Analytical Model to Infer Mask Peripheral Leakage Pattern in Large Population

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Abstract:

Using a facemask with proper fit is an effective method to diminish the airborne transmission of pathogenic agents, and facemasks have been a critical element in our defense against COVID-19. The mask material and fit on the wearer's face are critical to the overall effectiveness of the mask against the virus. Here, we propose an analytical integral boundary layer solution to quantify the flow field in the interface region between face and mask. The mask deployment study is performed for more than 1000 distinct morphable faces and different mask shapes. The space between the mask and face is represented with many radial interconnected channels. Each channel has a porous top boundary and extends from the inner mouth/nose high-pressure region to the mask's outer edge. The flow distribution in the channels is determined by the compatibility condition of the inlet pressure. The model is validated with a detailed flow simulation and employed to find the interconnected relation between fitness, porosity, and leakage through the mask. The results demonstrate the relation between breathability and filtration performance of the mask as a function of the mask's permeability coefficient and fit. Finally, we discuss the statistics of peripheral leakage patterns in a large cohort of faces obtained from the model.