Soft Upper Limb Exosuit for Musculoskeletal Injury Prevention of Firefighters

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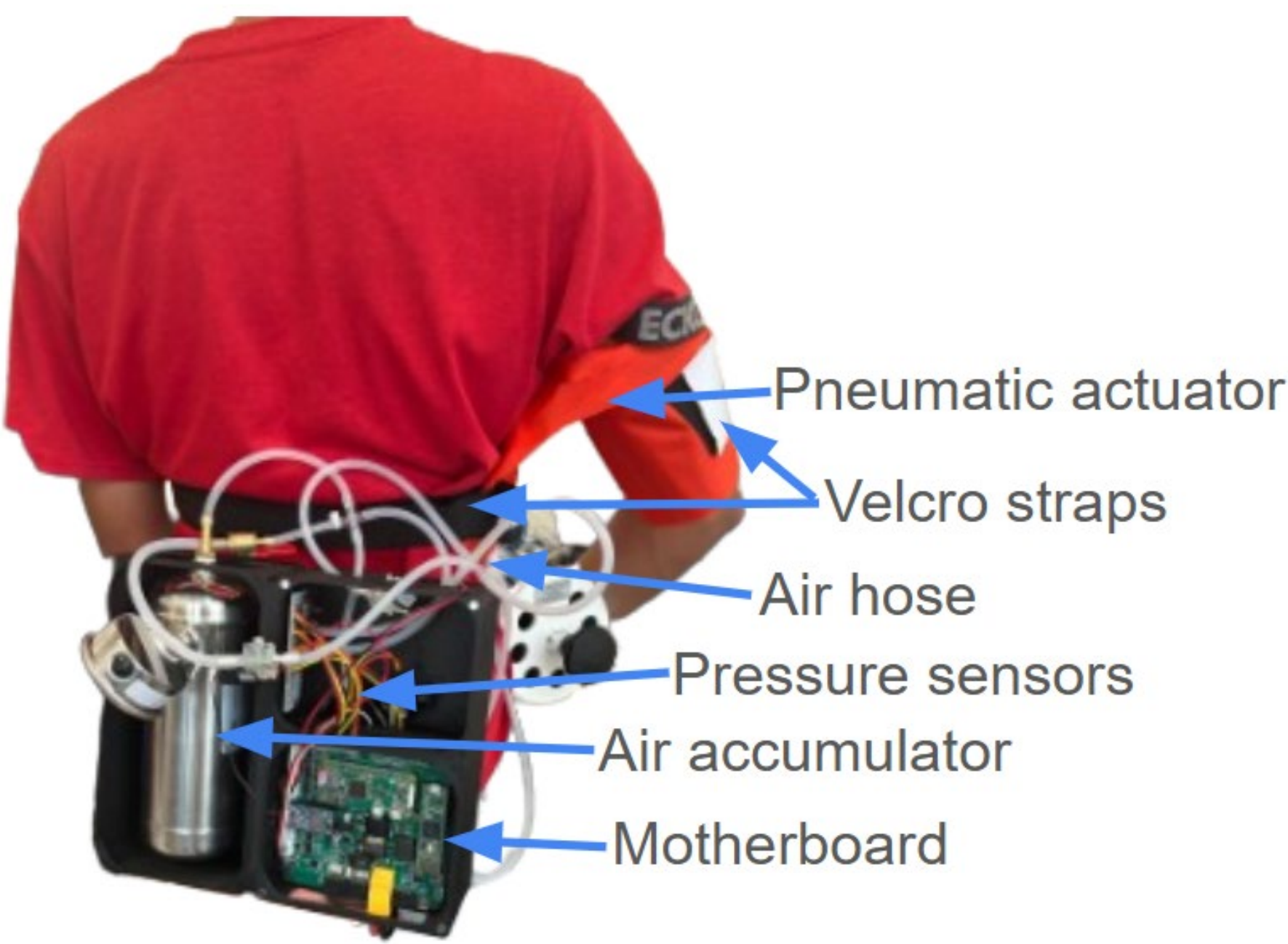Website: http://haosu-robotics.github.io
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Motivation / Introduction

- Firefighting can place extreme physical demands on the shoulder, often **requiring** sustained arm **elevation** and handling heavy tools, which leads to shoulder fatigue and injury
- Existing exoskeletons are rigid, heavy, and **incompatible** with firefighter mobility and gear [1, 2]
- We aim to develop a soft, **untethered** shoulder exosuit with pneumatic actuation and electronics for **unobtrusive** lift-assist and fatigue reduction [3]

Shoulder Exosuit Design

- Soft **untethered** shoulder exosuit which utilizes an air pump to inflate an actuator
- The exosuit fits over clothes and is **adjustable** to **accommodate** bulky firefighter gear
- Aids in hose handling by helping **elevate** and **control** the hose
- Aids in overhead tool use by **stabilizing** heavy tools and reducing **muscle strain**
- This design **minimizes** bulk and stiffness as well as **enhancing** comfort, mobility. In addition, the compact design allows for seamless integration with firefighting gear

Pneumatic actuator
Velcro straps
Air hose
Pressure sensors
Air accumulator
Motherboard

Controls

- Pneumatic actuator inflated via air pump [5]
- Controlled with PCB
- Solenoid valves control air flow
- Velcro straps attach the exosuit to the user
- Powered via 22V Li-Po battery
- Pressure sensor controls air pressure in air pump

Pneumatic Actuator
Solenoid Valves
IMU
Velcro Straps
Pressure Sensors
Air Accumulator
PCB
Air Pump (below)
Battery

Exosuit Integration

Hose handling posture:
Firefighters routinely **lift** and **control** hoses that, when charged, can weigh around 130 pounds as well as generating strong nozzle reaction forces [4].

Pneumatic actuator
Velcro straps
Hose
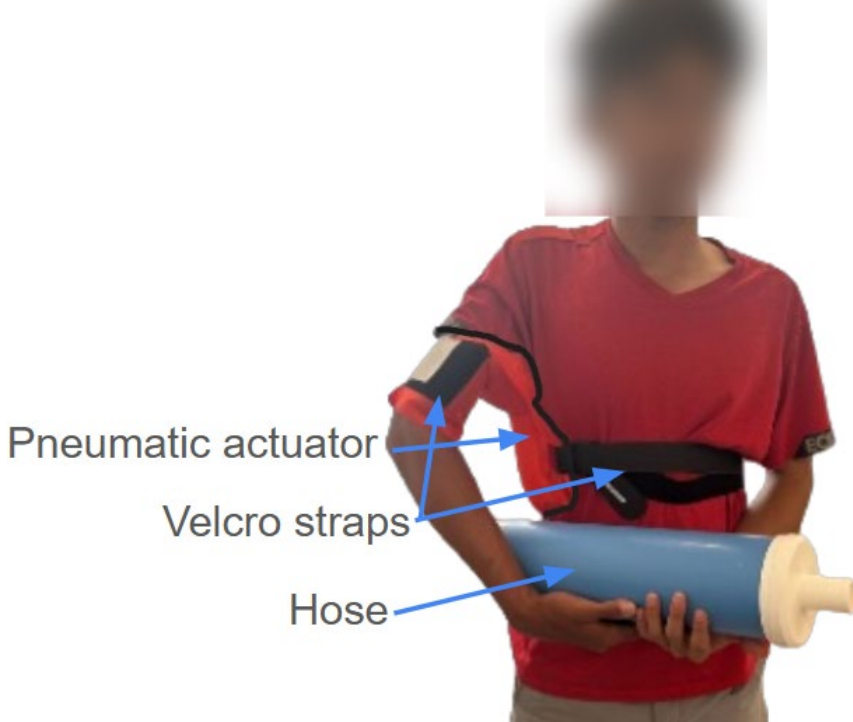
Overhead tool use posture:
Overhead tool operations require holding the arms at large **elevation** or **abduction** angles for **extended periods** in order to make accurate and precise movements
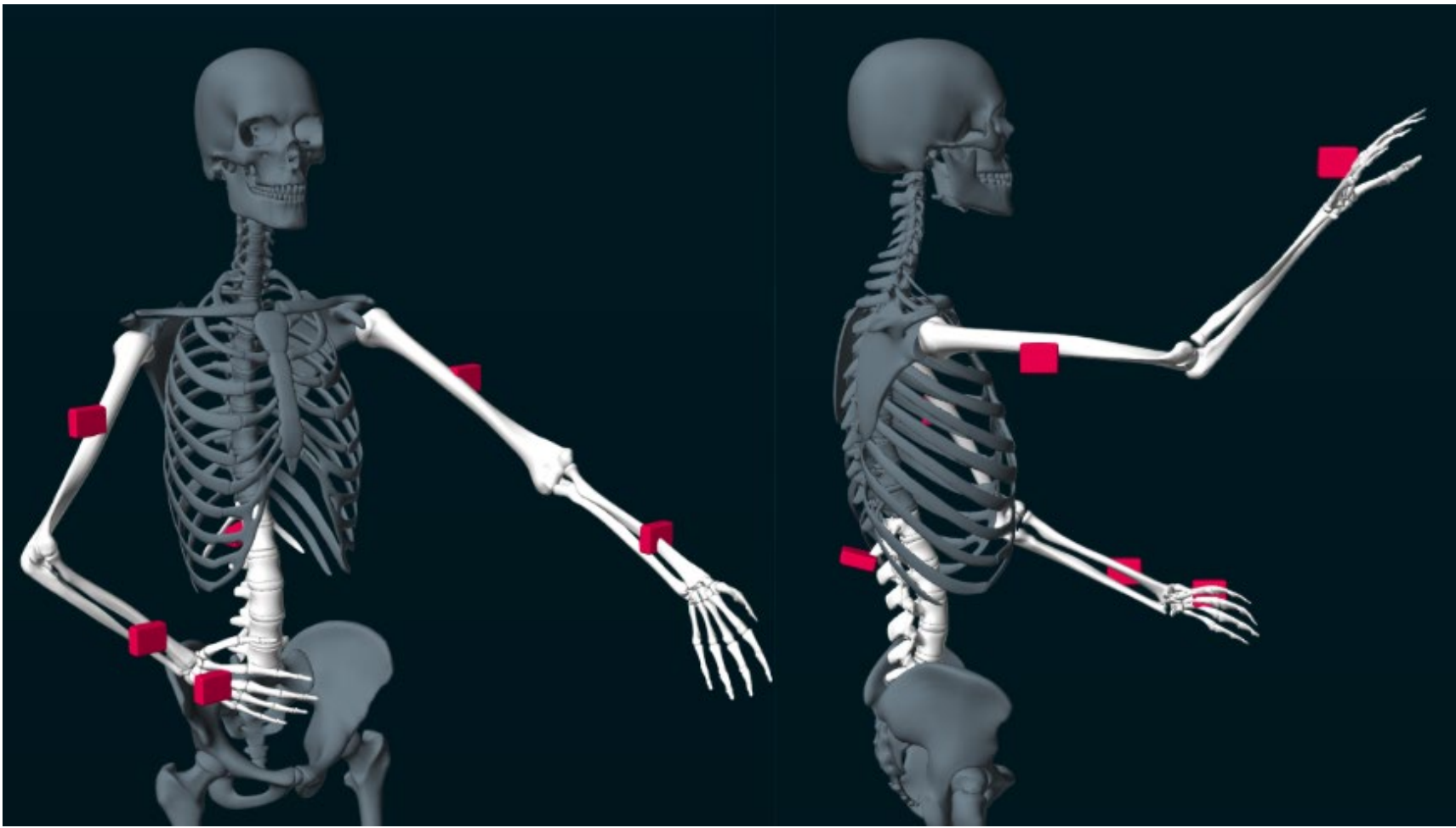

Pneumatic actuator
Air hose
Tool
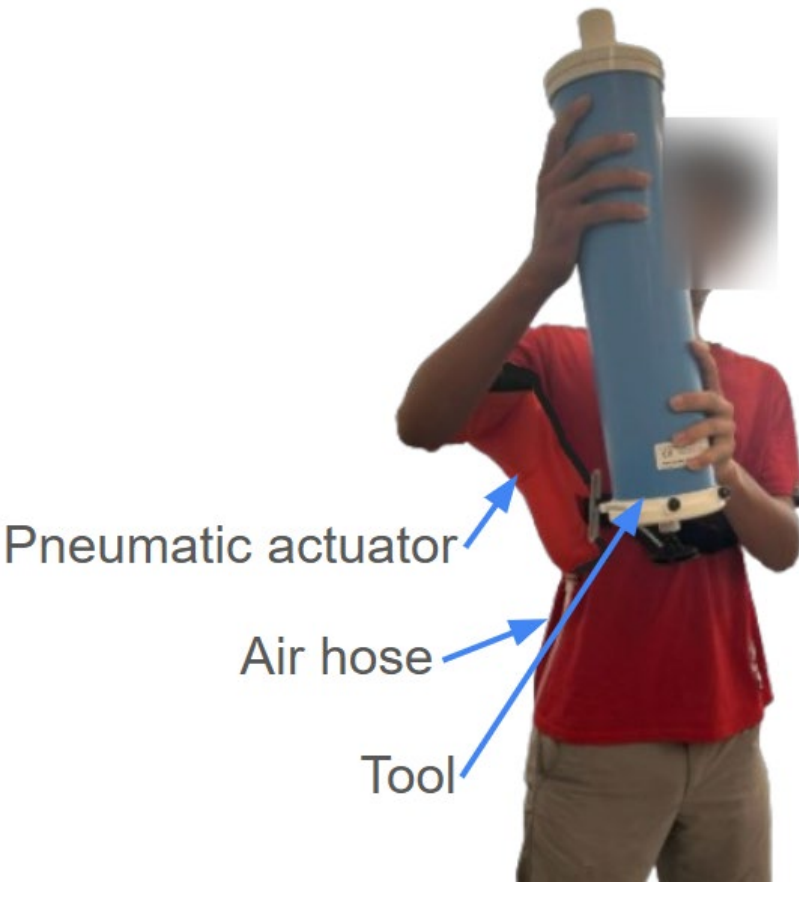
Noraxon Avatar

Skeletal model created by using seven IMU sensors. Three per arm on the wrist, forearm and upper arm, and one on the lower spine. By simulating fire fighting postures, the avatar **highlights** the muscles and joints that are **most heavily engaged**, such as the shoulder during hose handling and tool use.
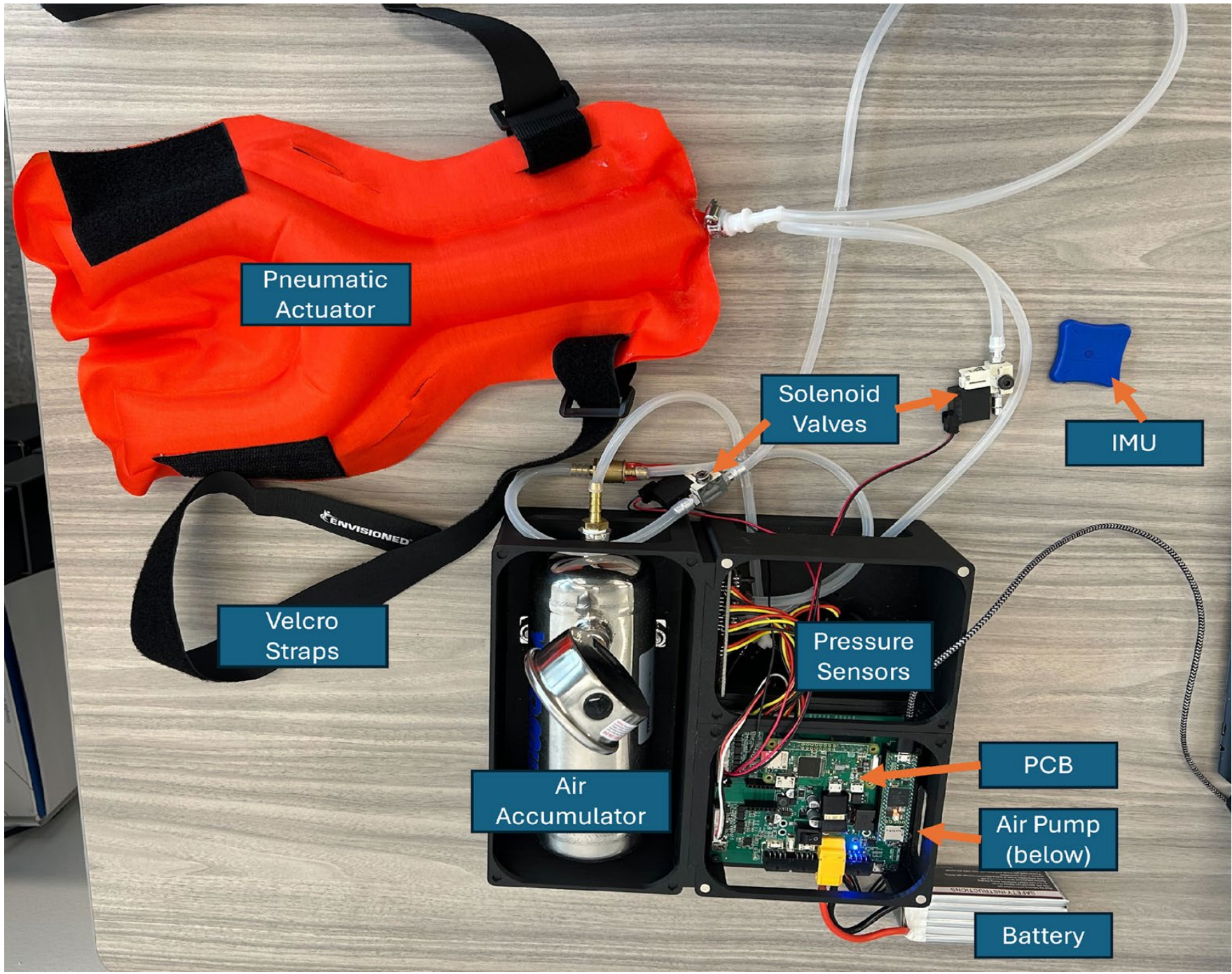
Hose handling   Overhead tool use

Acknowledgment

Reference

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