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قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

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تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

Diagnosis of Brain Disorders Employing Brain Biomedical Data

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Abstract

Brain disorders have been widely detected in recent years; however, their diagnosis is based on symptom reports performed by patients or profession-als without clinical or quanti ed judgments. Hence, it is prone to human mistakes. There is an urge for an objective computer assisted diagnosing system. One of the challenging brain disorders is the autism spectrum dis-order (ASD) which is a neuro-developmental disorder associated with im-pairments in social and lingual abilities. Failure in language development is variable in the ASD population and follows a wide spectrum. The autism diagnostic observation schedule (ADOS) is the current gold standard for di-agnosing, supported by expert clinical judgment. Early diagnosis allows for early intervention to reduce the severity of autism. Brain scanning technolo-gies have been widely developing and acquired extensively to understand brain functionality and structure. Magnetic resonance imaging (MRI) is a medical scanning technique that uses strong magnetic elds to form images of the anatomy and the physiological functionality of the brain. Main types of MRI include structural, resting-state functional MRI and task-based func-tional MRI (TfMRI). TfMRI demonstrates the functional activation in the brain by measuring blood oxygen level-dependent (BOLD) variations in re-sponse to certain tasks. The aim of this thesis is to develop a personalized computer-aided diagnosis (CAD) and grading system to classify autistic sub-jects against typically developed peers. A novel computer-aided ASD grad-ing framework, dependent on the analysis of brain activation in a response to speech experiment, is proposed. Increased hypoactivation of the superior

temporal cortex, angular gyrus, primary auditory cortex and cingulate gyri is detected with increasing autism spectrum severity. Less lateralization of the left hemisphere regions is also detected. For further local and global feature extraction in the proposed ASD grading system, only the region of interest (ROI) areas are examined. A comprehensive, two stage system is developed using di erent classi ers. Four-fold cross-validation is adopted for testing. The rst stage discriminates between moderate and the other two groups with an average accuracy of 83%. Subsequently, a second stage classi es subjects as mild or severe autism with an average accuracy of 81%. The vali-dation results prove the robustness of the proposed framework for early CAD system to place subjects on the autism spectrum. Recently, deep learning methods have been gaining more attention for fMRI classi cation. However, relatively few studies have applied deep learning techniques to TfMRI for diagnosing autism. For global diagnosis of ASD, a convolutional neural net-work (CNN) based framework and discriminant TfMRI feature extraction techniques are developed. FMRI is considered big data with four dimen-sions. Dimensionality reduction is required to achieve better performance. Therefore, a three-stage pipeline for both temporal and spatial feature ex-traction and reduction is built. Preliminary results on 100 TfMRI dataset (50 ASD, 50 TD) obtain 80% correct global classi cation using 10-fold cross validation. The experimental results show the improved accuracy of the pro-posed framework and hold promise for the presented framework as a helpful adjunct to currently used ASD diagnostic tools. As an early autism local and global CAD tool, A CNN deep local and global ASD classi cation ap-proach with continuous wavelet transform (CWT) is developed. In order to provide a detailed frequency and scale representation, CWT is applied on selected BOLD signals. CWT produces scalograms that provide a detailed representation on these BOLD signals. These scalogram images are used as input images to multi-channel 2D-CNNs for each area. The achieved global accuracy is 86%. Finally, brain maps that indicate level of ASD severity for each ROI are provided for each subject. The proposed framework works towards creating personalized diagnosis and treatment plans that handle the speci c case of each individual.

List of Publications

Peer-reviewed Journals

1. Reem Haweel, Noha Seada, Said Ghoniemy, and Ayman El-Baz. "A CNN Deep Local and Global ASD Classi cation Approach with Con-tinuous Wavelet Transform using Task-based FMRI", SENSORS, 2nd revision.
2. Reem Haweel, Noha Seada, Said Ghoniemy, and Ayman El-Baz "A Re-view on Autism Spectrum Disorder Diagnosis using Task-Based Func-tional MRI", IJICIS (2021).
3. Reem Haweel, Ahmed Shalaby, Ali Mahmoud, Noha Seada, Said Ghoniemy et al. "A robust DWT{CNN-based CAD system for early diagnosis of autism using task-based fMRI." Medical Physics (2020).
4. Reem Haweel, Ahmed Shalaby, Ali Mahmoud, Noha Seada, Said Ghoniemy, et al. \A Novel Grading System for Autism Severity Level Using Task-based Functional MRI: A Response to Speech Study" IEEE ACCESS (2021).
5. Dekhil, Omar, Mohamed Ali, Reem Haweel, et al. "A Comprehen-sive Framework for Di erentiating Autism Spectrum Disorder from Neurotypicals by Fusing Structural MRI and Resting State Functional MRI." In Seminars in Pediatric Neurology, p. 100805. WB Saunders, 2020.

Conference proceedings and abstracts

1. Reem Haweel, Ahmed Shalaby, Ali Mahmoud, Mohammed Ghazal, Noha Seada, Said Ghoniemy, Gregory Barnes, and Ayman El-Baz. "A Novel Dwt-Based Discriminant Features Extraction from Task-Based FMRI: An ASD Diagnosis Study Using CNN." In 2021 IEEE 18th International Symposium on Biomedical Imaging (ISBI), pp. 196-199. IEEE, 2021.
2. Reem Haweel, Omar Dekhil, Ahmed Shalaby, et al. "A Novel Frame-work for Grading Autism Severity Using Task-Based FMRI." In 2020 IEEE 17th International Symposium on Biomedical Imaging (ISBI), pp. 1404-1407. IEEE, 2020.
3. Reem Haweel, Omar Dekhil, et al. "A Machine Learning Approach for Grading Autism Severity Levels Using Task-based Functional MRI." In 2019 IEEE International Conference on Imaging Systems and Tech-niques (IST), pp. 1-5. IEEE, 2019.
4. Reem Haweel, Omar Dekhil, Ahmed Shalaby et al. "Functional Mag-netic Resonance Imaging Based Framework for Autism Diagnosis." In 2019 Fifth International Conference on Advances in Biomedical Engi-neering (ICABME), pp. 1-4. IEEE, 2019.

Abstracts

1. Reem Haweel, Omar Dekhil, Ahmed Shalaby, Ali Mahmoud, Georgy Barnes, and Ayman El-Baz "A Machine Learning Approach for Grading Autism Severity Levels Using Task-Based Functional MRI" International Society for Autism Research (INSAR), Seattle, WA, May 2020.
2. Omar Dekhil, Reem Haweel, Yasser ElNakieb, Ahmed Shalaby, Ali Mahmoud, Georgy Barnes, and Ayman El-Baz "Identifying Brain Areas Correlated with Autism Diagnostic Observation Schedule" International Society for Autism Research (INSAR), Seattle, WA, May 2020.
3. Reem Haweel, Omar Dekhil, Ahmed Shalaby, Ali Mahmoud, Mohammed

Ghazal, Hassan Hajjdiab, Robert Keynton, Georgy Barnes, and Ayman El-Baz, A Deep Learning Based Framework for Autism Diagnosis Using Functional MRI, BMES Annual meeting, Philadelphia, PA, Oc-tober 2019.

4. Omar Dekhil, Reem Haweel, Ahmed Shalaby, Ali Mahmoud, Hassan Hajjdiab, Mohammed Ghazal, Andrew E. Switala, Gregory Barnes, and Ayman El-Baz, Identifying Brain Areas Correlated With Autism Diagnostic Observation Schedule (ADOS) Raw Scores by Studying Al-tered Dynamic Connectivity Patterns, BMES Annual meeting, Philadel-phia, PA, October 2019.
5. Omar Dekhil, Reem Haweel, Ahmed Shalaby, Ali Mahmoud, Hassan Hajjdiab, Mohammed Ghazal, Andrew E. Switala, Gregory Barnes, and Ayman El-Baz, Localizing Subjects On The Autism Spectrum By Quantifying Overconnectivity and Underconnectivity: A Non-Parametric Surrogate Testing Approach, BMES Annual meeting, Philadelphia, PA, October 2019.

Book Chapters

1. Reem Haweel, Ahmed Shalaby , Aly Mahmoud, Mohammed Ghazal, Ahmed Kheli , Gregory Barnes, and Ayman El-Baz, \Early Autism Analysis and Diagnosis System Using Task-based FMRI in a Response to Speech Task," in Neural Engineering Techniques for Autism Spec-trum Disorder, Volume 1, Elsevier, in press.
2. Reem Haweel, Ahmed Shalaby , Aly Mahmoud, Mohammed Ghazal, Ahmed Kheli , Robert Keynton, Gregory Barnes, and Ayman El-Baz,, \Autism Diagnosis Using Task-Based Functional MRI," in Neurological Disorders and Imaging Physics, Volume 3: Application to Autism Spectrum Disorders and Alzheimer’s, Chapter 17, pp. 17-1 to 17-21, IOP Publisher, November 2019. DOI: 10.1088/978-0-7503-1793-1ch

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