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Research Title – Towards Personalized Inhalation Therapy by Correlating Chest CT Imaging and Pulmonary Function Test Features Using Machine Learning

Abstract – Inhalation therapy is the predominant method of treatment for a variety of respiratory diseases. The effectiveness of such treatment is dependent on the accuracy of medication delivery. Thus, personalized inhalation therapy wherein inhaler designs are specifically suited to the patient's needs is highly desirable. Although computational fluid-particle dynamics (CFPD)-based simulation has demonstrated potential in advancing personalized inhalation therapy, it still requires a 3D model of the patient's respiratory system. Such a model could be constructed with computed tomography (CT) images; however, CT scans are costly and have a high risk of radiation exposure. This concern motivates this study to bridge chest CT images and pulmonary function test (PFT) data, which is noninvasive and easy to obtain. To achieve this goal, an autoencoder is leveraged to find a lower dimensional representation of the CT image; PFT data can then be mapped to the encoded image. Both partial least squares (PLS) regression and artificial neural network (ANN) techniques were examined to quantify this mapping in this study. Using this mapping and the decoder in the trained autoencoder, a CT image can be reconstructed by the encoded image predicted by PFT data. This method would allow for greater accessibility to chest CT imaging without exposing patients to the potential negative effects of CT scans, significantly advancing personalized inhalation therapy for respiratory diseases. The results of preliminary experiments using a real-world dataset demonstrate promising performance with our proposed approach. Several image reconstruction metrics indicate the autoencoder is capable of reducing the dimensionality of our chest CT images, while PLS and ANN techniques can successfully correlate PFT data to reconstruct some key CT image features. These results indicate the significance of this work and motivate further advancement of this methodology.