Automated Feature Detection for Custom Conformal Respirator Design

BIOE 485 Capstone Group #12

Final Abstract

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Abstract

The COVID-19 pandemic has introduced a new set of challenges to all individuals, especially for healthcare workers who put themselves in harm's way to care for their patients. While current N95 respirators have efficient filtration of airborne particles, they are not customizable, reusable, or transparent. Thus, current respirators do not provide perfect seal, cause environmental concerns, and prohibit good communication between individuals. Our project," Automated Feature Detection for Custom Conformal Respirator", will significantly decrease the workflow by removing a labor-intensive step of positioning several components on top of 3D scans of individuals' faces and produce conformal respirators with customized fit for individuals, transparent, reusable and more affordable. The process begins with a scan of the user's face, using an Artec Leo scanner. The face model is then imported into Meshmixer and with the use of a Python script, the model is correctly oriented along the defined plane. The oriented mesh is exported from meshmixer and imported into the Autodesk Fusion 360 software. An automated Python script produces a thin flange body that represents the face contours that interface with the respirator. The resulting customized flange is printed using fused deposition modeling for each unique customer; the reusable mask solids themselves are only printed once with resin stereolithography. To form a complete thermoforming mold, the mask solid is slid through the flange in a predetermined orientation. Using this mold along with PET, a thermoforming process is used to generate the conformal respirator. The respirators can then be fitted with N95 filters and straps to secure them on the user's face. This final product is tested using a Portacount fit tester 8048 to ensure a consistent seal. The production and use of the conformal mask poses little to no ethical concerns. Rather, the conformal mask has a positive benefit-risk relationship in that it decreases the emission and transmission of the viral particles. At large, this benefits the target population and brings us one step closer in defeating a virus that has taken the lives of many.