

Chapter 15

Comparative Study on ASD Identification Using Machine and Deep Learning

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ABSTRACT

Autism spectrum disorder (ASD) is a neurodevelopment disorder that consists of a lack of social interaction and repetitive behavior of a person. It must be diagnosed at an early stage; otherwise it may adversely affect the life of that person. However, ASD consists of numerous overlapping neurodevelopment disorders such as autism and schizophrenia, which share some common brain structures. The medical image analysis is very popular to identify and segment different diseases in healthcare. In recent years, due to the tremendous changes in imaging devices, neuroimaging has recorded a great increase in identifying neuropsychiatric disorders. Moreover, MRI (magnetic resonance imaging) is a powerful non-invasive medical imaging to distinguish between these overlapping diseases by extracting brain connectivity. The researchers have applied numerous algorithms to understand common and distinctive brain connectivity features for these disorders. This chapter will focus on state-of-the-art techniques based on machine and deep learning with their comparative analysis and challenges of ASD.

INTRODUCTION

Autism spectrum disorder (ASD) is a lifelong neurodevelopment disorder with core symptoms of social impairment like repetitive behavior, interaction and communication problem in a person. Autism was firstly discovered by Kanner in 1943 (Pratap A., Kanimozhiselvi, 2014). He described it as unusual behavior present in children from birth to 30 months. The onset of ASD is usually at the time of birth or during the first three years of life. Studies show that some demographic attributes like gender and

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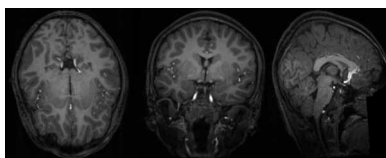
race vary among ASD and healthy individuals such that males are four times more prone to ASD than women (Baio, J., Wiggins, L., Christensen, D. L., Maenner, M. J., Daniels, J., Warren, Z., ... & Durkin, 2018). Some other factors such as environmental, socio-economic and risk related at the time of birth also affects the growth and general behavior of child which may further lead to ASD (Geetha, Sukumar, Dhivyadeepa, Reddy, & Balachandar, 2018).

Worldwide, there is one patient of ASD in 100 and in the United States; this prevalence is 1 in 68 (Mertz, 2017). In India, 1 in 500 children to 1 in 166 children are prevalent to have and this rate has increased from the last few decades. Currently, more than 2 million people in India affected from autism (Barua & Daley, n.d.). There are several reasons which may cause ASD, however, exposure to toxic metal-based pollutants play a significant role (Bhargavan, 2019). The other reasons include lack of care, stress, maternal illness, and lack of nutrition food for mothers and some other reasons related to birth of child.

To cope up with this problem, the different methods were proposed which mainly includes screening test, imaging of children and brain imaging based on machine learning (Thabtah, 2018) and deep learning (Razzak, Naz, & Zaib, 2018). The screening test is subjective and slow method while imaging is objective and more reliable testing method (Borràs-Ferrís, Pérez-Ramírez, & Moratal, 2019). Furthermore, in case of imaging of patients, the images of children taken and movement of eyes, hands, arms etc. observed to detect ASD. However, it is not so appropriate way for infants, also, behavioral observations may lead to misdiagnosis (Hyde et al., 2019).

The medical imaging such as MRI (Magnetic Imaging Resonance), CT (Computer Tomography), PET (Position Emission Tomography), US (Ultrasound), DSA (Digital Subtraction Angiography), and X-ray are popular imaging methods that are used to understand the different parts of the body and to detect different diseases. The brain imaging, which is part of medical imaging, is a reliable and quantitative approach to detect numerous brain diseases and connections. Brain imaging includes MRI (Magnetic Resonance Imaging), fMRI (functional Magnetic Resonance Imaging), rs-fMRI (resting-state functional Magnetic Resonance Imaging), sMRI (structural Magnetic Resonance Imaging), and dMRI (diffusion Magnetic Resonance Imaging) which are used by most of the state-of-art methods. The fMRI of brain slice, taken from ABIDE dataset, with axial view, coronal view, and sagittal view is represented in Figure 1 (Di Martino et al., 2014). Moreover, MRI is a powerful tool that helps to develop a method that is capable to find autism at an early stage. In addition, the identification of ASD can be done in less time and the treatment of a child can be started early which is required for the betterment of a child and his/her family (Borràs-Ferrís et al., 2019).

Figure 1. fMRI of brain slice representing Axial View, Coronal View and Sagittal View



The neuroimaging such as structural MRI and functional MRI, is a powerful tool in diagnosing ASD by investigating the structure and function of the brain. Different structural and functional characteristics of brain assist researchers to distinguish between ASD and healthy subjects. The abnormalities in gray

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