Hugging Suit

Pneumatically-Actuated System Design for Haptic Experiences

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Motivations

International Students

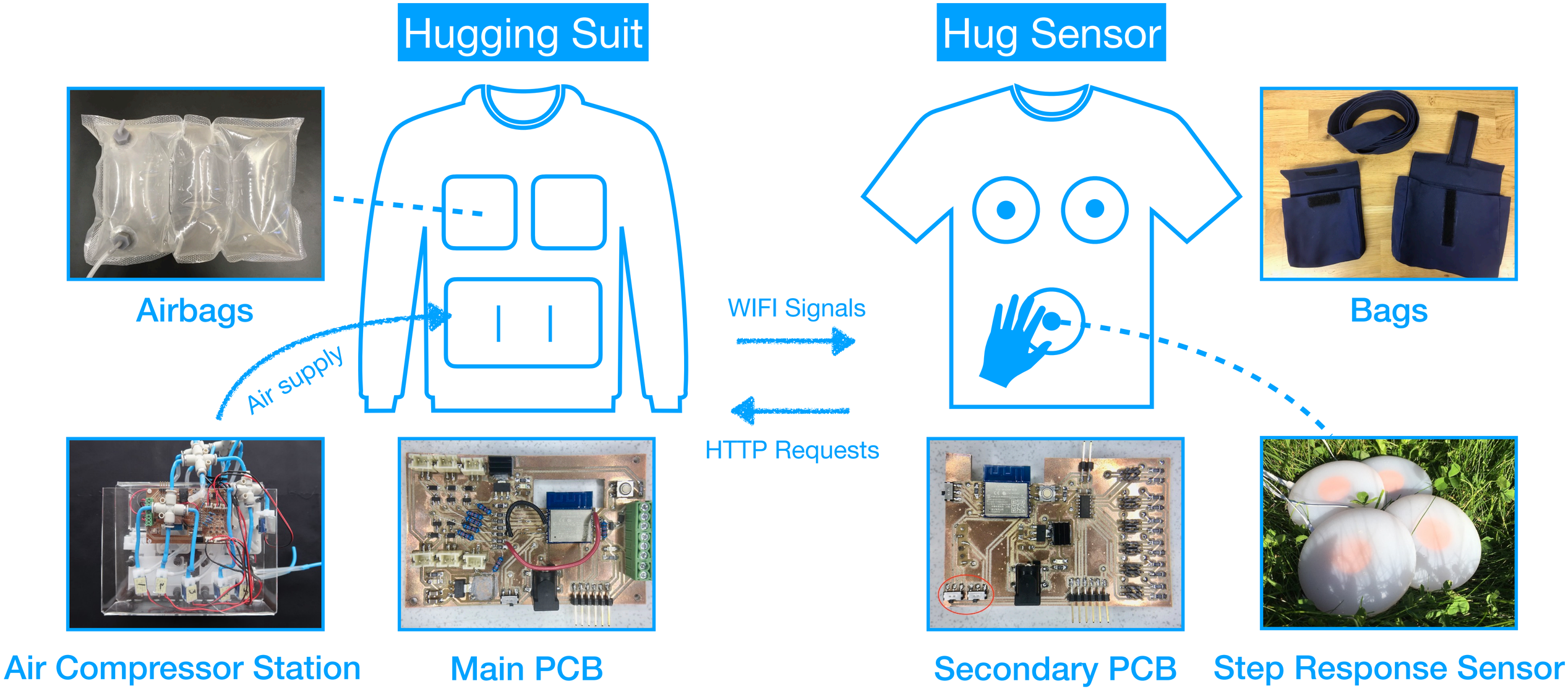
Covid-19 Restrictions

Remote Haptic Communications

Remotely Hugging

Hugging Suit 1.0

Hugging Suit 1.0



Research Questions

1. **Remote Environment:** What design factors to consider when attempting to recreate the physical experience of hugging in a remote environment?

2. **Wearability:** How should the pneumatically-actuated system be designed in a wearable approach?

3. **Fidelity:** How can hugging simulations become more realistic?

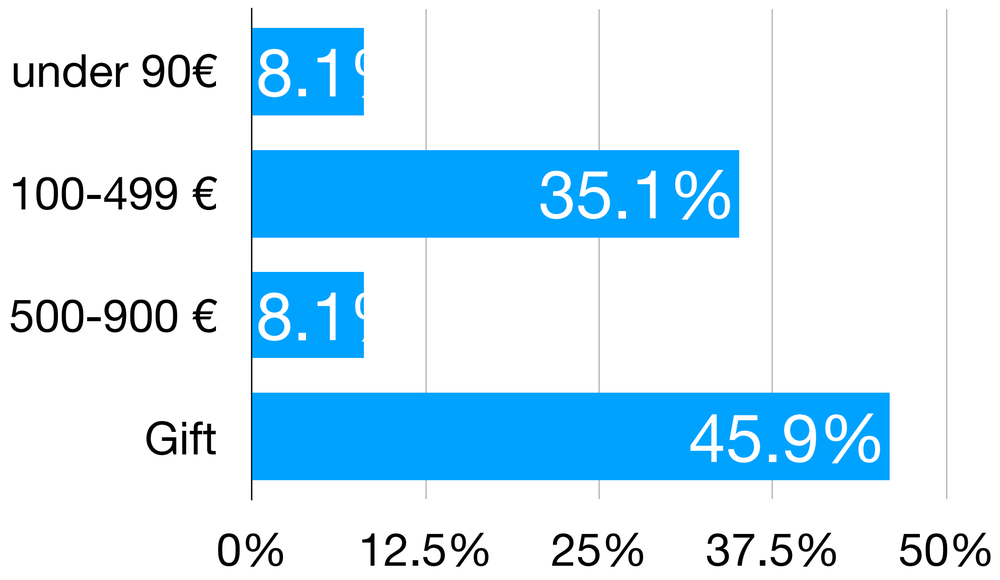
4. **Application:** What are the potential applications of the Hugging Suit?

Nov. 2021

1st User Study

Background Information

- 37 participants (20F:17M) from 19-65 years old
- Multidisciplinary backgrounds
  - Eliminating the bias
  - Integrative and professional suggestions
- 36 didn’t wear the similar products (Prices, usages, developing)

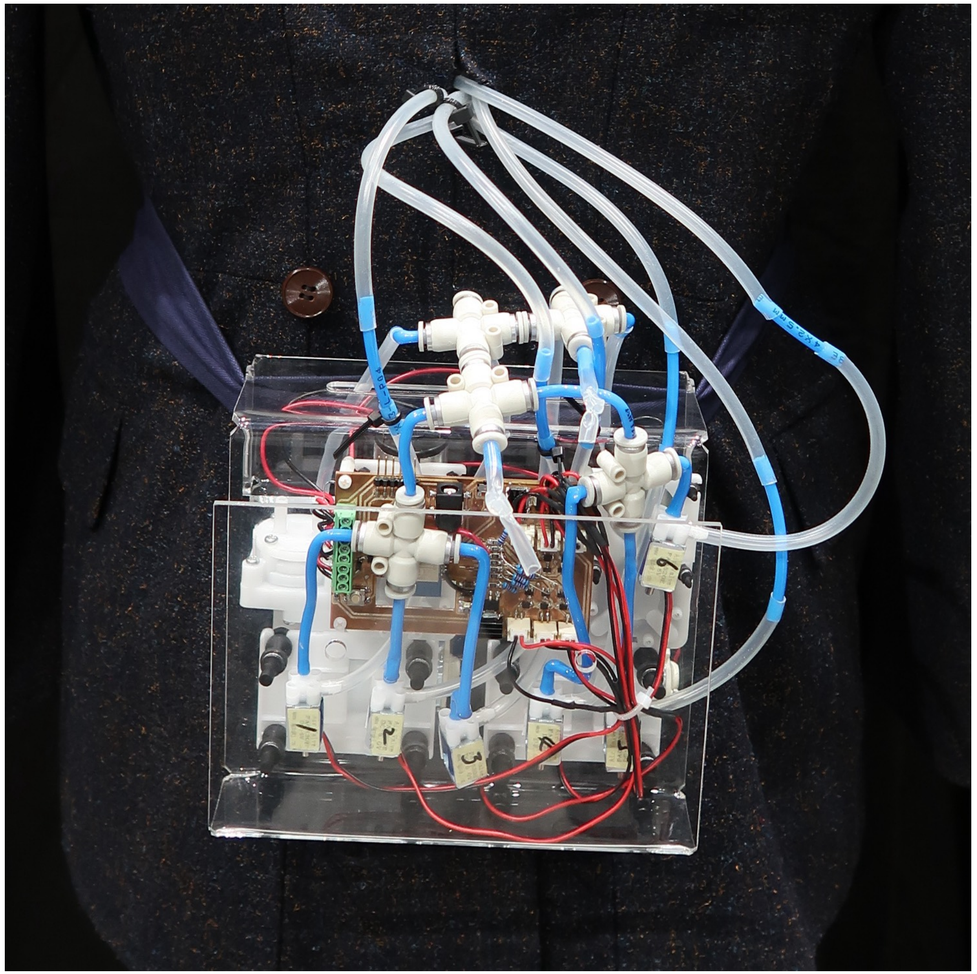


Name	TactSuitX40	Synesthesia Suit	Hug Shirt	Tesla Suit	Force Jacket	Hug Over a Distance	Huggy Pajama
Approach	Vibromotors	Vibromotors	Vibromotors	Electrical stimulation	Pneumatic Pressure	Pneumatic Pressure	Pneumatic Pressure
Price	US $499	-	US $685	US $12999	-	-	-
Year	2021	2016	2002	2020	2018	2005	2008

Findings from 1st User Study

Accuracy / Wearability (RQ2/3)

- Inflated airbags can simulate hugs but the simulations were unsatisfactory
  - Noisy and bulky
  - Lateness of inflation
  - Shape and coverage
  - ~~Temperature and Size~~
  - Step response sensor
- Safe and connected



Findings from 1st User Study

Design Factors / User Scenarios (RQ1)

- Low-lit, comfortable, private, and seeing the hug giver
- **Space:** Home, bed and sofa
  safety, warmth, and comfort
- **Sound:** Video calling and relaxing music
- **Mood:** Long-distance relationships, lonely and tired, Falling asleep
- Relieving psychological stress

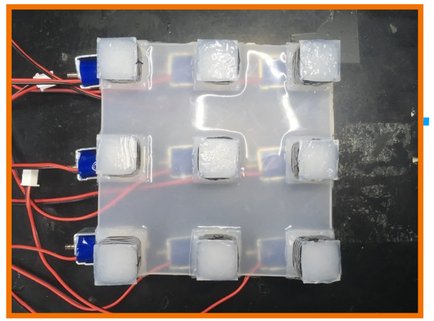
Requirements of Hugging Suit 2.0

Wearability / Portability

Precision of Hugs

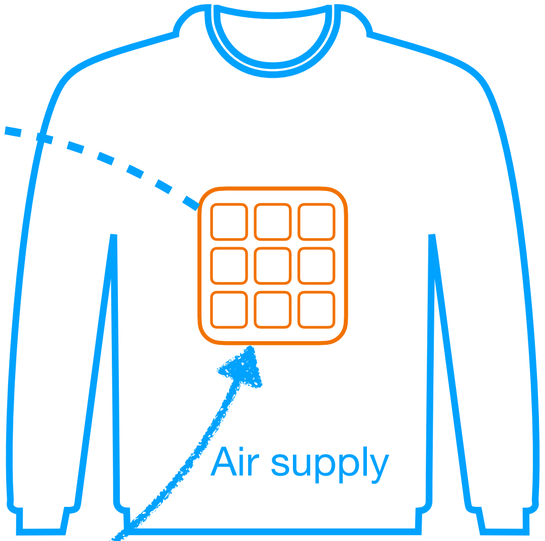
Immersion

Hugging Suit 2.0

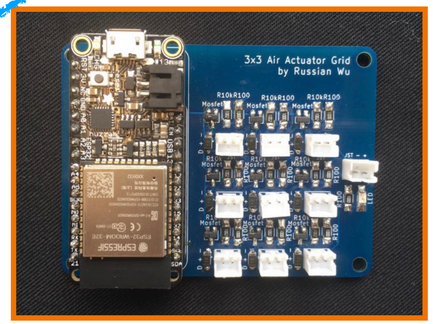


Air Actuator Matrix

Hugging Suit



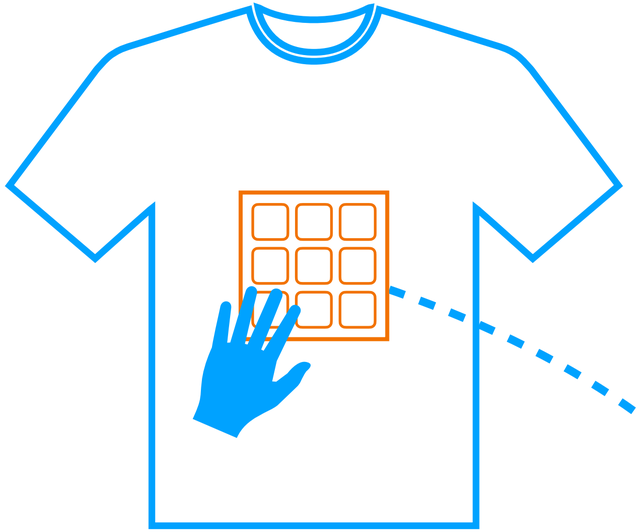
High-Pressure Air Tank



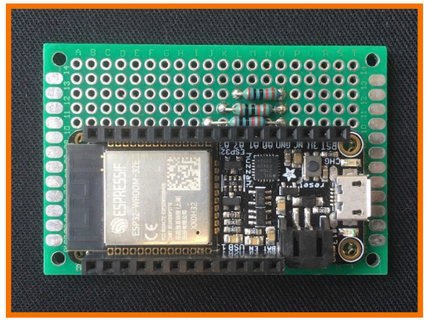
PCB

OSC communication

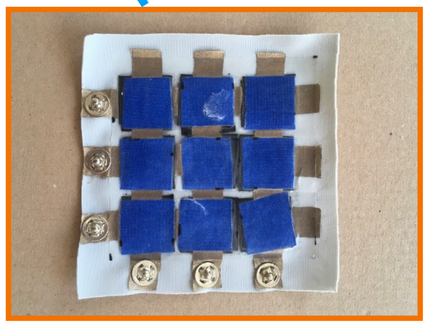
Hug Sensor



Bags

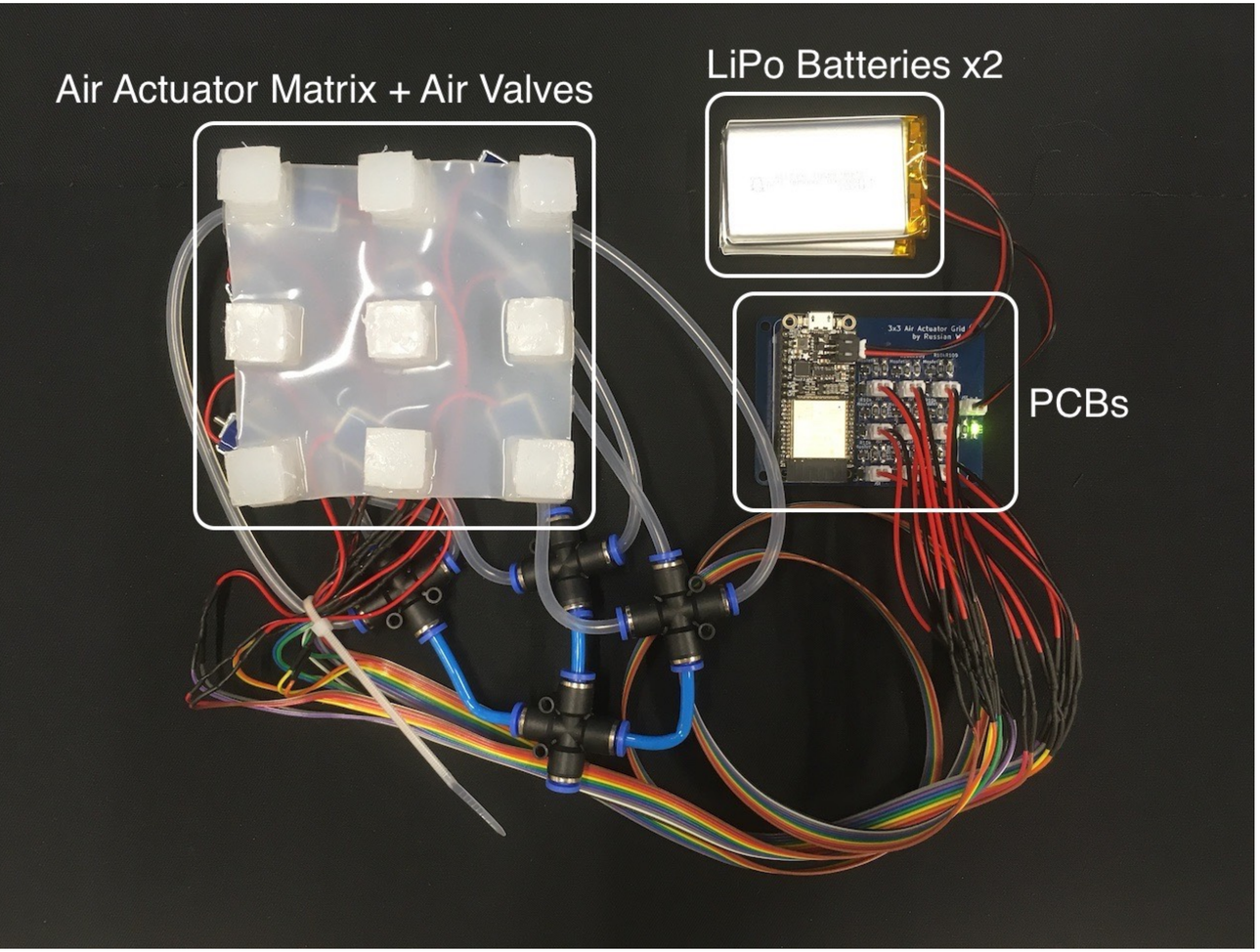


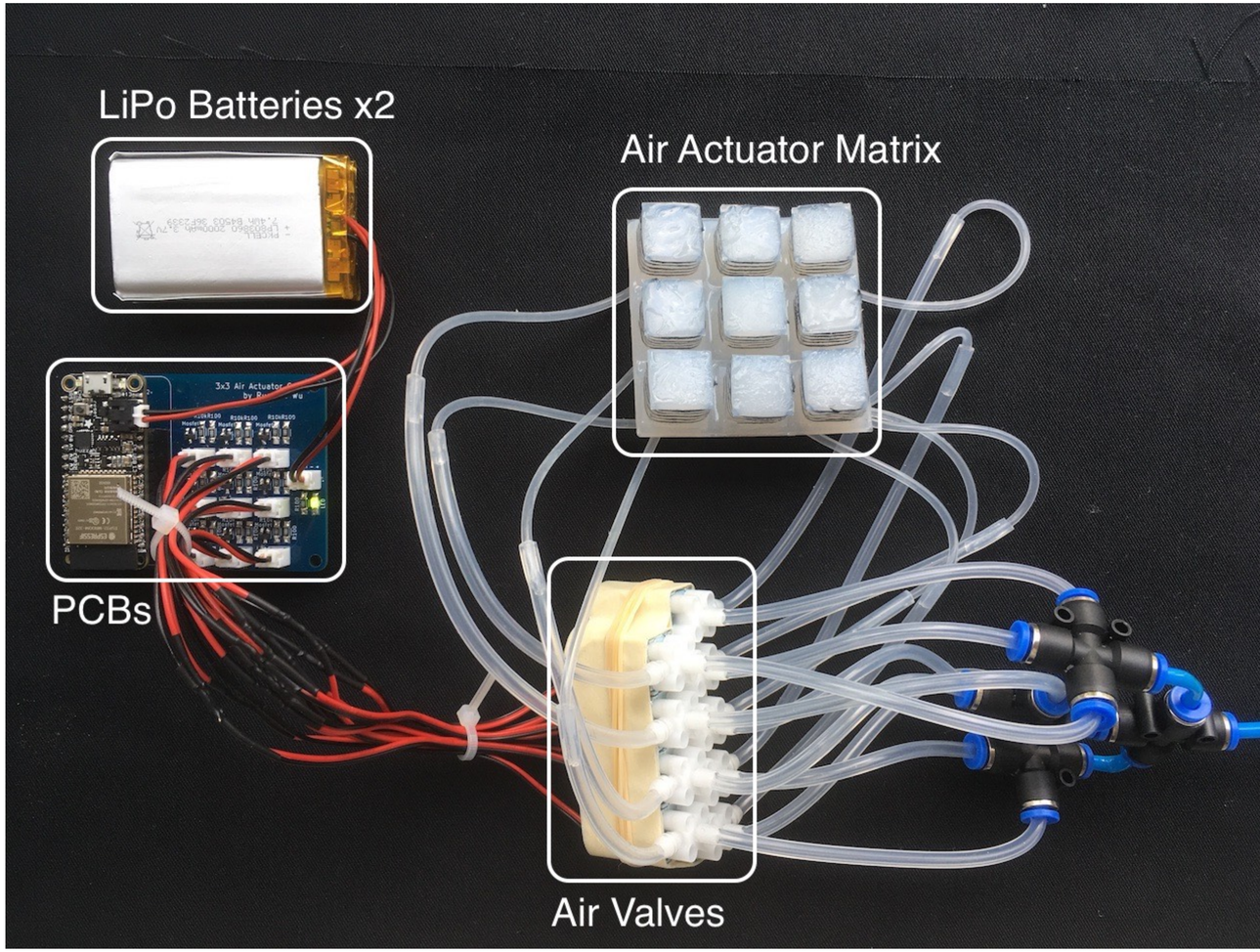
Dot PCB



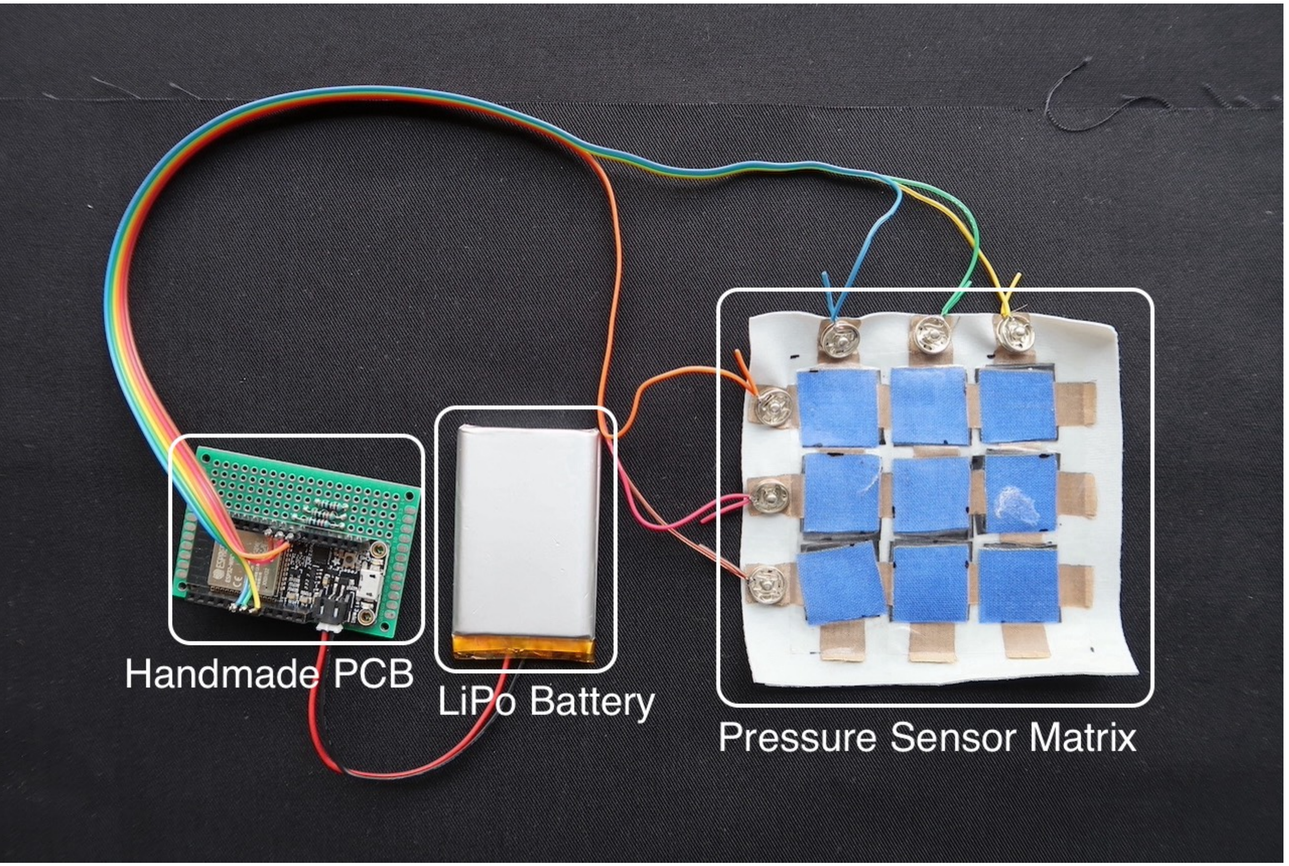
Pressure Sensor Matrix

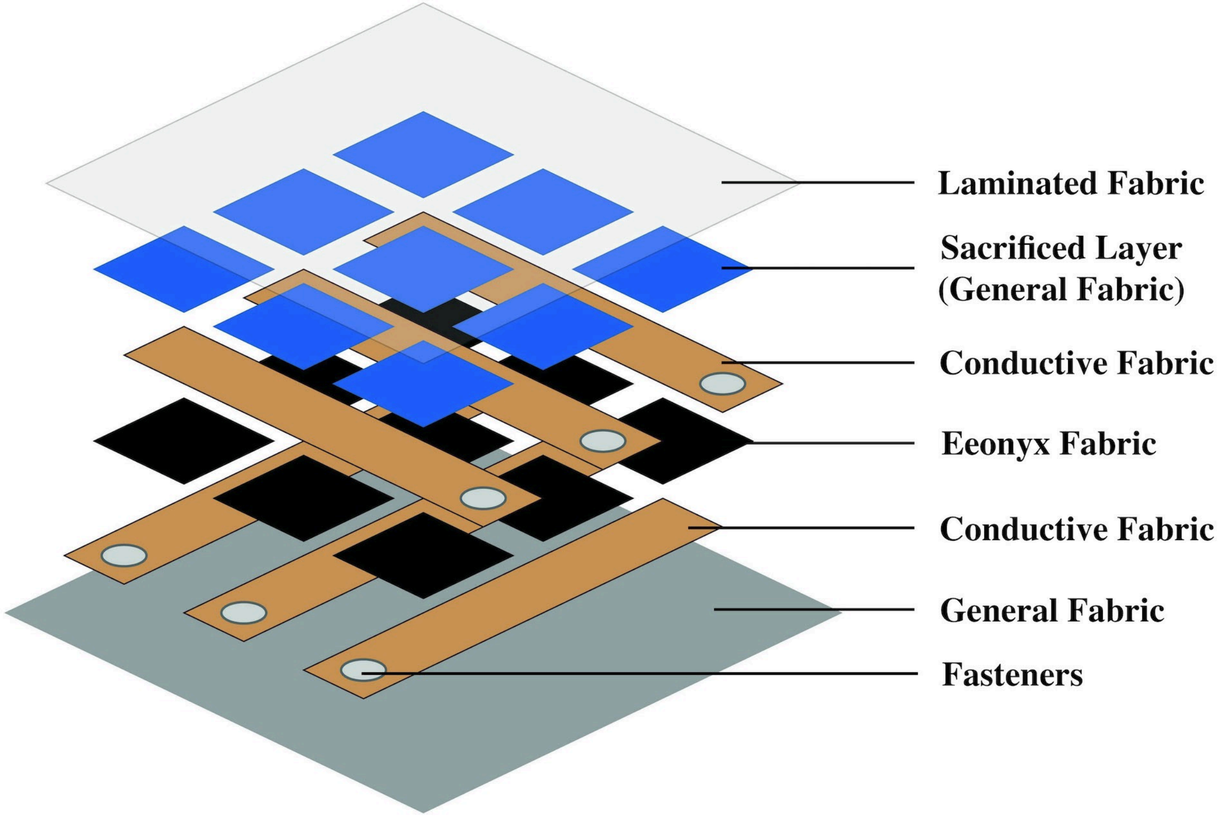
Air Actuator Matrix



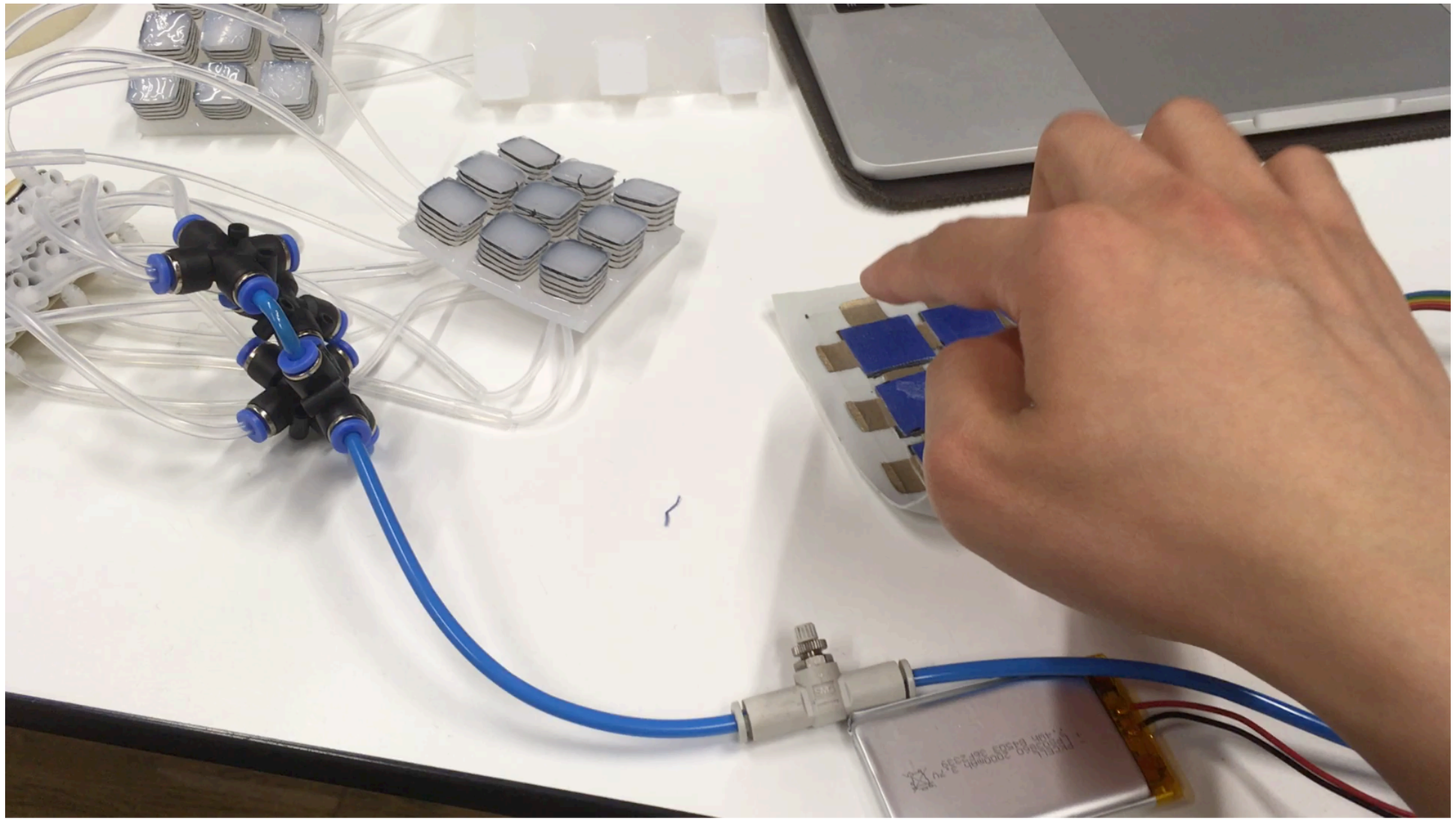


Pressure Sensor Matrix

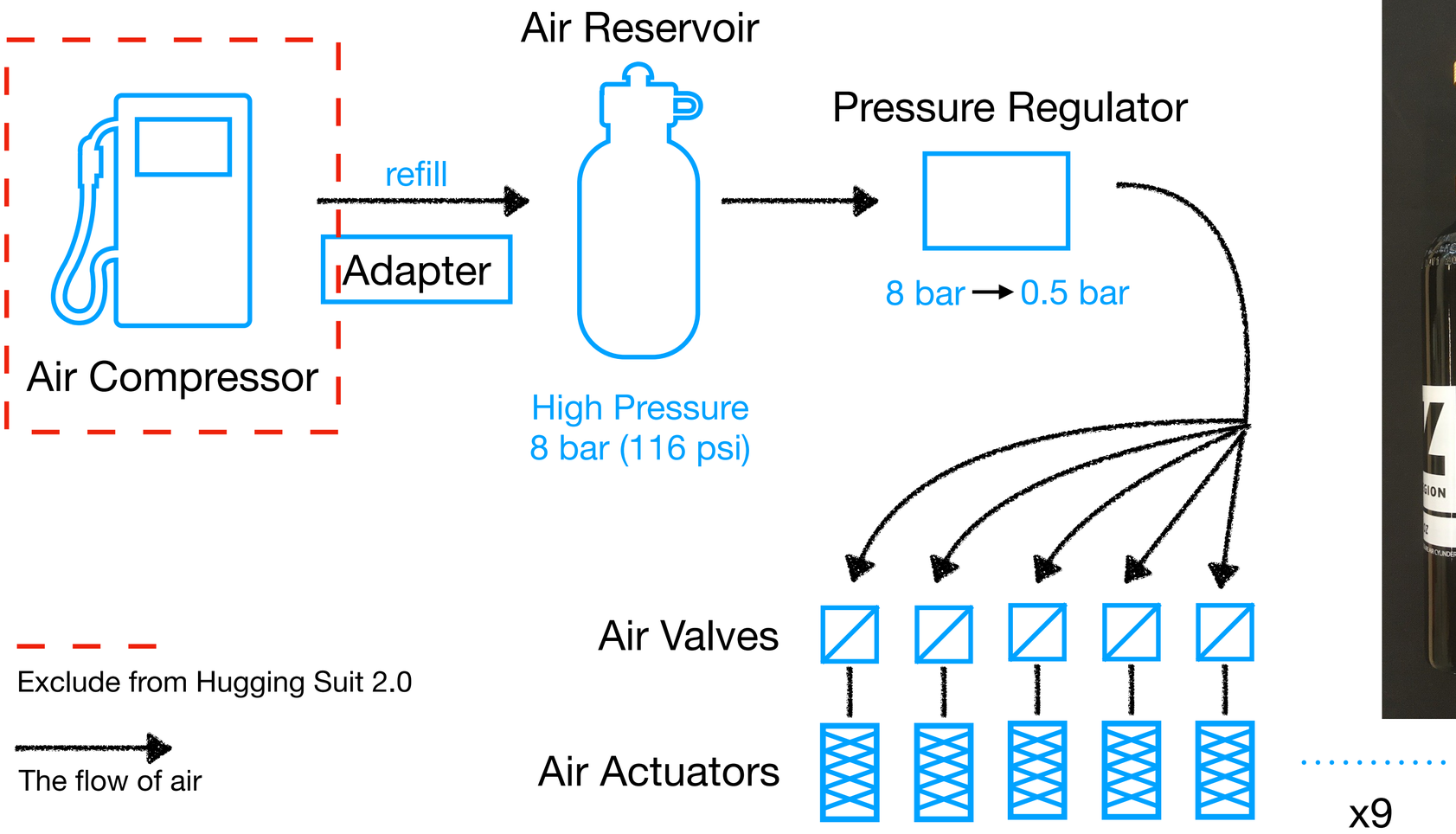


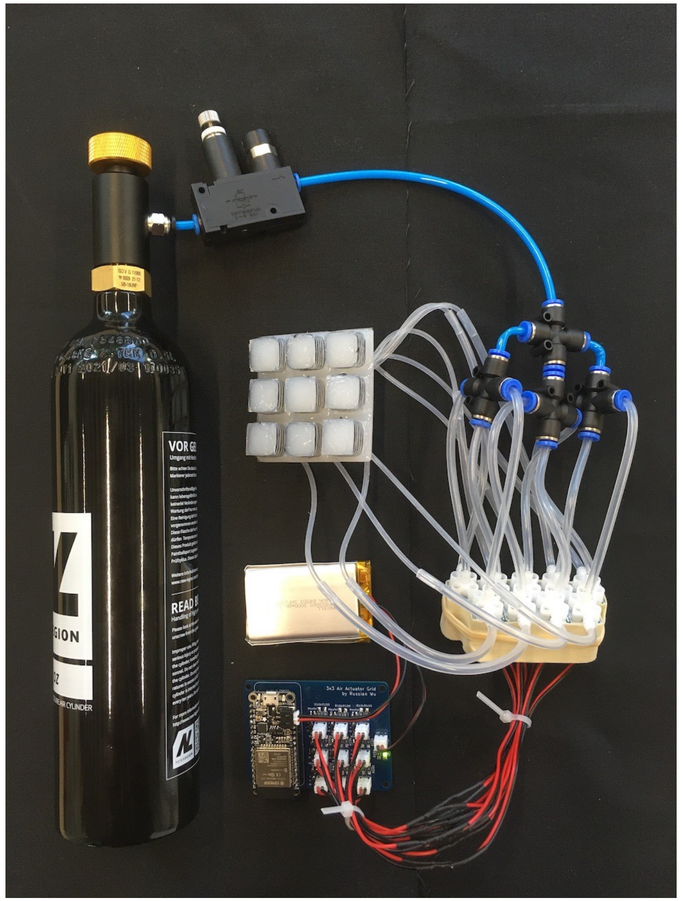


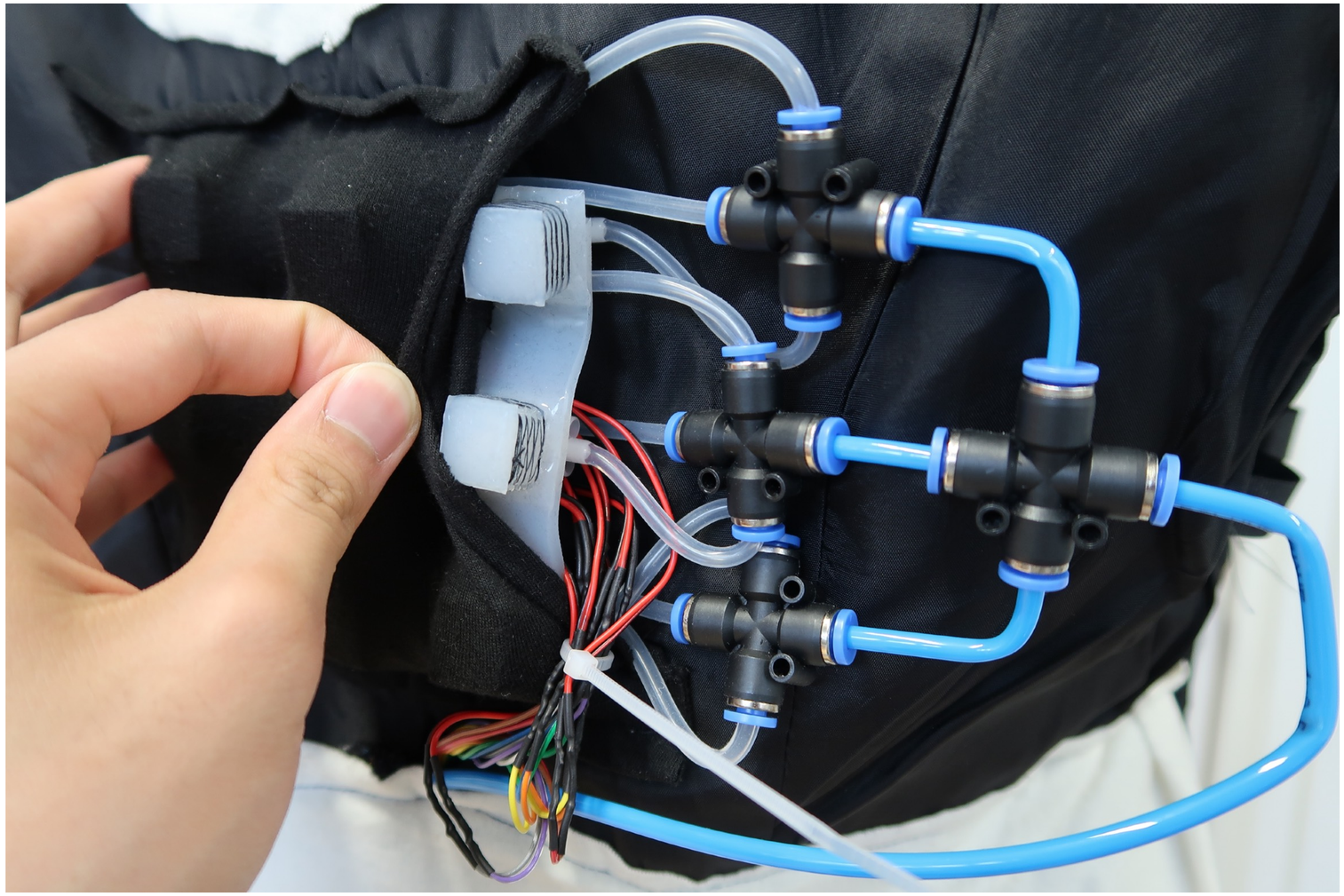
Air Actuator Matrix & Pressure Sensor Matrix



Pneumatic System







Aims of 2nd User Study

- Evaluating the improvements: AAM / PSM / HP System / PCB
- Answering Research Questions 2,3, and 4
- Reviewing Requirements: Wearability and Portability / Accuracy / Immersion

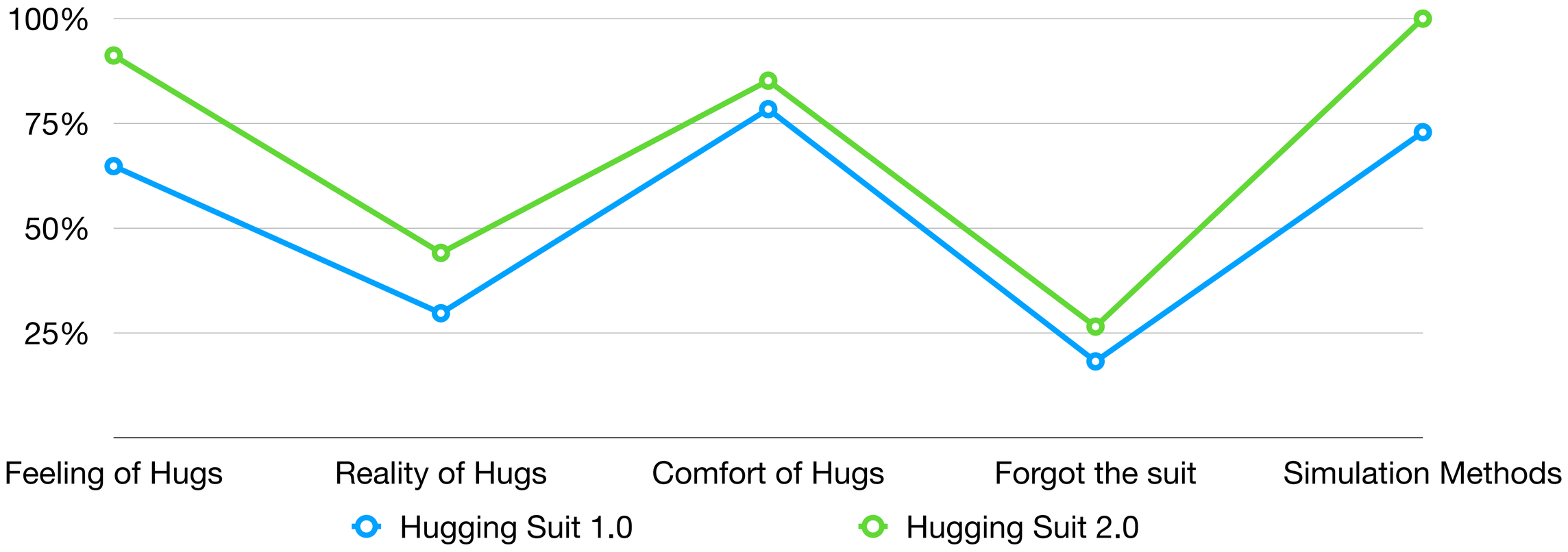
Findings of 2nd User Study

Accuracy / Immersion / Wearability (RQ2/3)

- 34 participants (16F:18M) from 18-60 years old
- 90% agreed the simulated hugs are accurate in position- and time-wise
- The clatter causes noticeable noise (85dB → 65dB) and slight vibration but only it doesn't disturb the hugging experience.
- 85% approved the portability (955g → 911g (694g))

Findings of 2nd User Study

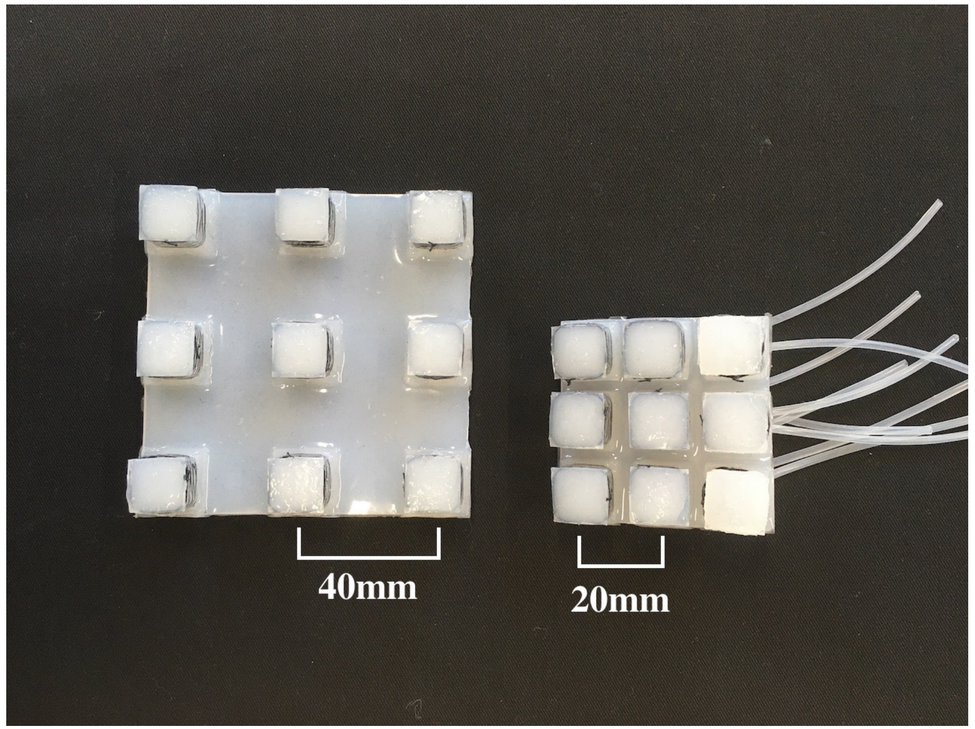
Comparisons of Hugging Suits (RQ2/3)



Findings of 2nd User Study

Two-point discrimination (RQ3)

- 90% feel the fingers; 53% feel the palms
- Two-point discrimination values didn't work
  - Distance too wide
  - Pressure too low (0.5-0.8 bar)
  - The thresholds of PSM too high
- "tapping and poking" them instead of touching (one air valve)



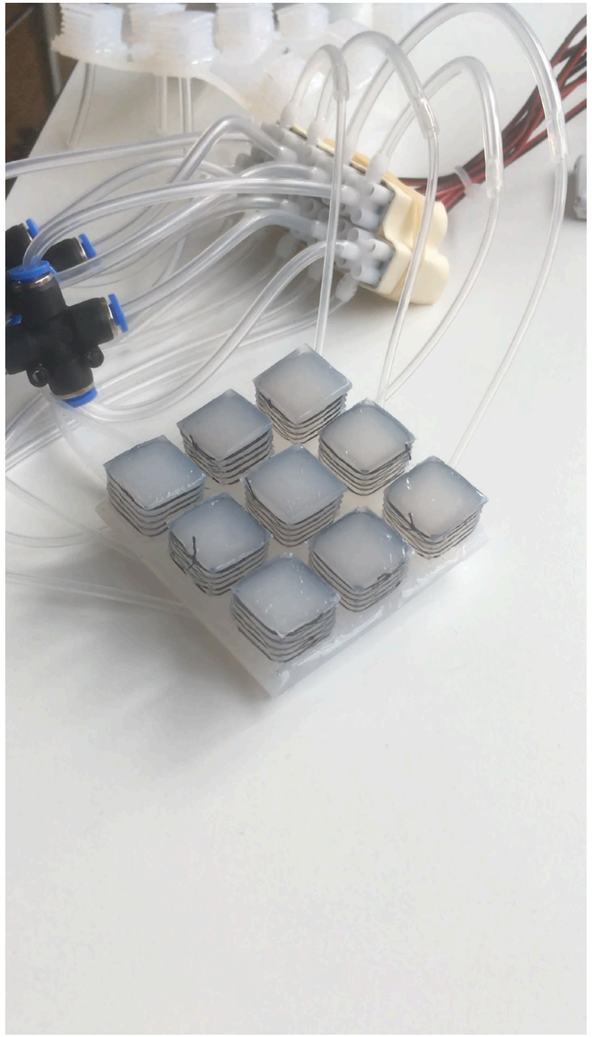
Findings of 2nd User Study

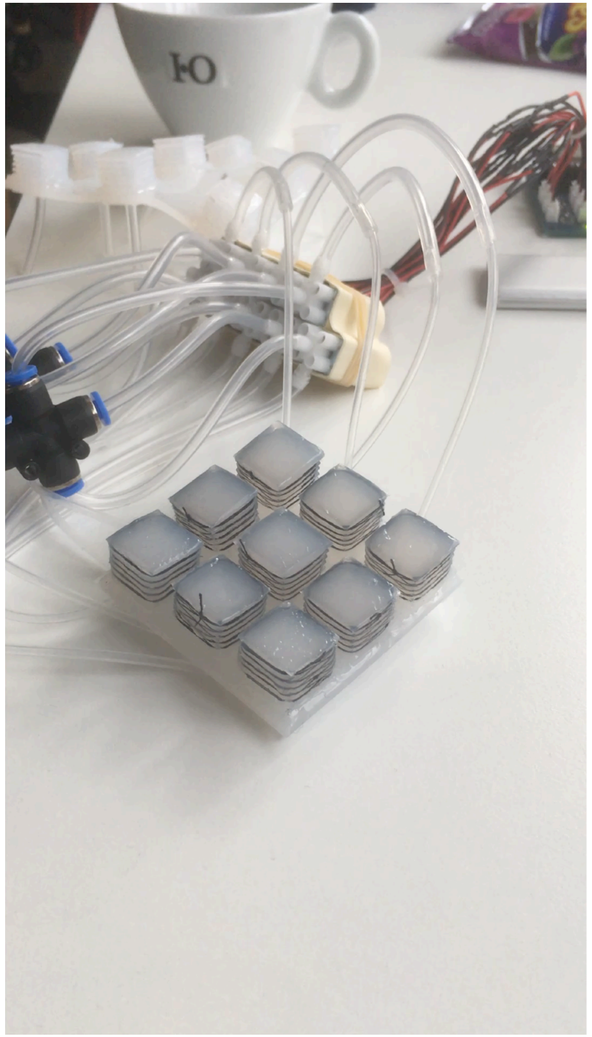
Potential Applications (RQ4)

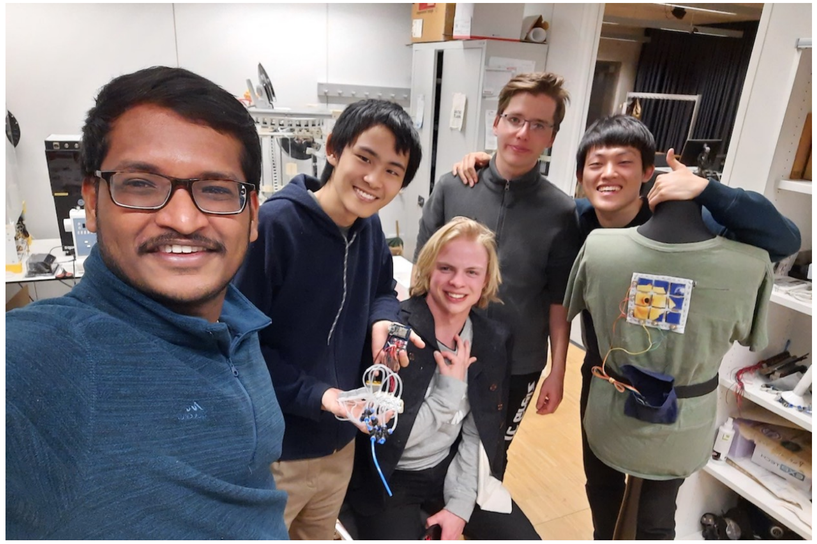
- Massage
- Remote intimacy interaction
- Guide visual impaired people
- Hugging Passwords
- Hmoji
- Memorizing the deceased loved people

Findings of 2nd User Study

Potential Applications (RQ4)





Limitations and Future Works

- 3x3 Air Actuator Matrix
- The temperature simulation
- Materials and sizes of suit
- High-Pressure air compressor
- Externalize the air valves
  - 3.3V (0.5 bar) → 6V (1.2 bar)
  - One air valve for each actuator