News from the Field

Lynette Jones

This year’s Haptics Symposium was held in Philadelphia from April 8-11, 2016. Over 105 papers, posters, and demos were presented at the conference and the Awards Committee determined the finalists and winners. In this “News from the Field,” we present the finalists and winners of the Best Paper, Best Student Paper, Best Work-in-Progress, and Best Demo Awards.

BEST PAPER AWARD: WINNER
A Wearable Fabric-Based Display for Haptic Multi-Cue Delivery
Matteo Bianchi, Edoardo Battaglia, Mattia Poggiani, Simone Ciotti, and Antonio Bicchi

M. Bianchi and A. Bicchi are with the Centro di Ricerca “E. Piaggio”, Universita di Pisa, Italy, and the Department of Advanced Robotics, Istituto Italiano di Tecnologia, Genova, Italy. E. Battaglia, M. Poggiani, and S. Ciotti are with the Centro di Ricerca “E. Piaggio”, Universita di Pisa, Italy.

Softness represents one of the most informative haptic properties, which plays a fundamental role in both everyday tasks and more complex procedures. Thus, it is not surprising that much effort has been devoted to designing haptic systems able to suitably reproduce this information. At the same time, wearability has gained increasing importance as a novel paradigm to enable more effective and naturalistic human-robot interaction. Capitalizing upon our previous work on grounded softness devices, in this paper we present the Wearable Fabric Yielding Display (W-FYD), a fabric-based tactile display for multi-cue delivery that can be worn on a user’s finger. The W-FYD enables both passive and active tactile exploration to be implemented. Different levels of stiffness can be reproduced by modulating the stretching state of a fabric through two DC motors. An additional vertical degree of freedom is implemented through a lifting mechanism, which enables softness stimuli to be conveyed to the user’s finger pad. Furthermore, a sliding effect on the finger can also be induced. Experiments with humans show the effectiveness of the W-FYD for haptic multi-cue delivery.

BEST PAPER AWARD: HONORABLE MENTION
Learning Constituent Parts of Touch Stimuli from Whole Hand Vibrations
Yitian Shao and Yon Visell

The authors are with the Department of Electrical and Computer Engineering and Graduate Program in Media Arts and Technology, University of California, Santa Barbara, CA.

Manual activities elicit touch stimuli that are widely distributed in the hand. To what extent can these stimuli be considered to be sum of their parts, and how might these parts relate to the structure and function of the hand? In this work, we measured spatially distributed patterns of vibration in the skin that were elicited during common manual interactions. We analyzed information content in this data by extracting informative low-dimensional representations, using an unsupervised machine learning algorithm known as non-negative matrix factorization. The latter is a technique for decomposing data into implicit components, inspired by neural processing. This analysis automatically yielded “parts of touch” — cohesive representations of touch-elicited vibration patterns that were localized in the fingers and other cohesive areas of the hand, reflecting to a remarkable extent, the most salient anatomical and functional specializations in the hand. In a subsequent classification task, we found these representations efficiently encoded the manual activities that elicited the (high-dimensional) vibration stimuli. The activities could be accurately classified using low dimensional representations with as few as three parts. The results provide quantitative evidence that vibrotactile information content in the upper limb is organized in ways that reflect the movement degrees of freedom of the hand.

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BEST STUDENT PAPER AWARD: WINNER

Tactile Paintbrush: A Procedural Method for Generating Spatial Haptic Texture
David Meyer, Michael Peshkin, and Ed Colgate

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In this work, we aim to represent tactile textures in such a way that a given texture may be “painted” onto a selected spatial region of a tactile display. We recorded a series of fingertip swipes across 11 textures and stored the data as spatial friction maps – friction as a function of position. We analyzed these maps with a space-frequency transform, and observed stochasticity in our physical measurements. We modeled the randomness in spectral magnitude across space with three distributions: Rayleigh, Rice, and Weibull. We analyzed the quality of parameterizations using goodness of model fit as well as consistency across multiple swipes of the same texture. We found that a two-parameter Weibull model best represented the measured data, and propose to use this model in the Tactile Paintbrush for applying virtual textures to spatial regions.

BEST STUDENT PAPER AWARD: HONORABLE MENTION

Space-Time Interactions and the Perceived Location of Thermal Stimulation
Anshul Singhal and Lynette Jones

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A number of tactile illusions involve distortions in the spatial representation of tactile stimuli applied to the skin, such as the perceived location of a stimulus or the perceived distance between points of stimulation. It is not known whether similar interactions between the spatial and temporal parameters of stimulation affect the perception of thermal stimuli within the innocuous range of temperatures. In the present experiment, four cooling pulses were presented on the forearm in varying spatial and temporal sequences. Participants indicated the perceived location of the first two pulses in the four-pulse sequence after each trial. The results indicate that the position of the second pulse changed substantially in the direction of the third pulse when the interval between the pulses was brief (0.2 s) and the distance, between the second and third pulse was larger. At longer intervals and shorter distances, there was no change in perceived location. These findings demonstrate that the temporal interval between thermal stimuli applied to the skin can influence their perceived location.
BEST DEMO AWARD: WINNER

The hRing as a Wearable Haptic Interface for Extra Robotic Fingers

Giovanni Spagnoletti, Irfan Hussain, Claudio Pacchierotti, Gionata Salvietti, and Domenico Prattichizzo

G. Spagnoletti and I. Hussain are with the Department of Information Engineering and Mathematics, University of Siena, Siena, Italy. C. Pacchierotti is with the Department of Advanced Robotics, Istituto Italiano di Tecnologia, Genoa. G. Salvietti and D. Prattichizzo are with the Department of Information Engineering and Mathematics, University of Siena, Siena, and the Department of Advanced Robotics, Istituto Italiano di Tecnologia, Genoa, Italy.

Towards a realistic and unobtrusive feeling of interacting with the environment, we devised a novel wearable cutaneous device for the proximal finger phalanx, called hRing. It consists of two servo motors that move a belt in contact with the user’s finger skin, a vibrotactile motor, and two pairs of push buttons. We used the hRing as an interface for an extra Soft Robotic Finger (SRF), which has been devised for compensating hand function in chronic stroke patients to regain the grasping capabilities of their paretic hand. The robotic finger and the paretic hand act as the two parts of a gripper, working together to stabilize the object being grasped. The hRing is worn on the healthy hand, and it is used to both control the flexion/extension of the SRF and to provide the patient with haptic feedback about the forces exerted by the SRF on the environment. Haptic feedback is particularly important for stroke patients affected by hypoesthesia (a partial loss of tactile sensitivity). Our objective is to enable patients to perceive on the healthy hand, via cutaneous stimuli, the forces applied by the SRF on the grasped object.

BEST DEMO AWARD: HONORABLE MENTION

A Scalable 4x4 Graphical Tablet based on Shape Memory Polymers

Nadine Besse, Juan José Zarate, Samuel Rosset, Luca Brayda, and Herbert Shea

N. Besse, J.J. Zarate, S. Rosset, and H. Shea are with the Microsystems for Space Technologies Laboratory, Ecole Polytechnique Fédérale de Lausanne (EPFL), Neuchâtel, Switzerland. L. Brayda is with Robotics, Brain and Cognitive Sciences, Istituto Italiano di Tecnologia (IIT), Genova, Italy.

We present a fully latching and scalable 4×4 haptic display with 4 mm pitch, 5 s refresh time, 400 mN holding force and 500 μm displacement per taxel. The heart of the device is the patterning of a compliant heater per taxel on a thin shape memory polymer membrane to reversibly, rapidly, and locally change its stiffness. Each taxel is individually electrically addressable and selectively movable by synchronizing its local Joule heating with a global pneumatic actuation mechanism. Switching off the driving voltage latches each taxel into its current position, enabling holding any array configuration with zero power consumption. Having one common pneumatic actuation mechanism allows for both displacing exclusively the heated taxels (leaving un-displaced the unheated ones) and significant holding force; while keeping a very simple and compact system design. More than 98 percent in correct symbol recognition was obtained when tested by 15 sighted users. We are currently manufacturing a 32×24 dynamic tactile tablet using the same technology, which aims at providing graphical data to blind and visually impaired users.
BEST DEMO AWARD: HONORABLE MENTION

Macaron: An Online, Open-Source Haptic Editor
Oliver S. Schneider and Karon E. MacLean

The authors are with the Department of Computer Science, University of British Columbia, Vancouver, BC, Canada.

Macaron is a free, open-source, online haptic editor. It is designed to be an easy-to-use tool for anyone working with haptics, and a platform for experimenting with new haptic design features. So far, we have used it to explore how people use examples when designing haptics. Currently, Macaron supports vibrotactile output, but it is being actively developed to include additional devices and features, such as DIY hardware kits which accompany the design tool. Macaron is available online at http://hapticdesign.github.io/macaron.

BEST DEMO AWARD: HONORABLE MENTION

Toward Open-Source Portable Haptic Displays: An Interactive Physics Demo with the Haplet
Colin Gallacher, Arash Mohtat, Steve Ding, and Jozsef Kövecses

The authors are with the Department of Mechanical Engineering and Centre for Intelligent Machines, McGill University, Montreal, QC, Canada.

We have created the Haplet, an open-source, portable, and affordable haptic device with colocated visual, force, and tactile feedback. The triple colocated user experience is delivered by a small-form parallel robotic mechanism featuring a simple vibrotactile actuator. The robotic arm is optically-transparent and is motorized at the base where it clips on a tablet or computer screen. All the electronics are encapsulated into a custom board based on the Arduino Due. The Haplet can be used for educational purposes, as exemplified in the demo by an interactive physics-based game that allows feeling concepts such as gravity and buoyancy.

The Haply Project Website: http://www.haply.co/

BEST WORK-IN-PROGRESS PAPER

Toward a Wearable Tactile Sensory Amplification Device: Transfer Characteristics and Optimization
Mercedes Chartier, Neha Thomas, Yitian Shao, and Yon Visell

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This project aims to create a wearable device capable of electronically enhancing touch, in the same way that a hearing aid enhances the auditory sense. Our prototype device utilizes electronic sensors, in the form of wide bandwidth MEMS accelerometers, that are worn on the finger to capture touch-induced skin vibrations, which are instrumental to haptic perception. Active, analog electronics are used to filter and amplify the resulting signals without digitization. A compact recoil actuator is used to accurately reproduce these signals, effectively enhancing the transient touch information that is produced when the finger contacts or slides against an object. In order to optimize the performance of this device, we measured and analyzed the frequency-domain transfer characteristics of this system. The results were used to determine sensor and actuator locations and orientations that would minimize feedback, increasing the range of feasible amplification gains. This study may help to guide the design of sensory prostheses and haptic displays worn on the upper limb. Such devices could be beneficial for individuals with impaired touch sensation due to peripheral neuropathy, or for those with prosthetic limbs.