell types covering the cervix [7]. The change zone is where these two cell types converge. In the change zone, most cervical malignancies first manifest. The cells that coat the cervix are where most cervical malignancies begin. These cells do not suddenly develop into malignant cells [8]. Instead, precancerous alterations are gradually created by the normal cells of the cervix, which eventually lead to cancer [3]. Numerous studies have been conducted on the early diagnosis and treatment of cervical cancer using data from imaging studies, clinical trials, genomics, statistics, and other sources [13]. For improved detection, care, and expectations, grouping, bunching, affiliation mining, man-made consciousness, fuzzy reasoning, etc., have been connected to cervical cancer information [10]. Each of these studies has been conducted with consideration for the growing cancer epidemic [12]. The following observations are made about the traditional approaches for detecting cervical cancer:.

- The conventional methods are suitable only for high resolution cervical images.
- The external boundary region of the cancer regions was only detected.
- The sensitivity and accuracy rate was not optimum for further cervical cancer diagnosis [9].

3. Proposed Work

A computer-aided automatic detection system is the suggested approach for the diagnosis of cervical cancer. Figure 1 shows the general process for the detecting technique. The original cervical picture undergoes initial preprocessing. Oriented Local Histogram Equalisation (OLHE) image enhancement is applied, and the improved image is subsequently converted into a Dual Tree Complex Wavelet Transform. Using the taught characteristics as a comparison, the neural network classifier is further trained to identify the cervical picture as

benign or malignant. Lastly, an analysis is done on the cervical image classification's performance.

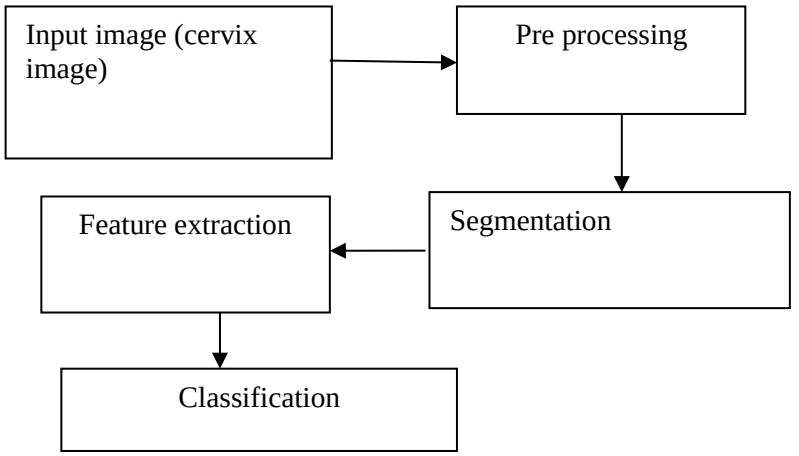


Figure 1: Overall Block Diagram

Convolution Radial Basis Neural Network (CRBNN), sometimes referred to as a convolution network, is a unique kind of neural network that has shown promise in its use for processing input in the forms of texts, images, and sounds. The term "Convolution Neural Network" refers to the network's use of the convolutional mathematical procedure. A dot product operation including filters and input matrices is what the convolution operation is. Convolution, pooling, and fully linked layers are the three primary layers of a CNN. These feed forward deep neural networks, like the CNN and RBN combo, have shown to be a significant advancement in the image classification problem. Compared to all other neural network types, CRBNN has shown to be a breakthrough in processing image, video, audio, and speech data. This network extracts properties that are incredibly useful for object recognition. Because CRBNN makes use of the shared weights principle, it can efficiently handle high dimensional data.

4. Experimental Result

The experimental results of the classification method using MRI cervical images with different types of cervical cancer are de-scribed in this section.

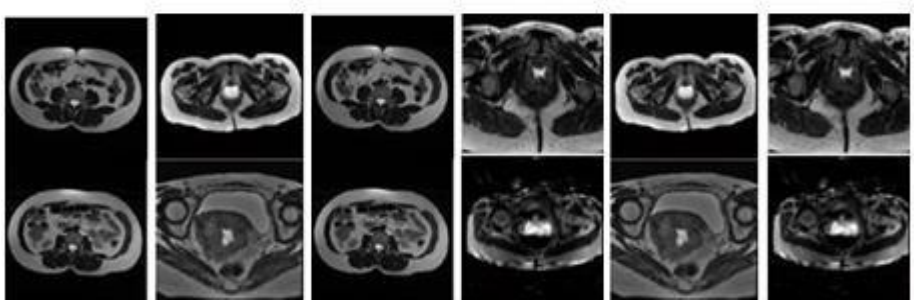
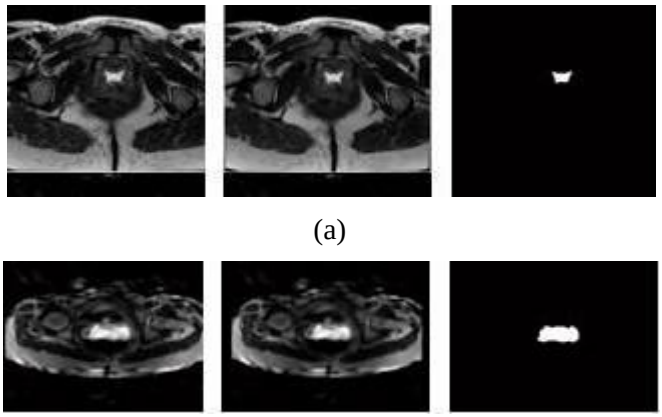


Fig 2: MRI cervix image data base



(a)

(b)

Figure 3: The input image, enhanced image and segmented image

The DT-CWT technique is utilised for segmentation after pre-processing; 13 characteristics are then retrieved from the segmented area (as indicated in Table 1), and CRBNN is used for further classification, correctly identifying benign and non-cancerous.

Table 1: performance value of CRBNN

classifier	CRBNN
Accuracy (%)	98.2
Error (%)	1.8
Sensitivity (%)	96.24
Specificity (%)	98.62
Precision (%)	96.83
F1_score	0.9521
MCC	0.9312
kappa	0.9386

From the comparison the CRBNN classifier produces best results and the classifiers used in the present work clearly produces better results than other classifiers.

5. Conclusion

Clinically important and biologically interpretable elements have been used in automated classification systems to diagnose cervical cancer from photographs. Neural network categorization serves as the foundation for the suggested cervical cancer detection method. An approach based on oriented local histogram equalisation is utilised to improve the cervical pictures. Neural network classifier is used to classify cervical pictures into normal and pathological images. The suggested cervical cancer segmentation approach is for the identification of cancerous and non-cancerous regions in cervical pictures, according to the simulation results. The cervical cancer detection system's performance metrics reach high performance values.

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