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Medical image segmentation using deep learning: A survey

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Abstract

Deep learning has been widely used for medical image segmentation and a large number of papers has been presented recording the success of deep learning in the field. A comprehensive thematic survey on medical image segmentation using deep learning techniques is presented. This paper makes two original contributions. Firstly, compared to traditional surveys that directly divide literatures of deep learning on medical image segmentation into many groups and introduce literatures in detail for each group, we classify currently popular literatures according to a multi-level structure from coarse to fine. Secondly, this paper focuses on supervised and weakly supervised learning approaches, without including unsupervised approaches since they have been introduced in many old surveys and they are not popular currently. For supervised learning approaches, we analyse literatures in three aspects: the selection of backbone networks, the design of network blocks, and the improvement of loss functions. For weakly supervised learning approaches, we investigate literature according to data augmentation, transfer learning, and interactive segmentation, separately. Compared to existing surveys, this survey classifies the literatures very differently from before and is more convenient for readers to understand the relevant rationale and will guide them to think of appropriate improvements in medical image segmentation based on deep learning approaches.

1 | INTRODUCTION

Medical image segmentation aims to make anatomical or pathological structures changes in more clear in images; it often plays a key role in computer-aided diagnosis and smart medicine due to the great improvement in diagnostic efficiency and accuracy. Popular medical image segmentation tasks include liver and liver-tumour segmentation [1] [2], brain and brain-tumour segmentation [3] [4], optic disc segmentation [5] [6], cell segmentation [7] [8], lung segmentation, pulmonary nodules [9] [10], and cardiac image segmentation [11] [12]. With the development and popularisation of medical imaging equipments, X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound have become four important image-assisted means to help clinicians diagnose diseases, to evaluate prognopsis, and to plan operations in medical