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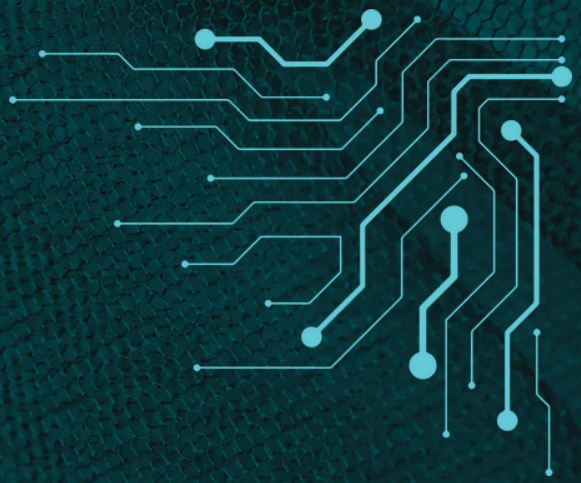

WEARABLES COLLECTIVE

WEAVING INNOVATION INTO STAGES OF LIFE

25-26 March 2024, University of California-Davis

Royal College of Art

UCDAVIS
UNIVERSITY OF CALIFORNIA

WELCOME

WEARABLES COLLECTIVE is a two-day symposium focused on e-textiles, smart clothing and other forms of wearable technology applications for health and wellbeing, organized by University of California-Davis in collaboration with the Royal College of Art, London.

The symposium aims for deep exploration and cross disciplinary discussion in wearables of all forms, smart material explorations and tangible human computer/robot interfaces for physical and mental health and wellbeing in all stages of life from infancy to older age, to sleep-work-leisure cycles as well as healthy versus unwell phases in life.

General Symposium Chairs:
Gozde Goncu-Berk (UC Davis, USA)
Elif Ozden-Yenigun (Royal College of Art London, UK)

Scientific Track Chairs:
Anne Toomey (Royal College of Art London, UK)
Marie O'Mahony (Royal College of Art London, UK)
Katia Vega (UC Davis, USA)

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Intuitive Surfaces with Artificial Intelligence and Knitted Textiles

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TUESDAY, MARCH 26

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Laura Devendorf, PhD, Unstable Design Lab, University of Colorado, Boulder, ATLAS Institute

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Dahua Shou and Erin Cho

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4pm - 6:00pm **Workshop:Making Biobased materials for Tangible Interfaces**
Eldy Lazaro, University of Colorado Boulder, ATLAS Institute

KEYNOTE SPEAKERS

INTUITIVE SURFACES WITH ARTIFICIAL INTELLIGENCE AND KNITTED TEXTILES

Jeanne Tan, PhD
Artificial Intelligence in Design (AiDLab)
The Hong Kong Polytechnic University

Jeanne Tan, Ph.D. is the COO of the Laboratory of Artificial Intelligence in Design (AiDLab) and a Professor of Fashion and Textiles at The Hong Kong Polytechnic University (HKPolyU). She is a design practitioner who investigates creative innovations that interface design and technology. Her research focuses on the integration of AI and textiles to create interactive materials for fashion, interiors, and rehabilitation. Jeanne's work had been collected as part of the permanent collection of the National Museum of Silk, China and examples of international showcases are at Milan Fashion Week A/W 2023 and Victoria & Albert Museum. Jeanne is often invited to share her work internationally at eventse, Fashionary, Kiabi, CLP Power Hong Kong Limited, and The Hong Kong Red Cross.

Artificial intelligence (AI) offers the potential for the development of e-textiles that give wearers a smart and intuitive experience. Interdisciplinary approaches and emerging emphasis on collaborative investigations have led to creative innovations that are pushing the boundaries of design and technology. The integration of technology in e-textiles is no longer a simple add-on for the sake of novel creations but as a means to create inclusive experiences that enhance everyday interactions with an omnipresent material. Drawing from practice and based on the topics of textile structural design, technology integration and real-world applications, this keynote presentation will discuss the evolution of reactive textiles to the current AI empowered illuminative textile system from the perspective of a textile design practitioner.

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DESIGNING HYBRID SKINS

Cindy Hsin-Liu Kao, PhD
Hybrid Body Lab, Cornell University

Cindy Hsin-Liu Kao is an Assistant Professor at Cornell University, where she founded and directs the Hybrid Body Lab. Her research practice in Hybrid Skins blends cultural perspectives into designing conformable interfaces across all scales. Kao was awarded a National Science Foundation CAREER Award for her research agenda. Kao and her lab have received numerous Honorable Mention/Best Paper Awards in top-tier Computer Science conferences (ACM CHI, UIST, ISWC and DIS) and media coverage by Forbes, CNN, and TIME Magazine. Kao served as a program chair for ACM International Symposium of Wearable Computers (ISWC), the premier venue for wearable computers.

Kao and her lab also strive to make an impact in the design and art communities. To this end, Kao's work has been exhibited internationally in venues including the Pompidou Centre in Paris, the Boston Museum of Fine Art, Ars Electronica in Linz, Austria, the Seattle Museum of Pop Culture, and on the New York Fashion Week runway, along with recognitions from the design community through the A'Design Award, the Fast Company Innovation by Design Award Finalist, an Ars Electronica STARTS Prize Nomination, and the SXSW Interactive Innovation Award.

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WEAVING AND COUNTERFACTUAL NARRATIVES OF TECHNICAL PROGRESS

Laura Devendorf, PhD
Unstable Design Lab, University of Colorado, Boulder, ATLAS Institute

Laura Devendorf, PhD is a design researcher who has a fascination with the relationship between frustration and design. Through practices of weaving (sometimes with circuitry, sometimes without) or performing as a machine I reflect the forces that shape humans and things—the benefits of struggle, work, labor, and not getting what you might expect. With many students and collaborators, I ask about the purpose of design in the Anthropocene, where not getting what we want might be exactly what we need. Some of these stories are told in the objects and some are presented as academic articles, largely published in the field of HCI. Some of these stories have required me to build new kinds of tools, techniques, and software and I commit to sharing those through open-source projects. Laura is an Assistant Professor at the ATLAS Institute and Department of Information Science at the University of Colorado, Boulder where she directs the Unstable Design Lab. I am also affiliate faculty in the department of Intermedia Writing, Art, and Performance. She received her PhD at the School of Information at University of California, Berkeley and have bachelors degrees in computer science and studio art from the University of California Santa Barbara.

Counterfactual thinking is a form of asking "what if" questions that consider how the present would have unfolded had historical events had different outcomes. In this talk, I'll draw from my research as an artist/computer-scientist and design researcher to present a counterfactual narrative of technical progress rooted in my deep fascination and immersion into the world of complex weaving (the practice of creating complex 3D, electronic and/or robotic structures). For example, how might our relationships with devices change if we hand crafted them from fiber, mended them with thin metals, and adapted them to our changing bodies with crochet hooks? I'll mix historical narratives of textiles and technology with the work of students and artists-in-residence at the Unstable Design Lab to craft this narrative of technology that emphasizes humility, care, and community.

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BOOK OF ABSTRACTS

DESIGN CONSIDERATIONS FOR THE CREATION OF ELECTRONIC YARNS FOR WEARABLE HEALTH MONITORING DEVICES

Arash M. Shahidi, Kalana Marasinghe, Carlos Oliveira, Nishadi Perera, Amanda Briggs-Goode, Tilak Dias and Theo Hughes-Riley*

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Textiles with embedded sensing capabilities can be an ideal solution for many health monitoring applications as textiles are comfortable to wear close to the skin. Various integration techniques have been explored over the years to create textiles and garments with electronic functionality. One method is to create yarns where the electronics are embedded within the core of a yarn that is then used to produce textiles. This is accomplished by first soldering a component onto conductive wires, encapsulating them within a discrete resin pod, and then covering the wires and component in a fibre sheath. This yarn can be incorporated into woven or knitted textiles to produce wearable garments. This technology has already been used to create a variety of textiles with different functions, including temperature sensing and motion sensing.Through the testing of different electronic textiles made using these electronic yarns, limitations have been identified. This paper will outline these limitations and discuss the approaches used to overcome these challenges.

Keywords: electronic textile; e-textile; wearables; smart textiles; electronic yarns; health monitoring

NOTES

NISHIJIN WEAVING AND PLEATING TO CREATE TEXTILE SENSORS

Bine Roth a* and Dr Kaori Ueda b

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b Textiles, Saga University, Kyoto, Japan

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This paper presents preliminary results from a study on woven pleated electronic textiles (e-textiles) sensors, with a focus on prototyping, 3D structures, and measuring electrical resistance in woven sensors. The research is a starting point for a larger project exploring the interaction between sensors and the human body, investigating how these structures can be utilised in dynamic settings. To date, knitted materials have been most commonly employed in e-textiles, known for their use of a single yarn and high stretchability. This paper serves as an initial exploration into incorporating stretch into woven textiles for the purpose of recording electrical resistance. Initial pleated structures were identified using Nishijin weaving to construct pleated conductive materials. The results underscore that a critical factor in using woven pleats as input devices lies in the combination of yarns and the construction of the woven pleat.

Keywords: pleats; e-textiles; sensors; woven

NOTES

DEVELOPMENTS AND IMPLICATIONS OF FLEXIBLE E-TEXTILE KITS FOR TRANSDISCIPLINARY DESIGN EDUCATION

Yumin Cho a*, Yeji Cho a, Mingyo Song a, Sophie Yang a, Byungkwan Ko a, Ju-Young Kang b and Sumin Helen Koo a*

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This study evaluated user perceptions and satisfaction with 'Flexi kits', electronic textile kits designed for educational purposes, especially teaching electronic circuits. A user-friendly Flexi kit was developed and assessed through a survey. The participants, who were predominately non-STEM female university students, perceived the kits as easy to use, useful, interesting, and safe, and were particularly impressed with the kit's versatility and aesthetic qualities. Of the participants, 87% expressed willingness to purchase the kit; 72% appreciated the kit's appearance and design, which made electronics more approachable to those typically disinterested in such products, whereas 22% valued its soft, comfortable material. There were significant differences in perceptions between those with and without prior knowledge of e-textiles, underscoring the impact of prior exposure on user expectations and perceptions. These findings emphasize the importance of design and functionality in educational tools, particularly e-textiles. The Flexi kit has the potential to enhance electronic circuit learning. This research highlights the role of e-textiles in fostering interest in and understanding of electronic circuitry among diverse learner groups and the need for educational tools that cater to a broad range of users, thereby enhancing their overall learning experiences.

Keywords: e-textiles; kit; flexible; module; design; education

NOTES

CHROMALIPSENSE: LIPSTICK-BASED BIOSENSORS FOR METABOLIC MONITORING

Shuyi Sun a and Yuan-Hao Ku a, Jae Yong Suk c, Ali K. Yetisen b, and Katia Vega c

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b Chemical Engineering, Imperial College, London, U.K.;
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Lipstick as a ubiquitous beauty product is an ideal substrate for the encapsulation of biosensors due to its direct contact with saliva, food and drinks, frequent use, and discrete nature. This article introduces ChromaLipSense, a lipstick that seamlessly embeds a colorimetric biosensor whose colors change in response to pH levels. This project addresses limitations in existing biosensor technologies, such as transdermal patches and temporary tattoos, which often pose challenges related to adhesion, invasiveness, and frequent calibration requirements. Saliva is a readily-available bodily fluid for biosensing applications due to its transparent, regenerative nature and rich composition that indicates health-related information. The main contributions include the use of a lipstick as a biosensing form factor, a DIY fabrication process for biosensor lipstick using medical-grade commercial products, and the integration of machine learning algorithms for on-body biosensor detection. The data collection process involved five pH calibration solutions, six distinct lighting conditions, the use of two devices for photo capturing, and four participants.

NOTES

INTENTION VS. REALITY: MANAGING THE SENSORY LANGUAGE OF SOFT ROBOTIC SKIN STRETCH WEARABLES

Robert Pettys-Baker* and Brad Holschuh

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The development of haptic skin stretch systems strives to create technologies that produce consistent sensations for all users. The ability to achieve consistency relies on the ability to create a device that works with the body to afford the intended perceptual, cognitive, and emotional experience of a sensation. However, there is a tendency in the literature to prescriptively assign haptic sensations when testing, rather that conceptualizing the user's subjective experience of the stimuli being created first. This paper analyzes the perceptual experience of two iterations of a skin stretch device worn on the forearm in the users' own words. It was found that the newer iteration of the device produced more consistent sensations and a more positive user experience. The results demonstrate the need to consider haptic experiences more holistically without jumping to prescriptive conclusions, as well as the importance of good attachment, fit, and wearability for skin stretch wearables.

Keywords: Haptic Skin Stretch, Haptics Design, Soft Robotics, Wearable Technology

NOTES

DATA ACQUISITION AND ANALYTICS METHODS FOR E-TEXTILES ENABLING MEDICAL AND WEARABLE MARKETS

Eisuke Tsuyuzaki

Founder, Bayflex Solutions

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The commercialization of E-textiles products at scale requires the understanding of multiple disciplines from textiles and electronics and semiconductor industries. In this session, the most common technical challenges of designing rigid components on flexible substrates. An overview of Failure modes (i.e., delamination, deformation etc.) and mechanical motions (flex, elongation, torsion etc.) is presented
with recent performance criteria of thin and multi-layer substrates with thermo-mechanical approaches and various data and imaging techniques. While processes may be covered by various standardization efforts (e.g., IEC, IPC etc.), only with common data frameworks and analytical approaches can we begin to evaluate material/product performance for licensing or commercialization opportunities. Finally, we will briefly discuss the possible implications of artificial intelligence for reliability in flexible electronics.

Bayflex Solutions is based in Silicon Valley and provides lab automation and analytics dedicated to flexible electronics. Additionally, provides award winning mechanical testers which are interchangeable and modular, including integration with hostile and climate conditions. Proven with major device manufacturers and their supply chains, leading academia, and institutes around the world. (Nextflex, FFOA, Holst, Fraunhofer etc.) www.bayflextechnologies.com

NOTES

QUANTITATIVE ANALYSIS OF CIRCUITRY FOR WEARABLE FORCE MYOGRAPHY SYSTEMS USED IN HAND GESTURE CLASSIFICATION

Giancarlo K. Sagastume a, Peyton R. Young b, Marcus A. Battraw b, and Jonathon S. Schofield b*

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b Department of Mechanical and Aerospace Engineering, University of California - Davis, Davis, US

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Wearable technologies to detect hand gestures are becoming more prominent in a variety of control applications including prosthetic limbs and virtual reality avatars. Force myography is one such technique that uses non-invasive sensors to detect muscle forces in the forearms and predict the user's hand movements. However, the circuitry in these devices have the potential to influence performance and there remains no standard across devices. Thus, we reviewed three of the most used force myography circuits reported in literature to assess their efficacy in hand gesture classification. Interestingly, it was found that contemporary machine learning algorithms used to detect hand gestures were unaffected by the circuitry employed and thus we suggest that developers of wearable force myography systems can likely take advantage of benefits offered from using less complex circuitry.

Keywords: Force myography; circuitry, classification, hand gestures

NOTES

HAPTIC PERCEPTION INTERACTION EFFECTS BETWEEN VIBROTACTILE AND COMPRESSIVE STIMULI IN WEARABLE DEVICES

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Multi-haptic devices can simultaneously deliver different types of haptic feedback, allowing for an enhanced and richer user perception of the sensation delivered. Integrating different haptic actuation mechanisms in one device can lead to interference and masking of individual sensations. This work investigates a modular, soft goods-based wearable multi-haptic device to study perceptual interference between simultaneous haptic stimuli. The garment-based haptic system featured both vibrotactile and shape memory alloy (SMA)-based compression stimuli that could be individually (or simultaneously) deployed to the wearer. We studied the perception thresholds for both individual haptic sensations and for simultaneous sensation to evaluate the impact of simultaneous vibration on the resultant compression perception thresholds. The results show that the compression perception thresholds at the wrist were not significantly affected in the presence of vibration. Wearability factors such as sizing, and the material of the device, however, affected both the user experience and the functional performance of the device. This study highlights the impact of wearability-related parameters on haptic perception for future designers to consider while designing garment-based haptic devices.

Keywords: haptic devices; sensory perception; compression feedback; wearable technology; soft robotics

NOTES

INTELLIGENT E-WICKING ACTIVEWEAR

Dahua Shou and Erin Cho*

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Moisture management is crucial in activewear, particularly for highly active individuals such as athletes, construction workers, medical personnel, and firefighters. However, traditional activewear can become damp, heavy, and clingy, negatively affecting wearer performance and comfort. Herein, we develop intelligent electro-wicking (E-Wicking) activewear, mimicking sweat glands for superior moisture management. Employing a novel fabric-based, low-voltage E- Wicking technology, our active-perspiration activewear quickly expels excessive perspiration as droplets. The dissipation rate surpasses the maximum human sweat output and can be customized to individual perspiration levels. Additionally, our activewear features a root-like liquid transport system knitted from hydrophilic and hydrophobic yarns, reducing skin wetness and clinginess. This system guides liquid movement in an area-line-point manner, directing collected liquid to the “sweat glands” region for rapid dissipation. This next- generation, wearable-tech-integrated activewear keeps users dry and comfortable, substantially reducing the heat stress risk.

Keywords: wearable technology; moisture management; activewear; sweat glands region; rapid dissipation

NOTES

COCOON — A NOVEL SMART HOSPITAL GOWN FOR TODDLER PATIENTS

Hafsa Akter and Gozde Goncu-Berk*

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According to the Agency of Healthcare Research and Quality (AHRQ), each year, over 4 million children from 0-4 years are admitted to inpatient care. The average night stay is 3.8 days; 5 % of the ER visits result in hospitalization for toddler patients. Hospital gowns play an important role in the hospitalization experience, as it is a clinical supplement intended to provide physical and psychological well-being for inpatients. The goal of this study is to improve toddler hospital gown's functionality, usability and comfort from the users', caregivers', and practitioners' perspectives. Original data is collected through interview with healthcare professionals and parents of hospitalized children, problems associated with functionality of the gown and essential vital sign monitoring during hospitalization are determined. The research outcome presents a novel, human-centered, highly functional smart hospital gown with easy donning-doffing features, better closure positioning to attach hospital equipment, proper telemetry openings, and embedded e- textile-based ECG/Apnea and Pulse oximetry vital monitoring systems for non- intrusive health monitoring of restless toddlers while providing comfort, physical and emotional care, and well- being.

Keywords: electronic textile; toddler hospital gown; vital sign monitoring; donning and doffing

NOTES

INTELLIGENT WEARABLE HIP PROTECTOR FOR ELDERLY POPULATIONS

Dahua Shou and Erin Cho*

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By 2030, 1 in 6 people in the world will be aged 60 years or over. As society continues to age, the growing risk of hip fractures due to falls within the elderly population poses substantial health and economic concerns. However, currently available options for hip protectors are limited due to their discomfort and inadequate protection performance. Many of them are also devoid of critical alert systems for incidents when the elderly falls while being alone. Herein, we engineer an innovative and intelligent wearable hip protector designed for adequate protection and real-time monitoring. It leverages the shear thickening fluid (STF), which hardens upon impact to absorb significant energy, encapsulated in silicone tubes embedded within pants. Moreover, a triboelectric nanogenerator is incorporated to convert the impact response into a voltage signal, which can be transmitted wirelessly to a smartphone via a mini Bluetooth device for real-time detection. This novel wearable technology promises to augment personal safety for vulnerable elderly populations substantially.

Keywords: intelligent wearable technology; impact protection; shear thickening fluid; triboelectric nanogenerator

NOTES

WEARING GPT: ASKING QUESTIONS ABOUT HUMAN-AI AUGMENTATION

Avital Meshi

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Over the past five months, I have engaged in an experimental artistic practice-as- research project, involving the use of a wearable device that connects me in real- time to OpenAI's latest Large-Language-Model, GPT-4-Turbo. This device, which I attach to myself daily, is designed to record snippets of my conversations, transforming the spoken words into prompts for GPT. In return, GPT processes these prompts and generates responses that are converted into speech and "whispered" to me through an earpiece. When I hear GPT's responses I decide whether to incorporate them into my conversations, essentially making a choice between speaking my mind or voicing GPT.

Keywords: creativeAI, wearable technology, Performance Art, HCI

NOTES

MEASURING THERMAL CHARACTERISTICS OF WEARABLE ROBOTICS USING THERMAL MANIKIN: CHALLENGES AND OPPORTUNITIES

Konrad Rykaczewski a,b* and Ankit Joshi a,b

a School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, AZ, USA
b Julie Ann Wrigley Global Futures Laboratory, Arizona State University, Tempe, AZ, USA

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Thermal discomfort posed by the exosuits and exoskeletons is emerging as a major barrier to their widespread adoption in clinical and industrial settings. Such devices are designed to mechanically interact with the body to assist or enhance physical activity, but their thermal interactions with the users have predominantly not been considered. Recently, it was demonstrated that thermal manikin instruments, which are typically employed in the design of performance and safety apparel, can also be used to quantify exosuit's thermal properties and comfort characteristics and how the device augments a user's thermoregulatory response to strenuous work in hot environments. This paper quantifies the limitations of testing wearable devices using current thermal manikins and discusses how these challenges can be resolved.

Keywords: wearable robotics; thermal comfort; thermal manikin.

NOTES

DEVELOPING A TEXTILE VIRTUAL REALITY EXPERIENCE

Helen X. Trejo*

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A notable characteristic of Virtual Reality is the ability to create immersive experiences that can simulate environments that are not readily accessible. This can include exhibitions that convey art in a new way based on the navigation and interactivity that VR enables. VR exhibitions provide a unique opportunity for immersion that can extend apparel and textile design. The purpose of the VR app, Textured Textiles, is to showcase yarns and textiles in a new medium with the use of virtual reality. This is a practice-based approach to address a gap in 3D app development. The primary objectives include: (1) to determine the feasibility of developing a VR textile demo app with customized textures on 3D assets, (2) evaluate VR app functionality to propose a demo app device taxonomy and user activity model, and (3) identify app development challenges. Methods included applied approaches with software and hardware, such as Unity software and an Oculus Quest 2 Head Mounted Device. This study provides an example of an immersive leisure, cultural activity with a VR textile exhibition experience with attention to best practices in user experience that can contribute towards future development of innovative health and wellbeing approaches. This study can be useful to practitioners interested in VR app development and design scholars interested in emerging technologies.

Keywords: virtual reality; textures; textile design; exhibit; app development

NOTES

WEARABLES COLLECTIVE EXHIBITION

The exhibition is held at University of California, Davis California 25-26 March 2024 organised by WEARLAB at University of California, Davis in collaboration with Royal College of Art, Textiles Programme.

The exhibition is curated by: Anne Toomey, Marie O'Mahony, Gozde Goncu Berk and Elif Ozden Yenigun

DEVELOPMENT OF A WEARABLE NON-PHARMACEUTICAL COUNTERMEASURE TO SPACE ADAPTATION SICKNESS

Casey L. Miller and Stephen K. Robinson

UC Davis, Center for Spaceflight Research, USA

The human vestibular system can require days to adapt to a new gravitational environment, whereas gravitational transitions during spaceflight occur over minutes or hours. This delay in adaptation often results in Space Adaptation Sickness (SAS), frequently marked by nausea, disorientation, and other symptoms that pose a risk to crew safety and mission objectives. Although SAS is a well-documented phenomenon, no non-pharmaceutical countermeasures have been broadly successful. However, astronauts have been observed altering their head movement patterns to prevent or attenuate SAS symptoms.

The UC Davis CHANGES ("Capturing Human Activity in Novel Gravitational Environments in Space") team is developing a wearable countermeasure device to provide users with a means to self-limit movements that may induce or worsen symptoms of SAS. The device monitors the wearer's movements and provides external cues – via a head-mounted LED indicator in the wearer's peripheral vision and a wrist-mounted vibration motor – that immediately alert to motions that may provoke vestibular dysfunction. The wearer can use this feedback to adjust their head movement and potentially prevent the onset or worsening of symptoms. As such, the device can serve as both a real-time countermeasure as well as a pre-mission training aid that supports self-directed adoption of less provocative movement patterns prior to entering the spaceflight environment.

Since humans have a broad and varied range of vestibular responses to new gravitational environments, this device also incorporates a variable motion alert threshold. This allows the sensitivity of the feedback to be tailored to each user and each use case – for instance, the alerts can be activated by small movements during periods of heightened symptoms and adjusted to allow more dramatic motions as symptoms subside.

While this wearable countermeasure is inspired by the experiences of astronauts, many medical conditions are characterized by vestibular dysfunction. As such, this device may have future applications in the management of terrestrial vestibular dysfunction as well as human space exploration.

SOCIAL WEARABLES EDULARP AND FAMILIARS EXERCISE

James Fey, Raquel Robinson* and Katherine Isbister

UC Santa Cruz, Social Emotional Technology Lab, USA
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We showcase one design exercise from our social-wearables-based camp for middle schoolers, which was funded by an informal learning grant from the NSF. The 'Anywear Academy' is an inclusive informal learning experience that combines the culture and values of makers, larpers, designers, and STEM camps to create an engaging, educational, and safe experience for learners. The focus on creation of social wearables built using E-textiles builds on existing live action role play (larp) practices that use costuming as a method for establishing identity as well as for providing a platform campers can use to enhance their dramatic spectacles. Cultivating formation of community among campers was key to the camp's underlying mission to help broaden interest in STEM among those who participated. The camp's larp was designed to allow campers to take ownership of their experience while still structuring the overall narrative arc to guide them to a satisfying conclusion.

One of the key design exercises for campers was the creation of 'familiars'. The familiars are an educational wearable robotics activity that uses the BBC micro bit go bundle along with neopixel LEDs and continuous servos in which students create a companion character for use in the larp. This exercise emphasizes a flexible and creative approach; integrating concepts such as design thinking, iterative design, and collaboration. The familiars can serve as an educational entry point into STEM learning at any level due to the expressive and social element of wearable designs.

DIFFERENTIAL CARDIOPULMONARY MONITORING FOR ARTIFACT-CANCELED PHYSIOLOGICAL TRACKING OF ATHLETES, WORKERS, AND PATIENTS

Hyoyoung Jeong

UC Davis, Jeong Research Lab, USA

Motion artifacts can corrupt recorded signals, including those captured by devices that monitor cardiopulmonary processes through measurements of subtle motions and vibrations on the skin surface. A single device in a sealed, waterproof package that requires only mechanical coupling to the skin can produce a powerful breadth of health-related information. Advanced data filtering and analytical approaches can separate and quantify different events based on unique temporal and spectral features, but they often fail to operate reliably. For example, respiration and heart rate cannot be determined accurately while running. However, differential measurements remove common-mode motion artifacts, yielding precise signatures of cardiac and respiratory behaviors continuously, without interruption even during vigorous activity.

Aim 1: Development of soft, skin-interfaced dual-sensing devices that exploit intrinsic anatomical signal gradients which produce the necessary differential responses (e.g. suprasternal notch (SN) and sternal manubrium (SM)) to capture key vital signs even in the presence of extreme motion artifacts.

Aim 2: Develop automated platform for differential sensing model. Designs of automated devices that incorporate matched pairs of high-bandwidth IMUs with optimized soft mechanics for high measurement sensitivity and accurate time synchronization.

Aim 3: Develop data processing utilizing machine learning. Binary tree architecture utilizing a support vector machine (SVM) can classify extracted features from the thoracic cavity, esophagus, pharynx, and oral cavity into differentiated activities such as respiration, speech, swallowing, coughing.

This work will yield insights into signal responses and advanced system integration with secured data management while uncovering a new way to acquire high SNR with a dual sensing configuration. Key challenges include signal processing to ensure high fidelity signal extraction from high sampling IMUs (1.6 kHz-3.2 kHz) and reliable training for machine learning. This motion artifact-free, dual-sensing platform has potential across a broad range of applications, including sports performance, worker safety, clinical, and quantitative full-body physical rehabilitation.

GENERATIVE NISHIJIN WEAVING WITH AND FOR THE BODY

Karoi Udea and Bine Roth

Kyoto Saga University of Art, Japan
Royal College of Art, UK

This proposal explores the integration of Nishijin textiles, traditionally used for obi and kimono production in Kyoto's Nishijin area, with generative design techniques. With the decline of kimono culture leading to reduced production, the study aims to discover new strategies for product development. By employing a sophisticated weaving technique ‘Nishijin’ known as 'gold brocade' and utilising the unique Japanese high- twist yarn called 'Hatcho Twisted Yarn,' the research merges the artistry of Japanese textiles with the innovative possibilities of generative design. Creating 3D textiles has evolved through technical expertise, calculations, and design software. Effective design communication is emphasised in the collaborative work environment, facilitated by various design software applications. Digital transformation programmes such as Processing, Clo3D and Houdini allow for programming the woven structure and the digital simulation to be effectively utilised in real production.

Incorporating generative design methods into Nishijin textiles combines traditional craftsmanship with a computational design approach and increases the effectiveness and efficiency of 3D textile production. The research is investigating zero-waste pattern design, which expands the possibilities of Nishijin textiles and gives them a flat surface during cutting and a three-dimensional look after twisting.

In this exhibition, we would like to showcase material samples and a haori jacket as well as a new constructed ‘jumpsuit’, as a result of this research. The researchers have been developing three-dimensional weaving elements by controlling the unevenness after twisting the yarns, and have produced various clothing pieces. The design is an innovative approach, as the cloth is processed three- dimensionally by computer calculations, allowing for easy and waste-free sewing. The exhibition is a testament to the transformative power of generative design and has enabled the creation of new materials from the traditional technique of Nishijin weaving.

INTERDISCIPLINARY METAMORPHOSIS

Galina Mihaleva and Shawn Jordan

Arizona State University, USA

The fashion concept of two designs collaborating across disciplines and synchronizing their light patterns is a striking visual representation of interdisciplinary cooperation. While both looks appear the same structurally, both are embedded with LEDs that tell a different story. The first look displays a slow-moving pattern of blues and whites, representing a language and culture of careful consideration before change happens. The second look features a fast-moving rainbow pattern, representing a dynamically changing culture of bold changes. As the wearers approach each other back-to-back to create a complete physical form, the light patterns of both outfits converge and harmonize, reflecting the successful collaboration across different disciplines. The effect is both dazzling and thought-provoking, highlighting the power of interdisciplinary collaboration to create beauty and innovation.

COCOON — A NOVEL SMART HOSPITAL GOWN FOR TODDLER PATIENTS

Hafsa Akter and Gozde Goncu-Berk

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In the United States, each year, 4 million children from 0-4 years old are admitted as inpatients, and the average night stay is 3.8 days. A hospital gown plays a substantial role as it is a clinical supplement intended to provide physical and psychological well-being for inpatients. But the traditional toddlers' gowns are non-fitted one-piece knee-length tunic-like dresses with a full opening at the back with knot closures and loose short sleeves, which do not provide proper functionality to the users and practitioners. Dehumanizing aspects of care, as represented by the hospital gown, may adversely impact patient well-being.

This research focuses on designing a human-centered highly functional smart hospital gown with easy donning-doffing features, better closure positioning to attach hospital equipment, proper telemetry openings, and embedded e-textile-based ECG/EKG and pulse oximetry vital monitoring systems for non-intrusive health monitoring of restless toddlers while providing comfort, physical and emotional care and well being.

SOFT WEARABLE FOR MUSCLE ACTIVITY MONITORING: INTEGRATING EMG AND FMG SENSORS IN A WEARABLE SLEEVE

Diego Martinez Fernandez ,Peyton R. Young, Jonathon S. Schofield and Gozde Goncu Berk

Department of Davis, UC Davis, USA

In the United States, each year, 4 million children from 0-4 years old are admitted as inpatients, and the average night stay is 3.8 days. A hospital gown plays a substantial role as it is a clinical supplement intended to provide physical and psychological well-being for inpatients. But the traditional toddlers' gowns are non-fitted one-piece knee-length tunic-like dresses with a full opening at the back with knot closures and loose short sleeves, which do not provide proper functionality to the users and practitioners. Dehumanizing aspects of care, as represented by the hospital gown, may adversely impact patient well-being.

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MAKING BIOBASED MATERIALS FOR TANGIBLE INTERFACES

by Eldy Lazaro

University of Colorado Boulder, ATLAS Institute

In this workshop, participants will craft two readily biodegradable bio-based materials: (1) algae-based bioplastics and (2) gelatin-based biofoams. The focus is on experiencing the use of these biomaterials in wearable technology and tangible interfaces. Through hands-on activities, we'll showcase the practical integration of biomaterials into sustainable tangible interfaces. Discussions will encompass ethical considerations, care practices, and end-of-life scenarios, including intentional decay or "unmaking." The goal is to foster collaboration among researchers and designers, facilitating dialogue on opportunities and challenges specifically related to the application of biobased materials in soft systems or wearable products and technology

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