DESIGN AND DEVELOPMENT OF SOME METHODS AND MODELS FOR DENTAL IMAGE SEGMENTATION USING DEEP LEARNING APPROACHES

गहन शिक्षण दृष्टिकोण का उपयोग करके दंत छवि विभाजन के लिए कुछ तरीकों और मॉडलों का डिजाइन और विकास

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CHAPTER 7

CONCLUSION AND FUTURE SCOPE

This chapter presents the conclusion of the work conducted in this thesis, along with suggestions for future directions.

7.1 Conclusions

Automated and accurate teeth segmentation from dental panoramic X-ray is a challenging task but also a crucial step for preoperative surgeries and diagnosis in oral treatment. The segmented region assists the dentist in locating the diseases and planning a better strategy for the treatment of the patient. This thesis focused on designing and developing effective methods and models using deep learning techniques for dental image segmentation. The developed methods should be robust toward varying teeth structure and teeth boundaries. In this thesis, different novel methods using deep learning approaches for the segmentation of dental images were proposed. These deep models were implemented and tested on benchmark datasets and were compared to the state-of-the-art methods.

Chapter 2 presented a brief literature review of state-of-the-art methods for dental image segmentation. A brief review of medical image segmentation techniques based on capsule networks was also presented. Furthermore, this chapter also discussed the details of the benchmark datasets and performance measures used in this thesis.

Chapter 3 discussed about two novel deep models for the segmentation of teeth area from dental panoramic X-ray images. The first model was designed with multiCNN encoder, while the second model was a cascading of two deep networks with the attention mechanism in the first network. The proposed model addressed the issue of automated

and accurate segmentation of teeth area while preserving the teeth boundaries. Both the models were implemented and validated on the UFBA_UESC benchmark dataset and performed better than state-of-the-art methods.

Chapter 4 presented a novel multifusion deep neural net for enhancing teeth region segmentation in panoramic X-rays. The proposed model addressed the issue of clear tooth boundaries and structural information of teeth. This model also dealt with the limitations of the models proposed in Chapter 3. The model was implemented and tested on two benchmark datasets, UFBA_UESC and Tufts; results obtained showed that the model performed superior to the state-of-the-art deep methodologies.

Chapter 5 presented a novel deep-learning segmentation approach based on a capsule network for dental image segmentation. The proposed model demonstrated the potential on capsule-based network for the segmentation task. The model was implemented and validated on UFBA_UESC and Tufts dental datasets. The obtained results outperform the state-of-the-art approaches.

Chapter 6 discussed about a novel deep neural network using transformers for dental image segmentation. In the proposed model, a transformer was integrated with the encoder-decoder architecture to segment the teeth region. Various deep models using transformers were also implemented and analysed. The proposed model was evaluated on two benchmark dental dataset and performed better than state-of-the-art methods.

Finally, the overall conclusion of the thesis is summarized as follows:

- Performed an extensive study of the existing state-of-the-art methods for dental image segmentation using conventional as well as deep learning approaches to identify the research gaps.

- Proposed and evaluated performance of a novel deep learning model to exploit a Multimodal CNN architecture for automated teeth segmentation from dental panoramic X-ray images.
- Proposed and validated the performance a novel deep learning cascaded framework using an attention mechanism for segmenting teeth from dental panoramic X-ray images.
- Proposed and evaluated the performance a novel deep multi-fusion neural network to enhance teeth region segmentation in dental panoramic radiographs.
- Proposed a novel deep-learning architecture based on the Capsule network for dental image segmentation and analyzed the performance of the proposed model to show it protentional for segmenting dental images.
- Proposed a novel deep encoder-decoder network using transformers structure for segmenting dental images. Implemented and investigated the performance various transformer-based networks for dental image segmentation.

7.2 Suggestion for Future Research

The research work presented in this thesis can be expanded in various ways. Some of the future work is as follows:

- To build a publicly available largescale benchmark dataset for multiclass segmentation of dental images. The dataset can be created by focusing on dental implants, carries, numbering of teeth and fillings. Also, the datasets available for segmentation of dental images are very limited and are of small size. Thus, research can be focused in this direction.
- Further, new deep-learning models can be proposed for the benchmarking of the dataset.

- Deep learning models using the capsules-based architecture can be explored for segmentation tasks in dental imaging as capsule network requires less amount of data for training.
- Deep learning models like GAN can also be explored for better segmentation accuracy in dental images.