Project Title:

Intelligent Whole Slide Image Compression for Efficient Pathologic Diagnosis

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Project Abstract/Proposal Summary:

Pathologic diagnosis is widely recognized as the gold standard for cancer diagnosis. In this context, the integration of digital pathology imaging and Whole Slide Imaging (WSI) technology enables the conversion of traditional liquid-based pathology slices into digital format, representing a significant shift from "slide observation" to "digital observation" in pathology. Notably, computational pathology, leveraging digital pathology imaging and artificial intelligence, has greatly advanced quantitative pathologic diagnosis and prognosis, thereby prompting intelligent medical diagnosis and treatment.

However, it is imperative to acknowledge that achieving micron/sub-micron level observation on pathologic tissues is essential for pathologic diagnosis using WSI. As a result, WSI images encompass tens of billions of pixels, leading to a data size exceeding 1GB per image. This substantial data volume poses notable challenges in pathologic imaging and computing. Specifically, the large data volume leads to a considerable delivery latency to downstream diagnosis, thereby impeding the efficiency and timeliness of diagnosis. These limitations contribute to untimely diagnosis and treatment, posing risks to people's lives and safety. Herein, it is imperative to develop tailored data compression techniques for WSI images to improve the efficiency of pathologic diagnosis.

This project presents a comprehensive WSI image compression scheme for pathologic diagnosis, aiming to produce compact WIS representations for both expert and automatic diagnosis, thereby improving the efficiency and timeliness of pathologic diagnosis. In this project, we first propose a neural WSI image lossless compression method that encodes the original WSI images into compact representations. The proposed method can reduce the size of the delivered WSI images without compromising quality, enabling experts to access accurate WSI images for pathologic diagnosis in real time. Particularly, we design a hierarchical coding paradigm to efficiently process Giga-level pixels within WSI images, including a base layer to

compactly encode significant WSI information by lossy coding, and subsequent layers to losslessly encode residuals rather than original signals. Such hierarchical coding paradigm can address the challenge of compressing Giga-level pixels through a dividing and conquering strategy, thereby facilitating the compact representations of WSI images efficiently. Furthermore, we devise a WSI feature compression paradigm, improving the efficiency of remote automatic diagnosis pipelines via encoding compact task-specific features. This paradigm can effectively exploit the key information within WSI images to deliver accurate diagnosis under minimal transmission costs. Consequently, the proposed framework obtains the capable of supporting remote automated diagnosis while addressing challenges related to data volume, latency, and real-time processing requirements.