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Eye 2019: Disease strategy management for future artificial intelligence-based ocular magnetic resonance imaging

Laura Fanea

Cluj County Emergency Hospital, Romania

Abstract

Artificial intelligence (AI) implementation in medicine will increase the efficiency of medical services. Appropriate program implementation in ophthalmology is recommended to avoid, prevent, or treat the socio-economic issues caused by blindness and visual impairment. Artificial Intelligence (AI) will help medical specialists evaluate at the highest possible standards any medical condition offering the most complex and accurate medical information in the most rapid way. The complex geometric-physicochemical quantitative information offered by Magnetic Resonance Imaging (MRI) on the qualitative anatomical bio physiology and/or pathophysiology of the eye covers the main eye structures: Cornea, aqueous humor, ciliary body, lens, vitreous humor, sclera, optic nerve, and three retinal layers. Implementation of AI-based MRI techniques in ophthalmology could, therefore, play a crucial role in reducing the present socio-economic burden caused by eye disease.

Objective:

To develop a disease management approach for the direct and immediate implementation of AI MRI

Methods:

Relations between particular quantitative MRI limitations available in the works and the corresponding physio-anatomy were made to figure the human MRI physio-anatomical state chart (hMRI_PASC). Pathology can be assessed using the relative-to-normal (RN) values of each MRI parameter for corresponding control-normal (CN) and disease-affected (DA) regions,based on the equation:

RN_Parameter(%)=multiply(100,divide(subtract(ParameterDA ,ParameterCN), (ParameterCN))). The RN_Parameter 50% absolute value threshold for the selected MRI parameters was used to define a medical state severity staging scale (MCSSS). The disease management plan is presented for a scenario of DA human MRI organ model, the eye, using the hMRI_PASC, and MCSSS.

Artificial intelligence (AI) is considered the third eye for medical specialists and has a promising perspective field for medical imaging, offering the most complex and accurate information to patients and medical specialists in the most rapid way through the most performance of medical evaluations. AI-based imaging is needed to reduce the socio-economic burden caused by disease and improve the efficiency in radiology departments. The current situation of AI in medical imaging has been analyzed recently and the future directions have been suggested. Wandell et al., Benson et al., Jiang et al., and Dumoulin et al., have already made some steps in these directions and developed complex AI algorithms for image analyses. Strategies for data management to support reproducible research, the influence of feedback in intelligence processes, and algorithms for more rapid MRI data acquisition were also evaluated. Many Artificial intelligence developments are suitable for MRI due to the wealth of qualitative and quantitative pathophysiological info offered for any organ in the human body and the low imaging invasiveness.

The brain, prostate, heart, breast, and eye are the human organs most frequently evaluated using multiparametric MRI in recent years. Software developers need simple specifications for explainable MRI to implement these developments in AI-based clinical radiology. Conditions for reasonable MRI were obtained from complex correlations between the geometric-physicochemical MRI parameters and the consistent pathophysiology to evaluate the rat brain. A generalization of this approach combined with the already available clinical AI-based strategies for medical diagnosis in dermatology and cardiology was made to assess the clinical MRI data available in the literature and grow in the human MRI physio-anatomical state chart (hMRI_PASC) and the medical condition performance scale (MCSSS) for AI-based disease administration. These results can be presented directly and immediately in software for AI-based clinical ocular MRI.

Findings:

Detailed MRI physio-anatomical characteristics were defined based on the analyses of the MRI parameters evaluated. The complex disease staging scale was built using the relative-to-normal values calculated for the normal subjects and the MRI physio-anatomy defined. A scenario for AI-based ocular MRI is also presented.

Results:

The specifications relevant for the diagnosis of a medical condition detected are presented in the hMRI_PASC . The IDE MCSSS presented was used to detect bio-physiological changes in the regions-of-interest, produced by external agent infiltration, changes in the dynamics of the 1H nuclei in water molecules, and/or elastic deformations. Infiltration of blood or T1 and/or T2 lengthening or shortening agents, macromolecules, calcifications, and iron particles through broken blood vessels or broken blood vessels and blood-to-tissue barriers can be detected using MRI. The dynamics of the 1H nuclei in

water molecules can be assessed with diffusion and flow-sensitive MRI techniques applied to different regions of the human body. Inflammation, constriction, or stiffness of regions can be detected in MRI elastography studies. The geometric-physicochemical parameters in Table 1 were used to analyse the physiological IDE status of a region-of-interest based on the hMRI_PASC.

Discussion:

Results in this study can easily and immediately be implemented in AI-based ocular MRI and demonstrate the feasibility of introducing AI-based analysis of ocular MRI scans. This could potentially support a program for the prevention and treatment of eye disease.

The research has developed and described here has 3 main compatibility areas:

- human anatomy
- medical procedure
- imaging technique

The hMRI_PASC and MCSSS in this study have universal human body applicability. The strategy for disease management is explained with an ocular MRI example, but it can be generalized to any organ. The research method developed in this study can be further developed to integrate all imaging techniques used at present in radiology. A similar method to that presented here might be used to develop AI-based medical imaging strategies and spread the MCSSS for MRI in this study to:

- Ultrasonography
- Computed tomography
- Positron emission tomography
- Laser or infrared medical imaging

Example: The research method presented in this study is compatible with many medical procedures: diagnosis, prognosis, response to therapy, and surgery, for example. After the generalization to these 3 main compatibility areas has been achieved, software developers can integrate the research method in software for general human body AI-based medical imaging.

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