Ferrozuit: Ferromagnetic Electronic Textile System for Zero-Gravity Spatial Anchoring

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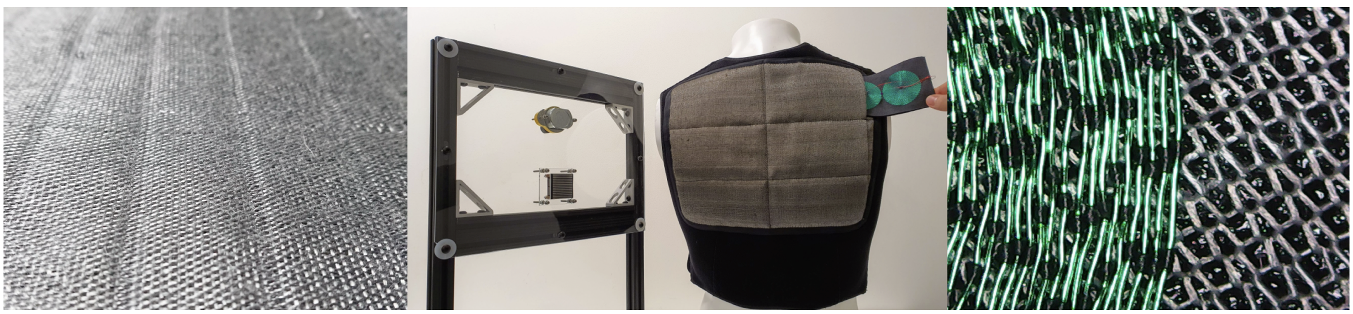

Figure 1: The Ferrozuit System features a magnetic vest integrated with an electro-permanent magnet-embedded rig (center). The vest incorporates custom double-weave textiles made of ferromagnetic yarns (left) and embroidered coils (right)

Abstract

Long-duration human space missions introduce persistent physical, physiological, and psychological challenges stemming from the absence of gravity. Beyond major concerns like bone deterioration, cardiovascular deconditioning, and muscle atrophy, astronauts frequently experience spatial disorientation, discomfort during routine tasks, and difficulty maintaining stable body positioning. These subtle yet pervasive issues impact daily functioning, underscoring the need for lightweight, unobtrusive solutions that support orientation, comfort, and stability in microgravity environments.

Ferrozuit introduces a solution to address these challenges in microgravity. It is a prototype crafted from custom ferromagnetic thread, woven and tailored to interact with programmable (electro)permanent magnets embedded within the microgravity environment. This system aims to provide an anchoring force intended to improve stability during tasks, enhance comfort during rest, and create a sense of orientation. This paper details the design rationale, the fabrication of the ferromagnetic textile, the magnetic docking system, initial technical evaluations, and potential applications. Ferrozuit reimagines spatial anchoring as an embedded, textile-driven experience, blending textile craft with advanced materials for adaptive wearable anchoring in microgravity environments.

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**.

Keywords

Human-Space Interaction; Wearable Technology; Zero-Gravity Environments; Smart Textiles; Ferromagnetic Textiles; Electro-Permanent Magnets; Space Exploration

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1 Introduction

As long-duration space missions advance, wearable technology is becoming essential for astronaut health and performance [1, 4, 5, 15]. Innovations in areas like haptics and human-computer interaction are enabling more adaptive body-environment integration, reshaping how astronauts work in microgravity [12, 16, 21, 26].

However, astronauts face ergonomic and orientation challenges [24]. Simple actions often require restraints such as straps or Velcro. While straps provide secure fastening and adjustability, they are difficult to manipulate, uncomfortable, and impede movement. Velcro is lightweight and easy to use but produces undesired noise and degrades over time [3]. Both can impact comfort and workflow. Moreover, maintaining a stable orientation for precision tasks demands effort, leading to fatigue and reduced task efficiency. Ferrozuit explores a novel approach to address these aspects of life in microgravity, providing magnetic anchoring. The system includes a garment woven from custom ferromagnetic yarns that interacts with strategically placed magnets within the habitat. The goal is to offer a subtle, distributed anchoring force, not as a primary physiological countermeasure, but as a system to improve stability during tasks, comfort, and an intuitive sense of place that gravity normally provides [23]. This work details the design, fabrication, and initial evaluation of the Ferrozuit prototype, positioning it as a wearable experimentation for spatial anchoring in space environment.

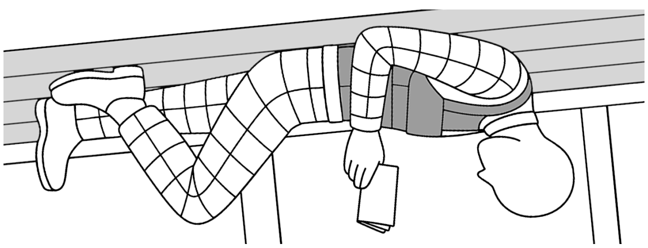

Figure 2: Illustrating a user anchored in Zero-Gravity: the gray zones indicate (ferro)magnetic materials.

2 Related Work

Previous approaches to microgravity stability, such as 1970s-era magnetic footwear [20] or more recent ferrofluid-based concepts [9], faced limitations including parasitic fields, or issues with liquid containment and weight. Ferrozuit builds on this legacy by proposing a solid-state solution using ferromagnetic textiles, leveraging recent progress in e-textiles [10, 17, 18, 22, 25, 27]. Our approach combines these advanced textiles with controllable electro-permanent magnets (EPMs), creating a dynamic anchoring system that is both passive and active. Our technical choices are grounded in prior e-textile innovations. Integrating ferromagnetic yarns with magnets for controlled interaction was demonstrated in recent work like MagKnitic, which uses it for haptic feedback [11]. The design of a body-conformable garment builds on platforms like Second Skin, which emphasizes adaptable wearable systems [6, 7]. Finally, our use of embroidered coils for active magnetic control is informed by techniques seen in projects like SonoFlex, which creates magnet-free speakers from similar embroidered structures [19].

3 Design Rationale and System Overview

The core function of Ferrozuit is to provide a persistent, gentle sense of anchoring in microgravity, akin to a subtle gravitational pull, through a wearable textile interface (as seen in figure 2). This is intended to enhance comfort, facilitate orientation, and reduce the reliance on cumbersome restraints.

The Ferrozuit system comprises two primary components:

(1) **The Ferromagnetic Garment:** A wearable vest prototype constructed from a custom-developed textile containing ferromagnetic yarns. A primary design emphasis was on comfort and wearability, ensuring the garment is soft, flexible, and comfortable for extended use [2]. The garment itself can be either passive, relying solely on its attraction to external magnetic fields, or active, by incorporating embroidered electromagnets for dynamic, localized control over the anchoring force.

(2) **The Magnetic Anchoring Surface:** Structures, such as wall panels or furniture, that host the magnetic anchoring points (figure 1). A critical design requirement is the ability to switch the magnetic field off to prevent attracting unwanted metallic objects, and to allow the user to detach freely. To meet this low-power, bi-stable need, we explored two types of controllable magnets, EPMs, which are toggled with a brief electrical pulse, and mechanically-switched permanent magnets (e.g. MagJig), which can be toggled with motors. Both types are crucial for resource-constrained space environments as they consume no energy to maintain their magnetic state (either on or off).

The initial concept imagines an astronaut wearing the Ferrozuit garment and being able to dock or anchor, to adhere gently onto designated surfaces for tasks, rest, or sleep, thereby creating a subjective sense of "down" and stability as illustrated in figure 2.

4 Implementation

The realization of Ferrozuit involved the fabrication of custom yarns, textiles and garments (figure 3).

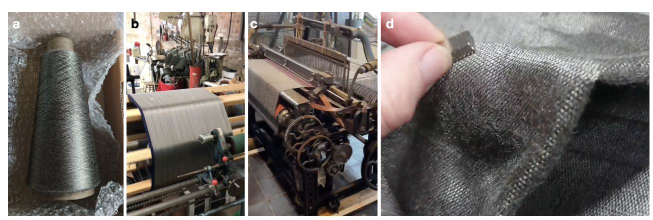

Figure 3: a) Custom ferromagnetic yarns that were integrated through b-c) weaving process to create d) magnetic textiles.

4.1 Ferromagnetic Textile Development

- **Custom Yarn:** A key innovation was the development of a suitable ferromagnetic yarn. After experimentation, an iron-based thread was custom manufactured by Filix (France). They produced 20 spools of 1 kg for this prototype.
- **Weaving Process:** The ferromagnetic yarn was woven by the London Cloth Co. (UK), using analog looms, chosen for their mechanical flexibility with non-standard materials.
- **Weave Structure Evolution:** Initial tests of an iron warp with a cotton weft yielded a pleasant textile but the magnetic force was insufficient. An all-iron weave (iron warp and weft) was reasonable magnetic but proved unwearable due to stiffness. The successful solution was a multilayered double

cloth weave. This structure used the custom iron-based yarn as a thick weft and a strong synthetic yarn as the warp (Dyneema). Two layers were woven together, increasing the magnetic material density while maintaining textile integrity, softness, and durability.

4.2 Garment Fabrication

Our vest prototype (figure 1 & 4) addresses comfort and safety:

- The ferro-textile was backed with YULEX, a sustainable neoprene alternative, providing cushioning and insulation.
- Seams were finished using bonded seam tapes made from recycled technical knit (Carvico Vita), ensuring flexibility and a smooth internal finish.

This construction resulted in a garment that is magnetically responsive yet flexible and body-safe.

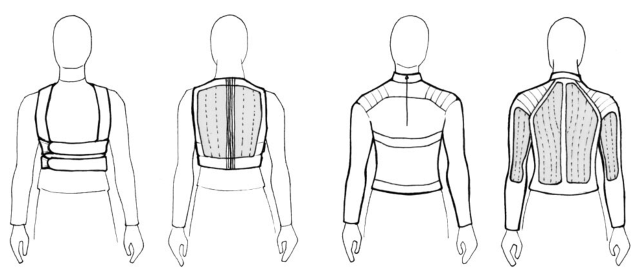

Figure 4: Illustrations of current and envisioned Ferrozuit: V1 (left) - simple harness to test: strength and weave of fabric, tension points for garment.
V2 (right) - softer full garment: engineered construction based on V1, increased comfort and movement.

4.3 Magnetic Anchoring System

To interact with the ferromagnetic garment, we implemented an anchoring system with several key components:

- **Anchoring Rig:** A demonstration rig was constructed using aluminum 80/20 modular framing. This rig housed the magnets for interaction with the vest.
- **Electro-Permanent Magnets (EPMs):** Open-source OpenGrab EPM v3 units were selected [8]. These EPMs generate a strong magnetic field with a brief (e.g., 20 us) high-voltage pulse and maintain their magnetic state (on or off) without continuous power consumption, requiring only approximately 0.67 mWh per activation/deactivation cycle.
- **Mechanically Switchable Magnets:** Commercially available mechanically switchable permanent magnets (MagJig 150) were also tested as an alternative or supplementary anchoring mechanism, offering strong holding forces that can be toggled manually or using a motor.
- **Embroidered Coils:** As an exploration into active garment-based magnetism, copper coils were embroidered directly onto textile swatches. These were powered by a simple 9V source, and their magnetic field strength was qualitatively assessed using a magnetometer-enabled smartphone:

5 Technical Evaluation

Initial technical evaluations were conducted to assess the feasibility and performance of our magnetic anchoring. The investigation focused on two primary approaches:

- **Passive Ferromagnetic Textile Interaction:** Measuring the anchoring force of our custom ferromagnetic textile against external electro-permanent and mechanical magnets (the simplest, low-power setup).
- **Active Embroidered Electromagnets:** Assessing garment-integrated embroidered coils that generate active magnetic pull over distance, allowing users to initiate controlled drift toward remote anchors during EVA free-float operations.

Our magnetic simulations showed that force is concentrated at the coil's center (figure 5), and larger diameters add more resistance than useful magnetic force.

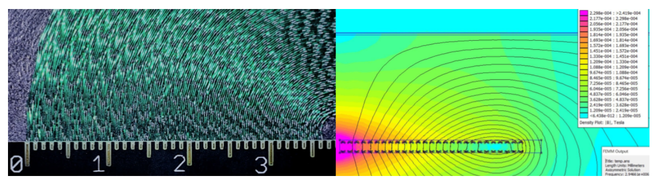

Figure 5: Top view of an embroidered coil VS a cm-based ruler, and cross section of its magnetic field simulation.

This led us to prioritize smaller embroidered coils. For our evaluation, we built a test jig that holds an electro-magnet (the coil), and observe its attraction force by measuring the weight variation of a magnet resting on a scale. To observe the temperature evolution of the embroidered coil, we attached a thermal camera above it, as seen in figure 6.

Our evaluation of each magnetic component yielded the following key findings:

- **EPM Performance:** Tests with the OpenGrab EPMs and the ferromagnetic textile showed that the initial magnetic force was relatively weak, measured at about 5 g of holding force despite a 34W power input during switching.
- **Mechanical Magnet Performance:** The mechanically switchable permanent magnets (Magswitch) exhibited significantly higher holding forces than the EPMs tested. However, moving parts are generally avoided when possible, as they are prone to mechanical wear and present potential points of failure.
- **Embroidered Coil Performance:** Smaller embroidered coils (0.15 mm Cu wire [19]) delivered roughly $\sim 3\times$ the force of the initial, larger coils at the same power thanks to lower resistance and higher current, yet still fell well short of EPMs and mechanical magnets.
- **Thermal Characteristics of Coils:** A 65 W drive raised an embroidered coil to 120°C in 10 s (see figure 6), emphasizing the need for strict power management and added heat-spreading layers (e.g., carbon or Kevlar) in higher-power designs.

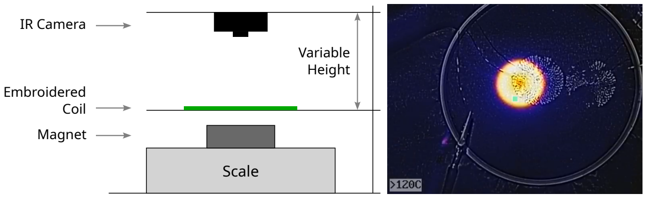

Figure 6: Test jig to measure the magnetic attraction (left), and thermal imaging of the embroidered coil (right).

Coil design and magnetic force

Inertia remains in microgravity, yet, routine ISS tasks, body motions, and minor equipment vibrations rarely cause drift speeds above $\approx 0.05\,\mathrm{m\,s^{-1}}$ [14]. Bringing a 90 kg crewmember to rest from that speed within 0.2 s requires an average force of around 22N. To overcome inertia, we need:

$$a = \frac{v^2}{2d} \quad \Rightarrow \quad F_{\text{required}} = m \cdot \frac{v^2}{2d}$$

where F_{required} = Force needed to initiate motion (N), m = Mass of astronaut (kg), v = Desired final velocity (m/s), and d = Distance to be covered (m). The magnetic force produced by a coil is:

$$F_{\text{magnetic}} = -\frac{\mu_0 \cdot M \cdot N \cdot X \cdot i \cdot (a^3 - b^3)(3d^2 - l^2)}{6(a-b)(d^2 - l^2)^3}$$

where $\mu_0 = 4\pi \times 10^{-7}$ H/m (vacuum permeability), M = Effective magnetic dipole strength, N = Number of turns in the coil, X = Geometric correction factor, i = Current through the coil (A), a, b = Inner and outer radius of the coil (m), d = Distance between coil and magnet (m), l = Magnet thickness or vertical offset (m). Rearranged to solve for desired force N:

$$N = \frac{-F_{\text{required}} \cdot 6(a-b)(d^2 - l^2)^3}{\mu_0 \cdot M \cdot X \cdot i \cdot (a^3 - b^3)(3d^2 - l^2)}$$

Based on the current limitations of our wire (32 AWG), a coil may not be able to generate the required force unless it is significantly thick. However, we use a distributed array of smaller coils to improve the magnetic load, optimize the minimum current load, and enhance the overall flexibility of both the coils and the vest.

Anchoring force and system capability

Bench tests show that an EPM coupled to one coil delivers 0.05 N of holding force (about 5 g) over its $16\,\mathrm{cm^2}$ footprint, i.e. 0.17 kPa. A lightweight 10×10 EPM matrix ($0.16\,\mathrm{m^2}$) would therefore supply $\approx$ 5 N of anchoring force. While this is below the target of 22 N, multiple arrays or higher-flux EPMs can be tiled around the habitat to achieve the desired margin without decreasing the wearer's comfort. Because EPMs are bi-stable, each unit draws power only during its 20 µs switching pulse (34 W peak, 0.67 mWh per cycle). Once latched, its coils are idle, so there is no battery drain. By contrast, our exploratory embroidered coils must be driven continuously (65 W in tests, reaching 120°C in 10 s) and are only suited for transitions rather than sustained anchoring.

These evaluations indicate that while the concept of ferromagnetic textiles for anchoring is viable, optimizing the magnetic flux coupling between the textile and various magnet types, managing thermal loads, and achieving sufficient force for practical anchoring are key areas for further development.

6 Discussion

The Ferrozuit project explores the feasibility of creating custom ferromagnetic textiles and integrating them into a wearable garment for potential microgravity anchoring. The multi-layered weaving technique offer static anchoring while the embroidered coils can help for transient attraction, and the electro-permanent magnet offers a promising low-power solution for controllable anchoring points. However, significant challenges remain. The complexity of achieving high magnetic density in a flexible textile require further material science and engineering refinement. The embroidered coils, while an interesting avenue for dynamic control, pose thermal challenges at higher power levels. The much stronger forces from mechanical magnets suggest that hybrid systems or improved EPM designs tailored for textile interaction might be beneficial.

Despite these technical challenges, the Ferrozuit concept explores several advantages for enhancing the quality of daily life in space. The distributed, soft anchoring could provide a more comfortable and psychologically grounding experience than rigid tethers.While not intended to replace resistive exercise for mitigating muscle atrophy, such a system could reduce the daily fatigue and awkwardness associated with constant free-floating or using rigid restraints for simple tasks. This could be particularly beneficial for sleep, focused tasks, and general orientation. The aesthetic and tactile qualities of a textile-based system [13] could also contribute positively to the habitability of long-duration space missions, an often-underestimated factor. Future iterations could explore:

- Heat-dissipating textiles for the embroidered coils. Lower resistance with smaller coils should improve performances.
- fibers could also be created with co-extrusion of the same materials, and surrounding coils.

7 Conclusion

Ferrozuit explores adaptive wearable technology for microgravity environments by combining textile craftsmanship with functional yarns and electronics. The project envisions a ferromagnetic garment paired with an anchoring system, demonstrating how magnetic textile-based interfaces can offer a more integrated and comfortable solution to the challenges of living and working in space. Beyond space applications, this approach also opens up possibilities for magnetic textiles in Earth-based contexts, such as modular clothing systems, or hands-free support in dynamic environments.

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[1] http://filix.fr
[2] https://www.londoncloth.com/
[3] https://web.archive.org/web/20250122134442/https://mi-lab.org/sonoflex-embroidered-speakers/
[4] https://aureliainstitute.org

References

[1] Javier Andreu-Perez, Daniel R Leff, Henry MD Ip, and Guang-Zhong Yang. 2015. From wearable sensors to smart implants—toward pervasive and personalized healthcare. *IEEE Transactions on Biomedical Engineering* 62, 12 (2015), 2750–2762.

[2] Ahmet Baskan and Gozde Goncu-Berk. 2022. User experience of wearable technologies: a comparative analysis of textile-based and accessory-based wearable products. *Applied Sciences* 12, 21 (2022), 11154.

[3] Annalisa Dominoni. 2020. *Design of supporting systems for life in outer space: A design perspective on space missions near earth and beyond.* Springer Nature.

[4] Ariel Ekblaw, Juliana Cherston, Fangzheng Liu, Irmandy Wicaksono, Don Derek Haddad, Valentina Sumini, and Joseph A Paradiso. 2023. From UbiComp to Universe—Moving Pervasive Computing Research Into Space Applications. *IEEE Pervasive Computing* 22, 2 (2023), 27–42.

[5] Caleb Ferguson, Louise D Hickman, Sabera Turkmani, Paul Breen, Gaetano Gargiulo, and Sally C Inglis. 2021. "Wearables only work on patients that wear them": Barriers and facilitators to the adoption of wearable cardiac monitoring technologies. *Cardiovascular Digital Health Journal* 2, 2 (2021), 137–147.

[6] Rachel Freire, Cedric Honnet, and Paul Strohmeier. 2017. Second skin: An exploration of etextile stretch circuits on the body. In *Proceedings of the Eleventh International Conference on Tangible, Embedded, and Embodied Interaction.* 653–658. doi:10.1145/3024969.3025054

[7] Rachel Freire, Paul Strohmeier, Cedric Honnet, Jarrod Knibbe, and Sophia Brueckner. 2018. Designing etextiles for the body: Shape, volume & motion. In *Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction.* 728–731.

[8] FJ Garcia-Rubiales, P Ramon-Soria, BC Arrue, and A Ollero. 2019. Magnetic detaching system for Modular UAVs with perching capabilities in industrial environments. In *2019 Workshop on Research, Education and Development of Unmanned Aerial Systems (RED UAS).* IEEE, 172–176.

[9] Maximilian Guenther. 2019. Ferrofluid space suit: keeping your muscles active in zero gravity. *Prototyping our Sci-Fi Space Future: Designing & Deploying Projects for Zero Gravity Flights (MAS.838 / 16.88)* (sep 27 2019). https://zero-gravity.pubpub.org/pub/ferrofluidspacesuit.

[10] Cedric Honnet, Catherine Yu, Irmandy Wicaksono, Tingyu Cheng, Andreea Danielescu, Cheng Zhang, Stefanie Mueller, Joe Paradiso, and Yiyue Luo. 2024. Democratizing Intelligent Soft Wearables. In *Proceedings of the 37th Annual ACM Symposium on User Interface Software and Technology.* doi:10.1145/3672539.3686707

[11] Yiyue Luo, Junyi Zhu, Kui Wu, Cedric Honnet, Stefanie Mueller, and Wojciech Matusik. 2023. MagKnitic: Machine-knitted Passive and Interactive Haptics Textiles with Integrated Binary Sensing. In *Proceedings of the 36th Annual ACM Symposium on User Interface Software and Technology (UIST '23).* Association for Computing Machinery. doi:10.1145/3586183.3606765

[12] Severin Meyer, Daniel V Levine, Don D Haddad, Irmandy Wicaksono, and Joseph A Paradiso. 2025. Design, Control, and Testing of Intelligent Electromagnetic Footwear for Astronautical Applications. 2025 International Conference on Environmental Systems.

[13] Stephen Monteiro. 2017. *The fabric of interface: Mobile media, design, and gender.* MIT Press.

[14] NASA Johnson Space Center. 2019. *ISS Safety Requirements Document (SSP 51721).* Program Document. National Aeronautics and Space Administration, Houston, TX. https://ntrs.nasa.gov/api/citations/20210009936/downloads/SSP%2051721-Baseline.pdf Baseline revision, International Space Station Program.

[15] Pat Pataranutaporn, Valentina Sumini, Ariel Ekblaw, Melodie Yashar, Sandra Häuplik-Meusburger, Susanna Testa, Marianna Obrist, Dorit Donoviel, Joseph Paradiso, and Pattie Maes. 2021. SpaceCHI: Designing human-computer interaction systems for space exploration. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems.* 1–6.

[16] Syamantak Payra, Irmandy Wicaksono, Juliana Cherston, Cedric Honnet, Valentina Sumini, and Joseph A Paradiso. 2021. Feeling through spacesuits: Application of space-resilient E-Textiles to enable haptic feedback on pressurized extravehicular suits. In *2021 IEEE Aerospace Conference (50100).* IEEE, 1–12.

[17] E Rehmi Post and Maggie Orth. 1997. Smart fabric, or" wearable clothing". In *Digest of Papers. First International Symposium on Wearable Computers.* IEEE, 167–168.

[18] Ernest Rehmatulla Post, Maggie Orth, Peter R Russo, and Neil Gershenfeld. 2000. E-broidery: Design and fabrication of textile-based computing. *IBM Systems journal* 39, 3.4 (2000), 840–860.

[19] Thomas Preindl, Cedric Honnet, Andreas Pointner, Roland Aigner, Joseph A Paradiso, and Michael Haller. 2020. Sonoflex: Embroidered speakers without permanent magnets. In *Proceedings of the 33rd Annual ACM Symposium on User Interface Software and Technology.* 675–685.

[20] A Rosener and A Hanger. 1970. The use of permanent magnets in zero-gravity mobility and restraint footwear concept. *IEEE Transactions on Magnetics* 6, 3 (1970), 464–467.

[21] Sue Ann Seah, Marianna Obrist, Anne Roudaut, and Sriram Subramanian. 2015. Need for touch in human space exploration: towards the design of a morphing haptic glove–ExoSkin. In *IFIP Conference on Human-Computer Interaction.* Springer, 18–36.

[22] Xiang Shi, Yong Zuo, Peng Zhai, Jiahao Shen, Yangyiwei Yang, Zhen Gao, Meng Liao, Jingxia Wu, Jiawei Wang, Xiaojie Xu, et al. 2021. Large-area display textiles integrated with functional systems. *Nature* 591, 7849 (2021), 240–245.

[23] Thad E Starner. 2002. Wearable computers: No longer science fiction. *IEEE pervasive computing* 1, 1 (2002), 86–88.

[24] Valentina Sumini, Manuel Muccillo, Jamie Milliken, Ariel Ekblaw, and Joseph Paradiso. 2020. SpaceHuman: A soft robotic prosthetic for space exploration. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems.* 1–8.

[25] Irmandy Wicaksono, Juliana Cherston, and Joseph A Paradiso. 2021. Electronic textile gaia: Ubiquitous computational substrates across geometric scales. *IEEE Pervasive Computing* 20, 3 (2021), 18–29.

[26] Irmandy Wicaksono, Ali Shtarbanov, Esha Ranade, Rebecca Slater, Dava Newman, and Joseph Paradiso. 2023. Design, Development, and Testing of Peristaltic Suit: Active-Dynamic Compression and Physiological Sensing Intra-vehicular Activity Spacesuit for Cardiovascular Deconditioning. 2023 International Conference on Environmental Systems.

[27] Tianhong Catherine Yu, Cedric Honnet, Tingyu Cheng, Ryo Takahashi, Bo Zhou, Cheng Zhang, Paul Lukowicz, Yoshihiro Kawahara, Josiah Hester, Joseph A. Paradiso, Yiyue Luo, and Irmandy Wicaksono. 2025. Intelligent Soft Wearables. In *Proceedings of the ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp '25).*