THERAPEUTIC INCENTIVE LUNG SPIROMETER

Nikolas Faulkner[1], Kelly Wang[1] , Devon Castillo[2], Byron Vazquez[3], Noor Haidar[3], Elizabeth Bollich[3], Ethan Horn[4], Renee Yeung[4]

[1] Electrical & Computer Engineering, [2] Human Centered Design & Engineering, [3] Bioengineering, [4] Mechanical Engineering

Lung Technologies
The Digital Pre-Surgical Platform

Motivation

❖ Incentive spirometers encourage slow, deep inhalation to help expand the lungs and improve breathing after surgery

❖ **Current Limitations:**

➢ Current manual spirometers rely on patient compliance and self-reporting, giving clinicians no objective record of use

➢ Existing electronic options can be costly, difficult to use, or lack patient motivation features

Objective

➢ **Design a low-cost electronic attachment** for a traditional incentive spirometer that provides objective feedback on patient use and compliance.

➢ **Integrate an inhaler port into the spirometer** to combine breathing exercise with inhaler technique training and medication delivery support.

System Diagram

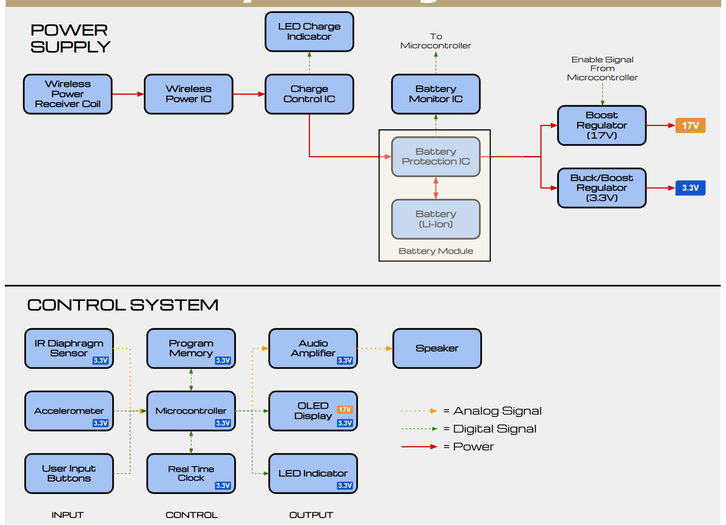

Fig 1. System block diagram of power and control system

Electronics Implementation

❖ Hardware and user interface design focused on **compactness** and **simplicity** for a clinical setting

Hardware Subsystems

❖ **Power:** Wirelessly charges 2 Ah LiPo battery pack with battery management system (BMS)

❖ **Flex PCB:** Lightweight, compact board

❖ **Infrared sensor:** Detects piston movement through the spirometer body

❖ **Accelerometer:** Detects pick-up motion of device to wake from sleep-mode

❖ **OLED Screen:** Displays counter value and flashes during alarm sequence

❖ **Alarm:** Real time clock triggers alert at set intervals to play non-irritating audio through speaker

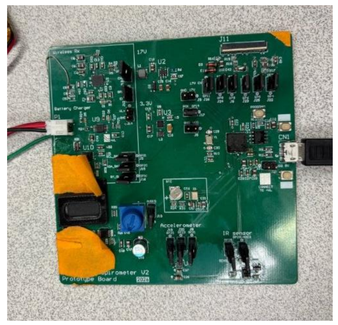

Fig 2. (Left) Prototype PCB (Right) Model of assembled final flex-PCB

Software

❖ **RP2040** communicates with OLED, BMS, clock, and accelerometer via I^2C to simplify routing

❖ Utilized dual-core MCU to separate UI and sensor-processing tasks

❖ Customizable audio output using PWM inputs

❖ Alerts user every 10 minutes with alarm sequence

Integration

❖ **Electronics Container:** Aligns sensor position with volume setting in 250 mL increments

❖ **Sliding Rail Mechanism:** Slides electronics body for quick adjustment and secure locking

❖ **Device Body:** Replicates the standard Voldyne spirometer while adding an ergonomic handle and reducing the body volume

❖ **Integrated Inhaler Port:** Flexible one-way duckbill valve connects standard inhalers to deposit medication

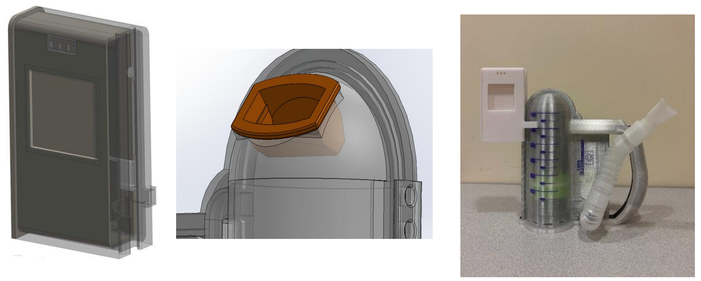

Fig. 3. (Left) Sliding electronic casing. (Middle) CAD model of integrated inhaler port. (Right) Final assembled spirometer prototype with domed top, ergonomic handle, and electronic monitoring enclosure.

Final Unit Cost $83

Bill of materials and board total. Does not include the spirometer body, attachments, shipping, or tariffs task. Subject to change.

Future Work

❖Submit a patent application through Lung Technologies

❖ Present the device to Teva Pharmaceuticals for potential manufacturing collaboration

❖ Scale manufacturing for hospital distribution

❖Conduct clinical trials and user testing.

❖Pursue FDA clearance as a Class II medical device.

ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY of WASHINGTON

ADVISERS: Dr. Christopher Neils, Dr. Rupak Rajachar, Nello Gu

INDUSTRY MENTORS: Kerry Curran , Dr. Paul Horn

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