Chapter 1
Prediction of Neurological Disorders Using Visual Saliency: Current Trends and Future Directions

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ABSTRACT

Neurological disorders are diseases of the central and peripheral nervous system and most commonly affect middle- or old-age people. Accurate classification and early-stage prediction of such disorders are very crucial for prompt diagnosis and treatment. This chapter discusses a new framework that uses image processing techniques for detecting neurological disorders so that clinicians prevent irreversible changes that may occur in the brain. The newly proposed framework ensures reliable and accurate machine learning techniques using visual saliency algorithms to process brain magnetic resonance imaging (MRI). The authors also provide ample hints and dimensions for the researchers interested in using visual saliency features for disease prediction and detection.

INTRODUCTION

Neurological disorders are medically defined as disorders that affect the brain as well as the nerves found throughout the human body and the spinal cord. Structural, biochemical, or electrical abnormalities in the brain, spinal cord, or other nerves can result in a range of symptoms. Machine learning (ML) techniques have influenced all aspects of human life and neurology is no exception to this growing trend. Modern medical imaging techniques are powered by ML and several ML architectures are using this ability to analyze medical data in disease prevention, diagnosis, and patient monitoring. Visual saliency detection is a crucial application of medical image processing, and it made a considerable movement in the easy

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and accurate diagnosis of the disease. The visual saliency algorithms predict eye fixations on a visual scene and it improves the accuracy of complex scene analysis. These algorithms have shown tremendous improvements over the classic models on disease prediction and perform close to the human observer. This chapter discusses the current trends in visual saliency-based approaches for predicting neurological disorders and throws light on the future directions on the same. A new framework for detecting and predicting a neurological disorder using visual saliency is also proposed in this chapter. This chapter will act as a guideline that provides ample hints and dimensions for the researchers and academicians interested in using visual saliency features to detect and predict neurological disorders.

BACKGROUND

Neurological Disorders

Neurological disorders are among the most common diseases of this age, and their global prevalence has increased over the past decades. Neurological disorders are brain and nervous system disorders including Alzheimer's, brain tumors, dementia, depression, epilepsy, memory loss, stroke, psychotic, and Parkinson's disease, to mention but a few. The exact reason for these may vary but can include genetic disorders, congenital abnormalities or disorders, infections, lifestyle or environmental health problems including malnutrition, and brain injury, spinal cord injury, or nerve injury. The World Health Organization (WHO) indicated that hundreds of millions of people worldwide are affected by neurological disorders (Bali & Garba, 2021). These disorders increase the mortality rate, disability rate, and have a significant effect on global economies. The WHO has provided the latest global health estimates that Alzheimer's, Stroke and heart neurological disorders are among the top 5 global causes of death and the top 5 global causes of disability-adjusted life years in 2020. An early and accurate diagnosis can reduce the progression of disorders, But unfortunately, no such strategies or devices are available for accurate early detection. But researchers are making an effort to find appropriate treatment for these disorders which can improve the quality of life for both the patients and their families.

Neurological disorders are the most challenging to diagnose, manage and monitor due to the complex nervous system. Diagnosis of neurological diseases and their treatments demand high precision, dedication, and experience. Nowadays, modern technology and systems allow neurologists to provide proper neurological care (Siuly & Zhang, 2016). Recently, varieties of advanced diagnosis technologies (figure.1) have been used to detect, manage and treat neurological diseases, such as Magnetic Resonance Imaging, Magnetoencephalography, Positron Emission Tomography, Computed Axial Tomography, Diffuse Optical Imaging, etc. to name a few.

Structural MRI (sMRI) and Functional MRI (fMRI) are the most commonly used imaging modalities for classifying neurological disorders. Magnetic Resonance Imaging (MRI) is a non-invasive imaging technique used to capture both the anatomical structures and the functional signatures of the brain. It is based on the principle of Nuclear Magnetic Resonance (NMR). It uses magnetic fields and radio waves to produce detailed images of the brain and other organs. Structural MRI qualitatively and quantitatively describes the size, shape, and integrity of the brain's y and white matter structures. It can also measure volumes of brain regions and sub-regions and identify any localized lesions. In contrast to Functional MRI which is used to map the physiological mechanisms of the brain over time, structural MRI is static and captures only anatomical information. Figure 2 shows the MRI sequence of normal brain and dis-