Department of MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

Sports Ready Oxygen Backpack & Control System

Elevate O_2

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Introduction

There is a rising number of active people in need of oxygen supplementation, including individuals struggling with pulmonary diseases such as COPD, Cystic fibrosis, pulmonary hypertension, and COVID-19. Active patients have an unmet need for suitable oxygen supplementation options and ways to carry the oxygen; the current available solutions are outdated and flawed. This includes the design of the oxygen storage unit (active backpack) and the need to accurately adjust their oxygen flow (see Figure 1).

Figure 1. *AirLift* backpack (left) and *AirLift* shoulder sling (right) currently on the market.

Goal

Design an active backpack that can house a liquid oxygen tank and an autonomous control system that adjusts the user's oxygen intake based on their SpO2 level.

Objectives

Develop an autonomous oxygen control system that:

- Uses an ear oximeter to read blood oxygen levels
- Uses oximeter data to control the flow of oxygen via a valve (see Figure 2)

Design and create an active Backpack that is:

- Ergonomic
- Lightweight
- Comfortable

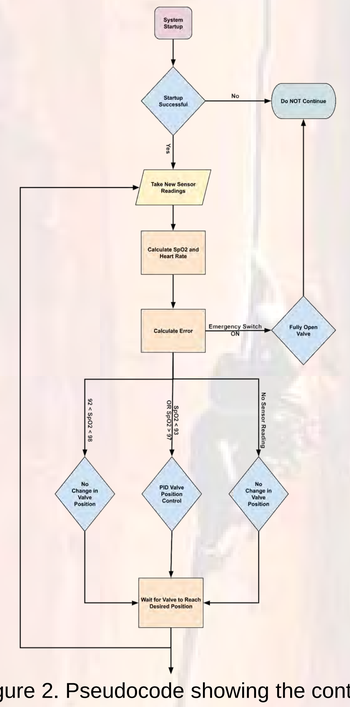

Figure 2. Pseudocode showing the control system.

Key Results & Conclusion

The prototyped backpack secured the load effectively and proved to be more comfortable compared to bags already on the market (see Figure 6).

The earpiece provided a hands free and consistent way to obtain user SpO2 values that fed into our control system (see Figure 7). The control system was then able to control the delivery of oxygen to the user and is proving to be an efficient alternative to traditional oxygen therapies (see Figure 8).

What We Accomplished

1 Backpack

Requirements

- Lightweight and comfortable
- Load secured in the bag and on the person

Specifications

- Weight must be under 8 lbs
- One (1) hip strap and one (1) chest strap (see Figure 3)
- Internal straps/frame to hold the oxygen tank in place

Figure 3. Sketch, to prototype, to finalized prototype.

2 Earpiece

Requirements

- House the oximeter sensor (see Figure 4)
- Securely and safely attach to the earlobe
- Provide results comparable to FDA approved oximeters

Specifications

- House the 1.0″ by 0.5″ sensor
- Spring coefficient that provides consistent readings and comfort
- Oximeter error should not be significant $\boldsymbol{\alpha} = 0.05$

Figure 4. Finalized design of the earpiece oximeter.

3 Control System

Requirements

- Provide fail -safe system
- Extend duration a single oxygen tank can be used

Specifications

- Fit inside backpack (see Figure 5)
- 4 hour battery life
- Modulating valve for precise oxygen control

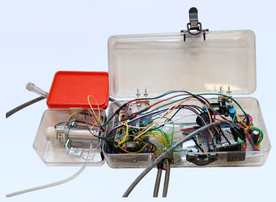

Figure 5. Control system inside of the mobile housing.

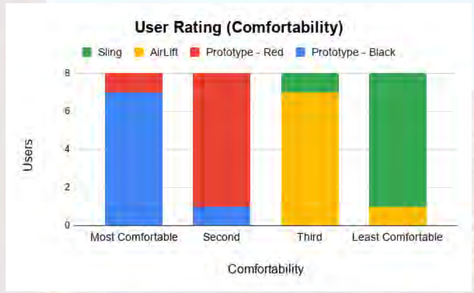

Figure 6. Graph showing user preference of various bags.

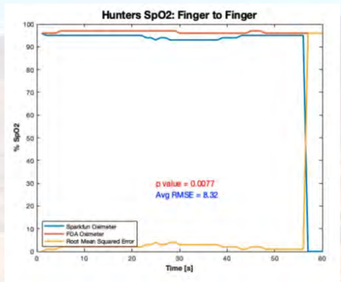

Figure 7. Graph comparing FDA finger oximeter to ear oximeter.

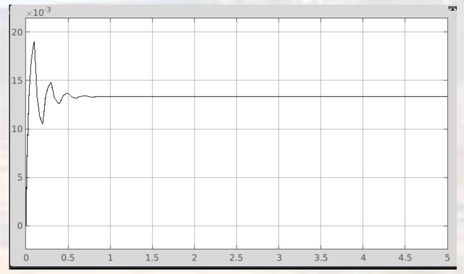

Figure 8. Simulink simulation showing how valve ready oxygen SpO2 level and reacts..