The Novel Aerosol-Reducing Mask: A Low-Cost Mask for Non-Invasive Ventilation

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Problem & Scope

COVID-19: Global shortage of ventilators and care staff [1, 2]

- Spread of respiratory aerosols
- CO_2 build-up in existing masks
- Expensive or single-use designs → $$$

This project aims to design a **low-cost, open-source, reusable non-invasive ventilation mask** and **alarm system** for patients with respiratory infections.

Functions

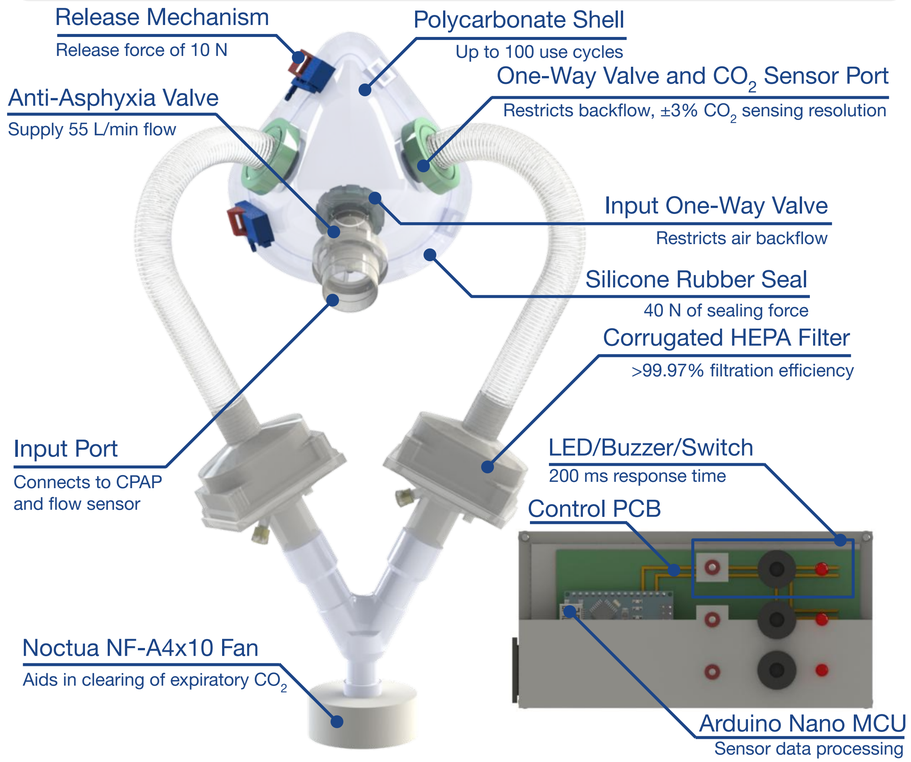
Deliver air from CPAP machine to the patient and **remove** expiratory air without releasing infectious aerosols into the environment.

Continuous Positive Airway Pressure (CPAP) → N-ARM
- ✕ Release infectious aerosols
- ✕ CO_2 accumulation

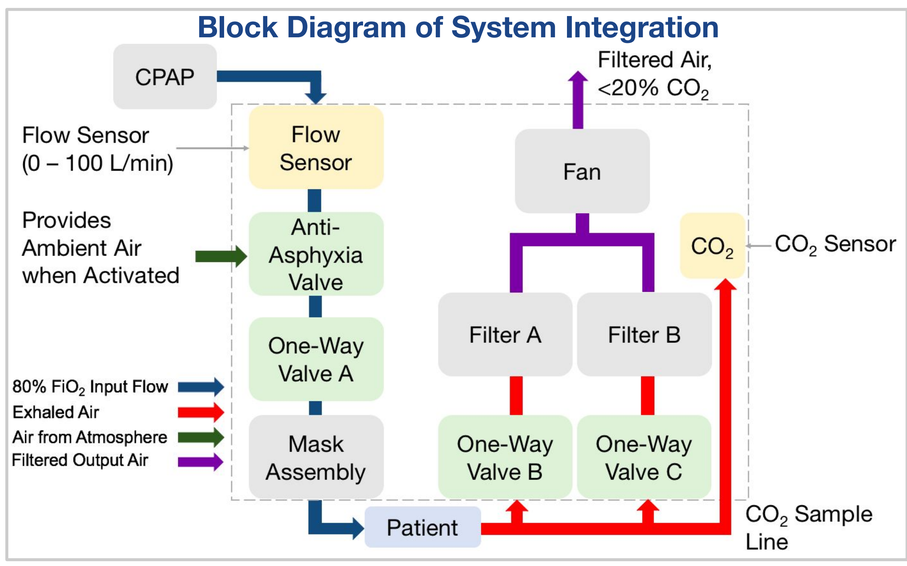
Trigger a **visible** and **audible alarm** when any of the following conditions occur:

1. **Input Flow < 4 L/min**
2. **ΔCO_2 [%] > 20%**
3. **Voltage Supply < 5V**

Mask System Design

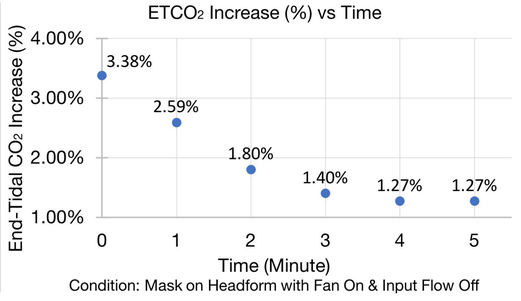


Block Diagram of System Integration



Testing & Results

Resistance to Flow *< 5 cmH_2O at 50 L/min*	• 3.686 cmH_2O at 52.367 L/min [3]
Leak Flow Rate *50 mL/min at 10 cmH_2O*	• 4 L/min with the majority of the leak from the patient-mask interface
Filter Resistance *≥ 5 cmH_2O PEEP at 30 L/min*	• Hydro-Guard Mini filter: 1.627 cmH_2O at 36.481 L/min • Simulation: PEEP of 6.258 cmH_2O [4, 5]
CO_2 Rebreathing *$ETCO_2$ Increase < 20% [3]*	• Percentage increase: -1.009% • Fan assists in clearing out CO_2 with no supplied input flow
Alarm Response Time *< 10 seconds*	• Less than 200 ms for all alarms • Alarms trigger independently, can be individually toggled via switches



Condition: Mask on Headform with Fan On & Input Flow Off

Improvements & Impact

- Incorporate a fan with **higher static pressure** [6]
- **Enhanced sealing** at the patient interface
- Reduction in **size and mass** of the electrical system

The **N-ARM design** improves **patient access to respiratory care** and affords greater **resilience** and **care capacity** to Canadian health systems during respiratory virus outbreaks.

References

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