Captures of user studies

Hugging Suit

Pneumatically-Actuated System Design for Haptic Experiences

Video Links

Project Description

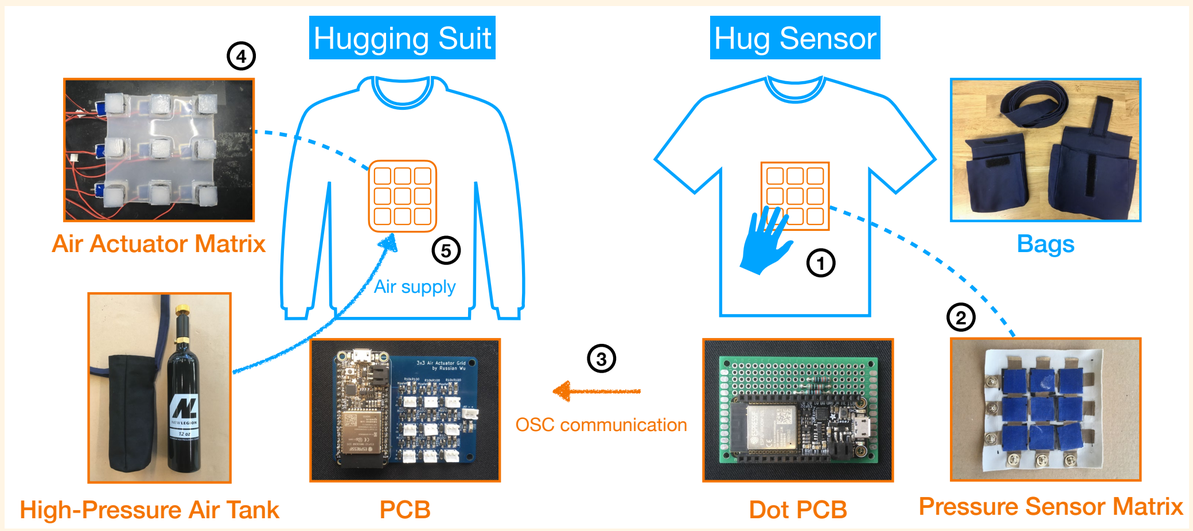
The Covid-19 pandemic has changed human interactions dramatically and highlights the needs for remote haptic communication, such as touches, hugs, and pats, since hygiene requirements generally avoid physical contact. Hugging family and friends at home has become an extravagant wish for international students and staff, because of high travel costs and compulsory quarantines. My master's thesis aims at achieving remote and real-time haptic communication with Hug Sensor (Haptic Sensing) and Hugging Suit (Haptic Simulations) which can "feel, transfer, and give" hugs to users in different spaces.

In contrast to present pneumatic VR suits, the thesis proposes **1. Haptic pressure sensing, 2. Pixelated haptic simulations, 3. High-pressure air supply.** Using Research through Design (RtD) processes, the research followed design, production, and evaluation, and provides the evolution from first to second prototypes, coupled with two user trials involving 71 participants, examining portability, wearability, and the fidelity of the hugging simulations. Moreover, the study found that low-lit, comfortable, private, and being able to see the hug giver are suitable environments so that the future designs of Hugging Suits can be identified accordingly. Finally, the potential applications of the Hugging Suit were revealed in the user study feedback, such as massages, “Hmoji,” “Hugging Passwords,” and memorizing deceased loved ones.

Research Questions

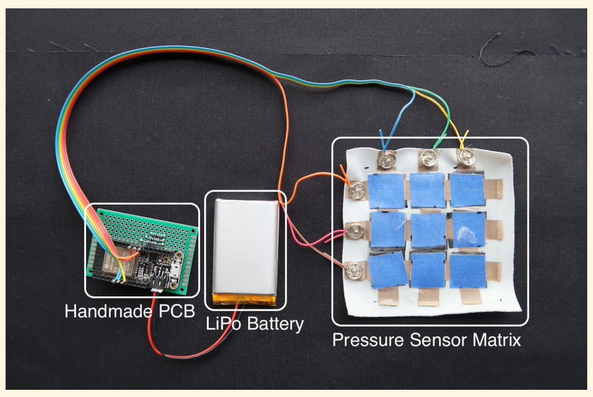
1. Remote Environment: What design factors to consider when attempting to recreate the physical experience of hugging in a remote environment?
2. Wearability: How should the pneumatically-actuated system be designed in a wearable approach?
3. Fidelity: How can hugging simulations become more realistic?
4. Applications: What are the potential applications of the Hugging Suit?

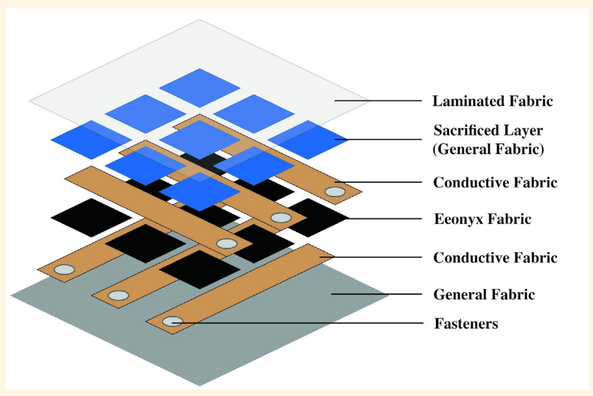
The Interaction Diagram of Hugging Suit



1. The hugger hugs and touches the Hug Sensor. 2. Pressure Sensor senses the hugs. 3. PCB collects and transmits the signal wirelessly. 4. The PCB controls the air valves of air actuators. 5. Inflated and deflated actuators simulate hugs and touches on the hug receiver.

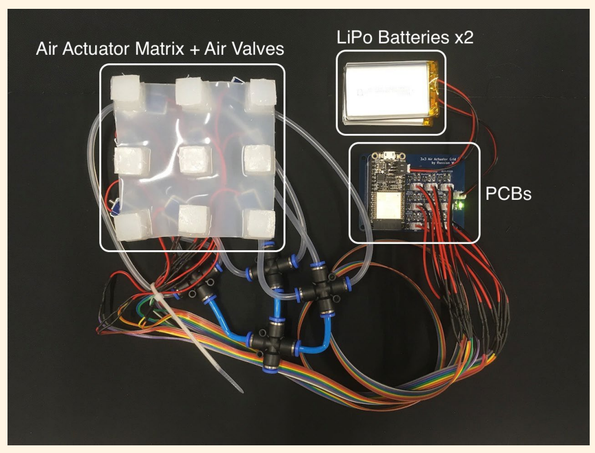
Hug Sensor (Haptic Sensing)

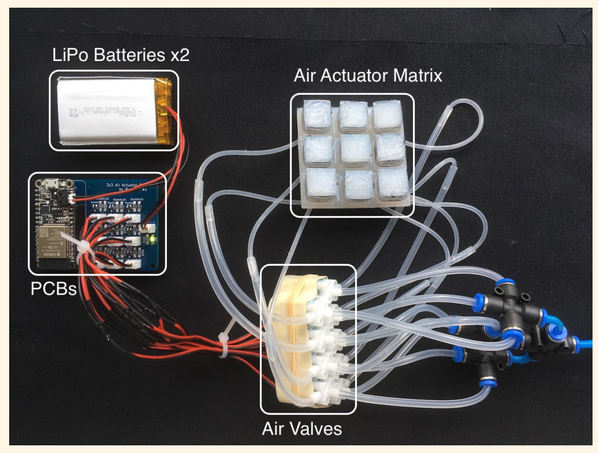




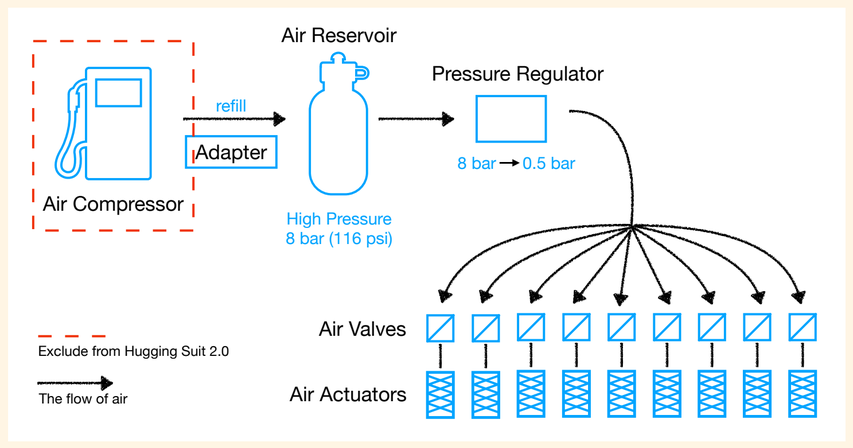
The Hug Sensor detects haptic pressure using a Pressure Sensor Matrix (resistive sensors) built from several layers of E-textile.

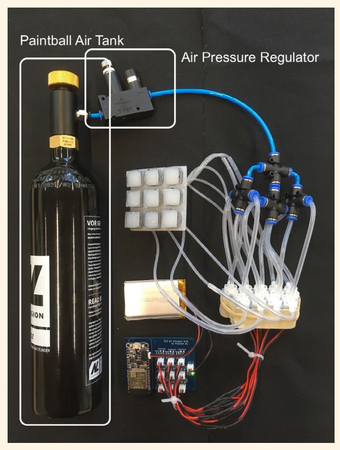
Hugging Suit (Haptic Simulations)





The haptic interface on the Hugging Suit provides pixelated haptic simulations with an Air Actuator Matrix (pneumatic actuators), which was created from customized silicone. The structure of McKibben artificial muscle and two-point discrimination values are utilized in the design.



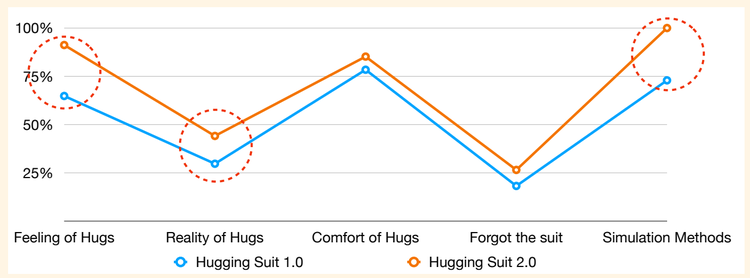


The system of high-pressure air tank not only provides air, but also reusability, mobility, and immersive experience for the user due to air regulators, refilling, lighter weight, and lower noise.

Findings from User Studies

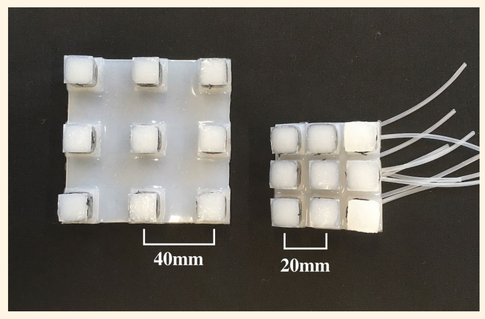
User scenario (RQ1): The research found that low-lit, comfortable, private, and being able to see hug givers are preferable environments.

Comparisons of Hugging Suits (RQ2/3)



According to the results, the simulated hugs are accurate, and the suit's noise decreased from 85dB to 65dB, and its weight decreased from 955g to 694g.

Two-point discrimination (RQ3)



From the feedback, I found that two-point discrimination values didn’t work. Because 90% of users feel the touch of fingers, but only 53% feel the touch of palms. The rest of them stated that they were experiencing “tapping and poking” instead of touching and hugging.

Potential Applications (RQ4)

Massages, remote intimacy interaction, guiding visual impaired people, “Hmoji”, memorizing deceased loved ones.

Credits

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