

A video fluoroscopic swallow study (VFS) is an essential diagnostic imaging technique that provides a contrast-enhanced, real-time 2D visualization of a patient's swallow. As the gold standard for diagnosing dysphagia, VFS enables detailed assessment of swallowing anatomy, physiology, and biomechanics. Clinical analysis of VFS typically involves evaluating the coordination, timing, and kinematics of relevant structures, as well as the presence of key swallowing events. However, existing analysis frameworks can be time-consuming and complex, limiting their clinical and research utility. Consequently, VFS interpretation still relies heavily on qualitative assessments, which are inherently subjective and prone to variability. The lack of standardized, quantitative methods presents a significant challenge for accurate and reproducible diagnosis.

Computer-assisted solutions, particularly those leveraging machine learning and deep learning, have the potential to address these challenges by automating key aspects of VFS analysis. Deep learning techniques can facilitate the segmentation of relevant anatomical structures, automate the extraction of clinically meaningful metrics, and enhance qualitative assessments through objective computational methods. Despite these advantages, applying deep learning to VFS presents unique challenges, including issues related to image quality, variability in fluoroscopic settings, and the need for clinically interpretable outputs.

This dissertation focuses on developing deep learning and algorithmic methods to enhance the quantitative analysis of VFS. Specifically, it explores approaches for anatomical segmentation, automated feature extraction, and classification of swallowing impairments. Additionally, this work examines the limitations of deep learning in VFS imaging and proposes solutions to improve model robustness and generalizability. By advancing the integration of

artificial intelligence into VFS analysis, this research aims to establish more reliable, objective, and efficient diagnostic tools, ultimately improving clinical decision-making and patient outcomes.