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Artificial neural networks for automatic segmentation and identification of nasopharyngeal carcinoma

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ABSTRACT

Nasopharyngeal Carcinoma (NPC) diagnostic is a challenging issue that have not been optimally solved. NPC has a complex structure which makes it difficult to diagnose even by an expert physician. Many researchers over the last few decades till now have established a lot of research efforts and used many methods with different techniques. However, the best solution to resolve the mentioned issue is very complex and needs innovative methods to find the optimal solutions. The study presents a novel automatic segmentation and identification for NPC by artificial neural networks from microscopy images without human intervention by developing the best characteristics towards preliminary NPC cases discovery. For getting accurate region of NPC in the microscope image, we propose a novel NPC segmentation method that has three major innovation points. First, *K*-means clustering will be used in the first stage after enhancing the image to be labelled in the regions based on their colour. Second, neural network has been employed to select the right object based on training stage. Third, texture feature for the segmented region will extract to ted to the segmentation. Regarding to the identification, the colour features have used to diagnose the ovarian tumours to the differential between benign and malignant. The findings outcome from this study have shown that: (1) A new adaptive method has been used as post-processing in detecting NPC, (2) Identified and established an evaluation criterion for automatic segmentation and identification of NPC cases, (3) Highlight the methods: based on region growing based technique and *K*-means clustering method for selecting the best region and (4) Assessed the efficiency of the anticipated results by associating ANN and SVM segmentation results, and automatic NPC classification. Also indicate that the texture features have some extra value or added value in separating benign from malignant. Therefore, we can use the proposed system, first, as indicator to diagnosis the case, second, use it as a support tool for the doctor to support his decision. We evaluated the effectiveness of the framework by firstly comparing the automatic segmentation against the manual, and then integrating the proposed segmentation solution into a classification framework for identifying benign and malignant tumour. Both test results show that the method is effective in segmentation the region of interest which is around 88.03% Consequently, this rate expanded to 91.01% when line presumption (NPC classification) based on ANN technique is employed with high level accuracy of classification (sensitivity) of 93.42% and specificity of 90.01%.

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1. Introduction

Medical Images are very much significant in medical analysis, where they offer beneficial data corresponding to tumor location, extent of tumor, capacity of tumor and its brutality. Various strategies that could generate medical images have to be analysed. Moreover, the methods which yield such images are quite vital so as to know about the particular method which could be applied over medical images for attaining good outcomes. Several approaches are brought out by different authors towards Computed Tomography, X-rays, MRI images, Microscopy Image and additional radiological methods. With such valuable efforts, the domain of processing medical images is still under constant expansion. There arises a question about the slow-progress of this field without a better acceptable strategy. One reason to this concern is that, the correctness should be typically higher and false negative rate should be lower, also such results could not be attained easily. The indication is in reducing manual error at the maximum, by supporting physicians or radiologists with some software which typically yields superior outcomes, thereby resulting in protecting the lives of human beings [1].

Number of computer-based image processing and analysis tools are proposed. These images can be taken from different ways that are viable and non-offensive. Usually, every image encompasses together the relevant and irrelevant tumor data. Microscopy images is a non-invasive medical imaging method. A Microscopy field is used to make imageries of dissimilar sections of human physique, allowing assessment or identification of specific diseases. Microscopy images method provides a lot of detailed knowledge, which might require good skills of specialists generally (doctors) otherwise might results in inoperative and inexact manual diagnoses. A computer-based system can be an effective method that processes information correctly inside a relatively brief time [2].

Nasopharyngeal Carcinoma diagnostic is a challenging issue that have not optimally solved. NPC has a complex structure which makes it difficult to diagnose even by an expert physician. Many researchers over the last few decades till now have established a lot of research efforts and used several methods with different techniques. However, the best solution to resolve the above mentioned issue is very complex, and needs innovative methods to find the optimal solutions. NPC is a type of cancer in the head and neck, and this cancer occurs in the oesophagus section among pharynx and adenoidal opening. This cancer represents major health problem in Malaysia, being the fourth most common tumor among Malaysians, and third most common cancer disease among Malaysian men. NPC is emphatically connected with Epstein-Barr Virus (EBV) and happens at the back of the nose. Radiotherapy is persuasive beside early stage NPC, be that as it may, more than 70% of cases gave late stage infection, primarily as a consequence of the non-particular indications and the trouble of analyzing the nasopharynx clinically [3,4].

Image Segmentation is quite problematic and significant step towards numerous computer vision issues and its pertaining applications. This dynamic field of scientific research in the recent years helps to makes an easy sample of medical image, and to indicate a region of interest (ROI). Segmentation is the process towards partitioning images to several regions as per particular rules. The purpose for segmentation is utilizing these regions for ROI recognition to distinguish any cancer lesions. Best results of segmentation decide the eventual success or failure of the cancer diagnosis or analysis. Most Segmentation methods of medical images processing utilizing seed region growing method is increasingly important turning into a well-known technique in view of its capacity to include important level of knowledge [5,6]. Region growing is one of the basic region based segmentation technique, which could be further categorized into a pixel-based segmentation technique, as this technique includes in determining the preliminary seed points. The word segmentation for a non-mathematician implies an image division into different regions or objects [7,8]. Usually in medical term, the image segmentation is all about in separating the image data to a flawless, expressive portions by assigning limits or identifies objects or regions that distinguish from the background or from other objects. Mathematically, segmentation being a decomposition of an image into dissimilar regions or categories, must restrict the overlap of image regions. It is strictly expressed as the following. Let, F represent collection of every pixels and P ( ) represents homogeneity predicate expressed in collections of interconnected pixels. Therefore, segmentation is the mechanism of dividing the set F to set of linked subsets or expanses ($Sub_1, Sub_2, Sub_3, \ldots, Sub_n$) thereby [9–11],

$$\cup_{i=1}^{n} S_i = F \tag{1}$$

With

$$Si \cap Sj = \phi i \neq j \tag{2}$$

The existing studies on automatic seed selection in medical image segmentation can be categorized into three methodologies: region extraction-based, features extraction-based and edges extraction-based. Region extraction-based methods incorporate techniques such as Region Grown [12], HMRF-EM with Maximum Entropy [1], Binarization [13], Moving k-means [14], Binarize technique [15], k-means [16], PSO clustering technique[17], Fuzzy c-means algorithm [18], etc. Huang et al. presented a novel automatic NPC segmentation approach that is used in MR images. Adaptive calculation of the nasopharyngeal district area is initially performed. The contour of the tumor is resolved through separation regularized level set advancement with the underlying form acquired by the closest neighbor diagram model. The proposed method is tested on MR images of 26 NPC patients and has accomplished great results [1]. According to Ritthipravat et al. presented an automatic segmentation technique to identify NPC regions in CT images. By the region grown method, they have proposed their technique, where one primary seed gets habitually created. A probabilistic map signifying to the probability in being the tumor pixel at each CT images shall be created and employed for commencing the seed determination. Such map has been formed from three functions that are created boundless supply of tumor considered, strengths of tumor pixels and unevenness of structures. A delegate of possible tumor pixels shall be chosen as the underlying seed [12]. An involuntary computer assisted scheme for breast tumour segmentation from MRI with enhanced automatic seeded region growing algorithm and automated initial seed threshold selection has been entailed. In their study, two techniques are used such as level set active contour and morphological thinning [13]. To attempt automatic system for breast tumour, Isa et al., anticipated modified seed based region growing (MSBRG) procedure. Their results revealed that, the proposed MSBRG method successfully detects and distinguish breast tumour. The moving k-means clustering algorithm is used to find the threshold value as introduced in [14]. A developed involuntary seed point assortment technique has been enumerated for breast US imageries. This proposed Binarize technique incorporates texture constraints and breast lesion spatial characteristics as revealed in [15]. The k-means algorithm used in Automated Multicells Segmentation from ThinPrep® Image adapted seed based region developing by means of clustering technique, and moments calculation has been presented in [16]. Automatic Seeded Region Growing for Breast MRI Tumour Segmentation by Particle Swarm Optimization (PSO) Image Clustering exhibited good performance over other segmentation studies, and has validated with same Breast MRI database as shown in [17]. Computer aided diagnosis system helps doctors to identify breast lesion in mammogram images by using Fuzzy c-means algorithm.

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