An Automated Strabismus Classification Using Machine Learning Algorithm for Binocular Vision Management System

Muhammad Amirul Isyraf Rohismadi
Faculty of Computing
Universiti Malaysia Pahang Al-Sultan Abdullah,
26600 Pekan, Pahang, Malaysia

Anis Farihan Mat Raffei *
Faculty of Computing
Universiti Malaysia Pahang Al-Sultan Abdullah,
26600 Pekan, Pahang, Malaysia
anisfarihan@ump.edu.my

Nor Saradatul Akmar Zulkifli
Faculty of Computing
Universiti Malaysia Pahang Al-Sultan Abdullah,
26600 Pekan, Pahang, Malaysia

Mohd. Hafidz Ithnin
Kulliyah of Medicine
International Islamic University Malaysia
25200 Kuantan, Pahang, Malaysia

Shah Farez Othman
Kulliyah of Medicine
International Islamic University Malaysia
25200 Kuantan, Pahang, Malaysia

Abstract— **Binocular vision is a type of vision that allows an individual to perceive depth and distance using both eyes to create a single image of their environment. However, there is an illness called strabismus, where it is difficult for some people to focus on seeing things clearly at a time. There are many diagnoses that need to be done for doctors to diagnose whether patients suffer from strabismus or not. Besides, a new practitioner could lead to misdiagnosis due to lack of professional experience and knowledge. To overcome these limitations, a machine learning algorithm, which is a case-based reasoning, is developed to automate the strabismus classification. The results showed that the case-based reasoning algorithm provides 91.8% accuracy, 89.29% precision, 92.59% recall and 90.91% F1-Score. This shows that using the case-based reasoning algorithm can give better performance in classifying the class.**

Keywords—Accommodative amplitude, strabismus diagnosis, machine learning, classification, case-based reasoning

I. INTRODUCTION

People are normally born with a pair of eyes that enable them to see the world. However, some people suffer from eye illness that makes it difficult for them to focus on seeing things clearly at a time. This condition is called a squint or strabismus, where the eyes do not align properly and point in different direction [1]. Strabismus is the most common cause of amblyopia, where both eyes do not develop properly during childhood. If this condition is not treated well, he or she will experience vision loss that is permanent and irreversible [2], [3]. Furthermore, strabismus can be diagnosed through several methods. One of the methods is evaluating the amplitude of accommodation (AA), which the maximum amount that the eyes can focus on an object at variance distances [4], [5]. This method also known as a diagnostic method. The diagnostic method is normally performed using a device called a Ruler for Accommodative Function (RAF ruler) [6]. The RAF ruler is a hand-held device that consist of a series of lines with different thickness and font size. The device is moved toward

or away from the eyes while the patient is fixating a target, until the patient can no longer clearly read the lines. The diagnostic method is usually performed for three repetitions to obtain accurate measurements for each eye in dioptres (D).

In addition, the diagnostic method is greatly dependent on physicians' professional experience and knowledge, which sometimes can lead to a misdiagnosis especially for a new practitioner [4] and providing accurate as well as accessible diagnoses is a fundamental challenge to medical diagnosis. Furthermore, this process will also take longer because it requires confirmation of the diagnosis from a more experienced doctor. To overcome this situation, a machine learning has showed promises in medical diagnosis [7, 8]. For the strabismus classification, only Kim et al. [9] proposed a convolutional neural network model to classify type of strabismus either esotropia, exotropia or normal eyes, according to the direction of the pupil in the color frontal eye images. Due to the limited amount of data, their proposed model showed only 66.7% classification accuracy.

A medical record is an account of a patient that contains information regarding symptoms, with comments from the physician or other healthcare practitioners detailing their observations as well as discussions with the patient [10]. Traditionally, in optometry clinic at Kuliyyah of Allied Health Sciences, International Islamic University Malaysia, the patient medical data is still recorded on paper (see Fig. 1). The use of paper in recording the patient medical data has caused many problems such as storage space is insufficient, the records are disorganized, mildew, moths, illegible handwriting, natural loss, and other phenomena may cause irreparable losses [11, 12]. With the rapid development of internet technology and the continuous improvement in managing information, digital medical record management has become an inevitable trend in hospitals. With this, the digital medical record is the important basic content, and the management system provides data statistics, querying, analysis, and summary functions. However, most of the existing medical record management systems do not have automatic diagnosis functionality.