DIABETIC RETINOPATHY CLASSIFICATION USING HYBRID SUPPORT VECTOR MACHINE-NEURAL NETWORK

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Abstract

Diabetic Retinopathy (DR) is a microvascular complication of diabetes which can cause permanent vision loss. The detection of DR is conducted through eye screening and it is done manually using qualitative scale to detect abnormalities on the retina. Although this approach is useful, the detection is not accurate; and creates an obligation for a tool that can easing the experts to classify the severity of DR. Machine learning have been studied by previous researchers to propose an automatic DR classifier. However, it needs to be improvised especially in terms of accuracy. Hence, this paper aimed to find classifier with optimal performance in the study of DR classification. This study considered three classes of diabetic patients which were patients who do not have DR (NODR), patients with non-proliferative DR (NPDR) and patients with proliferative DR (PDR), instead of focusing only on two classes (NO DR, DR). Support Vector Machine (SVM) was used in this research due to the success of many classification problems that had been proposed which produced good result. Since it is known that hybrid algorithms have potential of giving better result, Artificial Neural Network (ANN) is chosen to be incorporated into SVM in order to improve the performance. The results obtained showed that SVM gave the best accuracy, 94.55% with average sensitivity of 0.9511 and average specificity of 0.9704 respectively.

1 INTRODUCTION

Diabetic Retinopathy (DR) is a part of complication of Diabetes Mellitus (DM) and it affects 1 in 3 person with DM. The number of DR prevalence is increasing year on year. According to WHO Global report, the number of adults living with diabetes has almost quadrupled since 108 million in 1980 to 422 million adults in 2016. This dramatic rise is largely due to the rise in type 2 diabetes and factors driving it include overweight and obesity [1]. With the increasing number of cases nowadays, abnormal retinal classification become a challenging task for ophthalmologist as they need to deal with a large number of retinal image to be diagnose every day. Screening and early detection of DR are playing an important role to help reduce the incidence of visual morbidity and vision loss. The screening tasks are done manually in most country [2]. Issue of variability in grading arise from this manual grading as the boundaries between the grades may differ between observers and also prone to error [3].

The process is carried out through naked eyes inspection. This inspection is carried out using an ophthalmoscope to directly inspect the fundus of the eye. The pupil will be dilate before it is examined. Usually, the experts identify relative charac-

teristics such as to differentiate between normal and abnormal retina based on their experience. The retinal is mostly evaluated using qualitative scale such as mild, moderate, severe and extreme. Occasionally, it is useful but not very effective [4]. Issue of variability in grading arise from this manual grading as the boundaries between the grades may differ between observers and also prone to error [3]. The prevalence of the disease is drawing an attention for all the parties to play their parts towards the prevention and treatment of the disease. Collaboration between experts from different areas can be achieved with the sophisticated technology nowadays. Currently, the application of computational technique has made a huge impact in health sector. Computational technique such as supervised machine learning is popularly used to predict the presence and absence of the disease. These methods play vital roles in improving the way for detection, diagnosis and treatment of the disease.

Among the solution that have been proposed by previous researchers is to come out with DR classification that can help ophthalmologist for grading process. There are various methods have been applied for DR classification. Some of them are classifying using retinal imaging which is a classification technique performed based on the abnormalities found on retinal fundus image such as exudates, microaneurysm, hemorrhages and also blood vessels. Although the retinal imaging technique facilitate early detection of DR, they required additional equipment which is quite cost-prohibitive or sometimes unavailable especially in rural areas. On the other hand, several DR classifiers have been developed using clinical variables as an alternative to retinal imaging. However, there is still some space for improvement especially in the accuracy of the classifiers.

Therefore, this study is proposed to classify DR with the objective to find DR classifier with optimal or near-optimal performance matrices using hybrid of Support Vector Machine and Artificial Neural Network. There are several advantages of this study. First and foremost, the clinical variables used in this study are selected by doctors, thus the validity of the features used are unquestionable. Equally important, this dataset encompasses of three classes of diabetic patients which are patients that do not have DR (NODR), patients with non-proliferative DR (NPDR) and patients with proliferative DR (PDR). Usually, DR classification focus only on two classes which are to classify whether a person being diagnosed with DR or not. This classification can assist the doctors to perform an optimum decision-making regarding the type and medication to be prescribed. In addition, unnecessary testing and check ups can be prevented.

2 PROPOSED WORK

SVM has difficulties to map the class labels which are close to each other, for example the value in clinical record for NODR patients are close to the value in clinical record for NPDR patients. Therefore, SVM sometimes misclassified NODR patients as NPDR. It is rarely to find SVM misclassified NODR patients to PDR patients as the NODR and PDR have large difference in relative value. In the context of SVM, the margin that discriminating between these two classes are large compared to NODR-NPDR classes.

In this study, ANN is chosen to be incorporated to this study to overcome the limitation of SVM. ANN is known to has a good ability to learn in complex data. The hidden layer introduced in the architecture of ANN gives it an advantage of learning the data pattern including non linear relationship between the variables.

In this hybrid SVM-NN, SVM algorithm is consider the main algorithm (A_1) while ANN algorithm is considered as the secondary algorithm (A_2). The process was started with initialization of input and SVM parameters. The kernel used is RBF kernel as it had shown a good performance in the previous chapter. Therefore, two hyperparameters of RBF, which are C and γ are set with the optimized value. C is set to 16 and γ is set to

0.03.

Figure 1 shows the overall flow of SVM-NN to form SVM-NN.

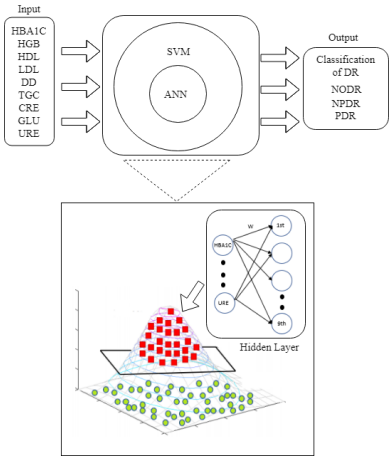

Figure 1: Process of SVM-NN

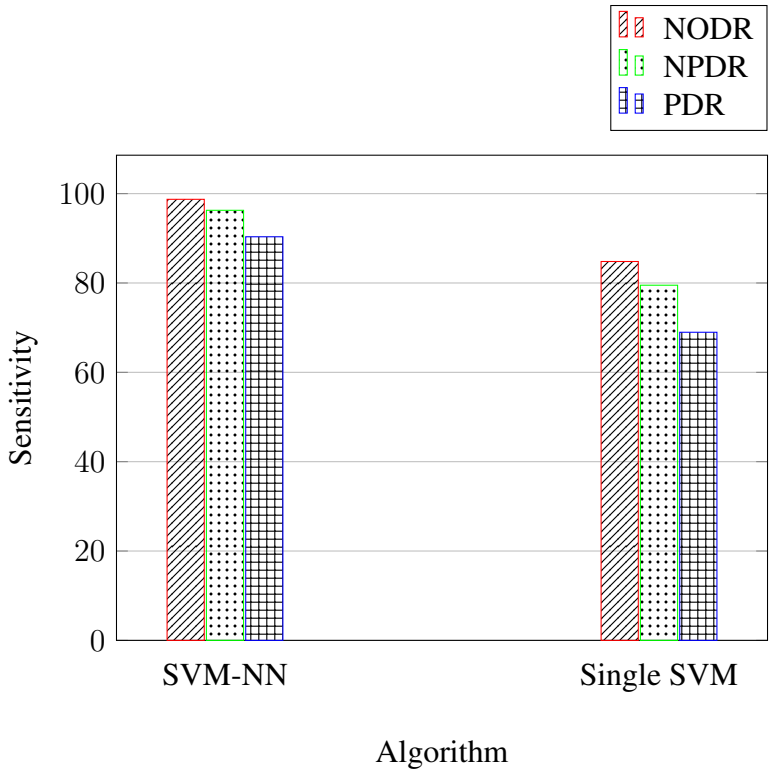

Figure 2: Comparison of sensitivity between SVM-NN and Single SVM

3 PRELIMINARY RESULTS

With the 9 input feeded and processed in hidden layer and also train with the kernel function, SVM-NN showed a great result in classification, which is 94.55% in accuracy. Besides, in the other additional metrics, SVM-NN also obtained a great performance measure. The average value of sensitivity and specificity for each class in optimized SVM is high which are 0.9511 and 0.9704 respectively.

When compared SVM-NN to single SVM, the accuracy of SVM-NN is higher than single SVM with difference in 18.13%. Besides, the result performance that demanded a high attention is the sensitivity value of an algorithm. It has already been mentioned by [5] that suggested the index, sensitivity has to be the first to be considered.

This is because in the reality of medical care cases, if a patient is true positive but he/she has not cured further, he/she will suffer an irreparable damage or in DR, it is permanent blindness. Based on the Figure 3, sensitivity measure of SVM-NN is higher than single SVM algorithm. Thus, it means that the ability of SVM-NN to recognized the patients for NODR, NPDR and PDR is better than single SVM.

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