ISCHEMIC STROKE CLASSIFICATION USING MACHINE LEARNING TECHNIQUE BASED ON 3D MRI DATA

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Supervisor's Name : NORHASHIMAH BINTI MOHD SAAD

Date :2 th June 2017

DEDICATION

For my beloved family

Amsah Bin B.N Kedar

Sa'yah Binti Kasim

Muhammad Nor Ezani Bin Amsah

Muhammad Zarul Azrin Bin Amsah

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ABSTRACT

Magnetic resonance imaging (MRI) is a medical imaging technique that uses magnetic fields and radio waves to produce high-quality images of the body. It is a non-aggressive, no-radioactive and pain-free medical imaging system for visualizing and non-invasively detecting the stroke. An accurate automatic detection and classification of images is very important task for a proper medication because any delay or wrong diagnosis may become a fatal to the patient. Besides, an assessment of brain lesion in MRI is a complicated process and only can be performed by experienced neuro radiologists with significant degree of precision and accuracy. The result from the MRI scan only can be reviewed by the professional neuro radiologist and the task is time-consuming. The objective of this project is to design a technique for stroke detection and classification using Machine learning technique, to analyze brain MRI for stroke detection and classification and lastly, to evaluate the performance of the machine learning technique in the detection and classification stage. The Region of interest (ROI) that obtained from the segmentation stage will be analyzed for classification process. First order statistical approach is applied on the Region of interest (ROI) to extract the feature of MRI image and used as input to Support vector machine (SVM) classifier. It will show the characterization of the ROI of different type of ischemic stroke either acute or chronic lesion. After the classification stage, the performances evaluation of the system are verified. The performance of this classification system are accuracy, sensitivity and specificity. The results demonstrate that 100% accuracy has been achieved for both lesion. Last but not least, the Graphical User Interface (GUI) was developing to make the system user friendly and attractive.

ABSTRAK

Penimejan magnetik resonan (MRI) adalah teknik pengimejan perubatan yang menggunakan medan magnet dan gelombang radio untuk menghasilkan imej yang berkualiti tinggi pada anggota badan. Teknik ini merupakan sistem pengimejan perubatan yang tidak agresif, tidak radioaktif and kesakitan bebas untuk menggambarkan dan tidak invasif dalam mengesan strok. Pengesanan automatik dan klasifikasi imej yang tepat adalah tugas yang sangat penting bagi mendapatkan rawatan yang betul kerana kelewatan dan salah diagnosis akan membawa maut kepada pesakit. Selain itu penilaian lesi otak MRI adalah satu proses yang rumit dan hanya boleh dilakukan oleh pakar radiologi yang berpengalaman dengan kepakaran yang cekap. Hasil daripada imbasan MRI hanya boleh dikaji oleh pakar radiologi dan tugasan itu memakan masa. Objektif projek ini adalah untuk mereka teknik untuk mengesan dan klasifikasi strok dengan menggunakan teknik Pembelajaran mesin, untuk menganalisis MRI otak bagi pengesanan dan klasifikasi dan akhirnya, untuk menilai prestasi teknik Pembelajaran mesin pada peringkat pengesanan dan klasifikasi. Rantau kepentingan (ROI) yang diperoleh dari peringkat segmentasi akan dianalisi untuk proses pengelasan. Peringkat pertama pendekatan statistik digunakan pada ROI untuk megeluarkan ciri-ciri imej MRI dan digunakan sebagai input untuk Menyokong Mesin vector (SVM) pengelasan. Pencirian ROI yang berlainan jenis bagi strok iskemia akan dapat dilihat samaada lesi akut atau kronik. Selepas peringkat klasifikasi, penilaian prestasi sistem akan dianalisis. Prestasi sistem pengelasan ini adalah ketepatan, kepekaan dan pengkhususan. Keputusan menunjukan bahawa 100% ketepatan yang telah dicapai oleh kedua-dua jenis lesi strok Akhir sekali, grafik antara pengguna (GUI) telah dibangunkan untuk membuat sistem mesra pengguna.

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μ	=	Mean
σ	=	Standard deviation
$\boldsymbol{\Phi}$	=	Empty set

LIST OF ABBREVIATION

CSF	-	Cerebrospinal Fluid
CT	-	Computed Tomography
DCM	-	DICOM
DICOM	-	Digital Imaging and Communication in Medical
FLAIR	-	Fluid-attenuated inversion-recovery (FLAIR)
FN	-	False negative
FP	-	False positive
GUI	-	Graphical User Interface
IQ	-	Intelligent quotient
ISLES	-	Ischemic Stroke Lesion Segmentation 2015
MRI	-	Magnetic Resonance Image
nmri	-	Nuclear magnetic resonance imaging
PET	-	Positron Emission Tomography
RF	-	Radio frequency

ROI - Region of Interest

TN - True negative

TP - True positive

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CHAPTER I

INTRODUCTION

In this chapter, the introduction of project, problem statement, objective and scopes of project. Besides, it is also explains about the thesis methodology and organization of chapter.

1.1 Project Background

Stroke is the second leading cause of death in Malaysia after coronary heart disease as stated by the World Health Organization (WHO) survey in 2014 [1] . A stroke occur every 40 seconds and every 4 minutes someone dies from stroke. The insufficient of the blood supply to the brain cells is a medical condition known as stroke, this disease may causes a damages of brain and may result in their death. The location of the damage brain and the total damages of brain show how someone affected with the stroke.

Strokes are mainly consists of two type which are ischemic stroke and hemorrhagic stroke. Ischemic stroke occur when a blood vessel blocked by a clot and the blood cannot flow to the brain and hemorrhagic stroke happens when a blood vessel burst. For about 80 percent of the stroke patient suffer with ischemic stroke.

Magnetic resonance imaging (MRI) is an imaging technique that using a magnetic fields and radio waves to provides a high-quality images of the body, thus it is a non-aggressive, non-radioactive and pain-free medical imaging system for visualizing and detecting the stroke non-invasively.

An accurate detection and classification of stroke lesion by multi-spectral magnetic resonance images are the key for implementing successful therapy and treatment planning as an initial planning when the situation of the patient become irreversible if the proper medication is not provided within first three hours of occurrence stroke in the body [2] . The patients that being diagnosed by conventional methods is sometimes erroneous because lack of adept by physicians. In stroke treatment, the faster treatment can be initiated, the better the chance of a successful outcome for the patient.

The classification of stroke lesion can improve this situation and help radiologists diagnose and make treatment plan. Therefore, a computerized stroke detection and classification is needed to aid physicians in examining the ischemic stroke.

1.2 Problem statement

Accurate detection and classification of images is very challenging task and it is very importance for given a treatment and medication to the patient because as any delay or wrong diagnosis may become an irreversible to the patient [3]. In addition, assessment of brain lesion in MRI is a complicated process and only can be performed by experienced neuro radiologists with significant degree of precision and accuracy. It is difficult for a clinicians to perform an assessment precisely to the lesion on the basic of radiographic appearance. So, quantitative analysis using computers can help the radiologists to solve these problem [4]. Patients that having symptom of stroke, will undergo a scan which can only be reviewed by a professional neuro radiologist and the task is time-consuming. Therefore, radiologists are continuously seeking for greater diagnosis accuracy by modern medical imaging system.

1.3 Objectives

The main objectives of this project are:

1. To design a technique for stroke detection and classification using Machine learning technique.
2. To analyze brain MRI for stroke detection and classification.
3. To evaluate the performance of the machine learning technique in the detection and classification stage.

1.4 Scope of work

The scope of this project includes:

1. This research analyzes several types of lesions which based on MRI, which is ischemic stroke.
2. The Data of stroke brain lesion is obtained from Ischemic Stroke Lesion Segmentation 2015 (ISLES2015).
3. MATLAB is used as the computational tool.

1.5 Thesis Methodology

In order to complete this project, these are the main parts of project:

1. Literature review

   Research and collect information on stroke, MRI and support vector machine to develop the system. The sources are based on journals, internet resources, previous project and books.

2. Data collection

   The MRI image is acquired from Ischemic Stroke Lesion Segmentation 2015 (ISLES2015) stored in DICOM (Digital Imaging and Communications in Medical) format.

3. Segmentation

   Image segmentation is performed to obtain region of interest (ROI). This process are performed based on the manual reference image by using MATLAB software.

4. Feature Extraction stage

   This process is performed using first order statistical approach to obtain the information from ROI after segmentation stage. The extracted features will become the input to the classifier which will consider the relevant properties of the image into a feature space.

5. Classification stage

   The brain lesion is classifying by using the Machine learning method which is support vector machine.

6. Classification performance

   Evaluation of the performance for classification techniques to show the efficiency of the proposed method.

7. Software development

   The automatic detection and classification of the brain lesion is developing by using Math Works and Graphic User Interface.