196 Fit Achieved through Contoured Engineering to Improve Tolerance (FACE-IT)

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Abstract

Introduction

This paper provides an overview of ongoing research into the development of a patient-specific mask interface for obstructive sleep apnoea sufferers. To develop a patient-specific mask, we must establish whether the scanned shape of a sleep apnoea mask user's face can be edited using volumetric computer aided modelling software and developed into a bespoke mask interface using additive manufacturing. Obstructive sleep apnoea syndrome affects 3-7% of men and 2-5% of women in the UK and causes significant health problems, from excessive sleepiness to an increase in road traffic accidents. One of the most promising new avenues of treatment is to increase mask compliance through improved fit. The overarching research aim of this project is to contemporary techniques in 3D scanning and volumetric modelling to assist the design of personalised interfaces which can be attached to standard CPAP masks to improve user experience.

Research Approach

The research began with the investigation of how facial morphology data could be could gathered and then converted into useful surface data for the creation of a bespoke mask. A number of different handheld image capture methods were trialled; including: laser scanners; handheld light-based scanners; and photogrammetry devices. Faces of CPAP users at Papworth Hospital who struggle to achieve a comfortable fit with existing masks were captured, producing surface data of a participant's face. This data was then refined using processing software (Artec), and exported into volumetric modelling software, called 'Freeform'. Bespoke mask inserts were then designed using this haptic volumetric modelling software, and prototypes produced. The four main development phases of this research project will be discussed, along with early findings. This will include design iterations, feedback from users, and possible workflows of how devices could be manufactured. Seven users with standard mask discomfort had their faces scanned, and masks produced for testing. Following testing, users were interviewed to gather qualitative feedback on comfort and fit during the CPAP trial session.

Findings

A number of alternative designs were developed and tested based on an individual's patient morphology. Digital manufacturing processes suitable for developing a mask interface which inserts into an off-the-shelf product, allowing for custom fit, were trialled. These included CNC tool machining; Additive Manufacturing (AM) of tools, and AM of parts. More recent research has included the design of a test rig with which to test and compare bespoke masks with off-the-shelf masks. This was developed as a result of access issues to mask users in mask clinics.

Future Research

Future research will develop the test rig to measure leakage of masks, along with additional mask designs to test using this rig.

Practical implications and original value of this research

Improved compliance of CPAP treatment for those with abnormal facial morphology. Investigation of individualised masks using digital manufacturing technologies and haptic volumetric design software.