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Haptics: Science, Technology, Applications

13th International Conference on Human Haptic Sensing and Touch Enabled Computer Applications, EuroHaptics 2022
Hamburg, Germany, May 22–25, 2022, Proceedings

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Preface

In this volume, you will find the proceedings of the EuroHaptics 2022 conference, held during May 22–24, 2022, in Hamburg, Germany. EuroHaptics is a major international conference, organized every two years, that features the latest advances in haptics science, technology, and applications. This year's proceedings are open access. We follow the example given by the EuroHaptics 2020 team in Leiden and hope that future organizers will decide to do the same.

Organizing a conference of this size and international impact is always special and unique, but our conference in particular faced many challenges due to the circumstances. When Hamburg applied to host the event in 2020, we all assumed that the COVID-19 pandemic would be over by 2022. So, we originally planned optimistically for an on-site conference with global participation. However, the virus proved to be more persistent than expected, so we had to plan three versions of the conference in parallel: an on-site conference, a hybrid conference, and a virtual conference. Fortunately, the situation stabilized such that, with some reassurance from the scientific community, we were able to decide on an on-site conference. However, just as decisions were being made, geopolitical challenges arose from Russia's war in Ukraine. Since this scientific community is traditionally more interested in interaction than in exclusion and separation, we again decided to keep open the opportunity for scientific cross-cultural exchanges. At the time of submitting this conference volume to production, more than 180 participants have confirmed their attendance, and a conference program has been designed with more than 140 papers ranging from oral presentations and posters to numerous hands-on demonstrations.

More than 350 (co-)authors submitted their contributions to the conference. In these uncertain times and after almost two years of the COVID-19 pandemic, the long paper category was comparatively small, with 65 papers, 36 of which were accepted for publication, yielding an acceptance rate of 55%. Impressively, 62 Work-In-Progress (WIP) short papers were submitted, of which 51 were accepted for inclusion in the conference, yielding an acceptance rate of 82%. In addition, we received 39 submissions for hands-on demonstrations and several industry exhibitors at the conference. We are excited to see how our scientific communication will evolve in the coming years, what will remain and what will revert to earlier times.

The entire evaluation and peer review process could not have been accomplished without the enthusiastic help of our haptics research community. In addition to the editorial board, 39 associate editors and 140 reviewers invested their time to provide valuable input to the organizers and authors. We are grateful for everyone's help, especially with so many things happening around us.

Haptics research is a growing community. There is no conference or journal on robotics, actuators, psychology, neurology, or human-computer interaction without at least a few papers related to our research area. This proliferation can be seen as a threat to general haptics conferences. However, we see it as an opportunity, since there are no conferences like EuroHaptics where technology, psychology, neuroscience, and applications coexist on an equal footing in a single-track event that promotes true interdisciplinary exchange. We are grateful to have been able to contribute to the progress of this community with a great team of editors and reviewers.

April 2022

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Contents

Exploiting a Wearable Extra-Finger for Haptic Applications

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Abstract. This extended abstract presents the design of a wearable device for haptic stimulation of hand palms and phalanges. Most of the wearable haptic devices for hand palms are based on a parallel structure, that guarantees good precision and stiffness but presents workspace limitations and encumbrance problems. In this work, we improve the design of a wearable extra-finger, previously designed to augment human hands and to provide assistance for people affected by hand and upper-limb diseases to apply as a haptic device. To employ this device for haptics applications, we provided it an additional adduction/abduction degree of freedom and we modified the fingertip/end-effector to include a micro force sensor.

1 Introduction

Human augmentation by means of supernumerary robotic limbs (SRLs) represents a recent and lively research topic [1]. SRLs are developed to allow humans to perform complex actions with increased strength and precision, and also to enlarge the human workspace. Our research group has been involved in particular in the development of supernumerary extra-fingers [2, 3]. Adding a single or double extra robotic finger can improve the grasping capabilities of the human hand and its dexterity even in complex actions.

In this work we propose to exploit supernumerary extra fingers as wearable haptic devices for cutaneous stimuli of hand palm and phalanges. Although the hand is one of the primary interfaces between humans and the surrounding environment, most of the haptic devices that return tactile stimuli are focused on the fingers [4], while fewer of them are developed specifically for the palm. Most of the wearable haptics devices developed for hand palm are based on parallel mechanisms, i.e. mechanical systems using multiple serial chains (typically varying from 3 to 6) to support a single platform, or end-effector [5–7]. One of the main drawbacks of parallel mechanisms is that their workspace, i.e. the set of possible configurations that can be reached by the end effector is rather limited,

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and in haptics context this means that a limited part of the hand can be stimulated. Serial mechanisms, on the other hand, typically are more flexible and less precise than parallel ones, but their open structure allows to reach a wider workspace.

2 The Improvement of the Sixth Finger

As mentioned in the previous section, in this work we improved the wearable extra finger developed in [3, 8] to exploit it in haptic applications.

The robotic extra finger [8] has a modular structure, each module is composed of a rigid part realized in ABS (Acrylonitrile Butadiene Styrene, ABSPlus, Stratasys, USA) and flexible part, made of TPU (thermoplastic polyurethane, Lulzbot, USA). We selected TPU in particular because the high elongation of this material allows for repeated movement and impact without wear or cracking proving. Seven modules were employed in order to achieve a length of the finger similar to the average size of human hand. The robotic extra finger is tendon-driven and is actuated by only one motor, providing the flexion movement.

To exploit the extra finger in haptic applications, we increased its workspace by providing it the adduction/abduction motion, by connecting the proximal module to a platform orientable by means of a gear system. To reduce the encumbrance on the wrist, the motor was substitured by a linear actuator. Furthermore the distal module was sensorised with a microforce sensor, necessary to

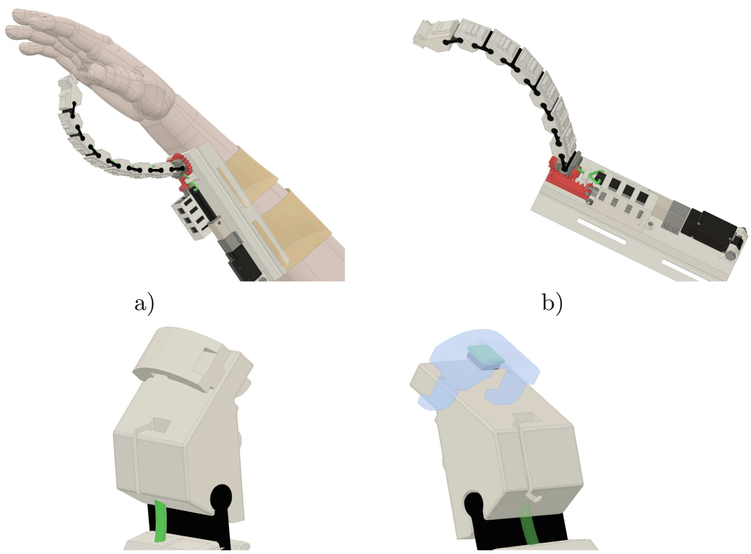

Fig. 1. (a) CAD model of the wearable extra finger exploited for haptic applications, worn by the user. (b) CAD model of the wearable extra finger, showing the actuation. (c) Fingertip module. (d) Sensing elements in the fingertip module.

control haptic interaction with human hand. CAD model of the proposed device is shown in Fig. 1. Furthermore, the stiffness of the flexible elements connecting finger phalanges has been calculated using the procedure proposed in [8] so that when the actuator pull the tendon, the extra-finger flexes by keeping the distal phalanx approximately perpendicular to hand palm.

3 Future Works

The device is currently in the prototyping phase. A first set of experimental tests will be aimed at verifying its functional characteristics, in particular, we will identify the part of the hand that can be stimulated with the device and the corresponding force that can be applied. Then in a second experimental phase we will compare it with the device presented in [7]. Then, users studies will be carried out to assess device usability in VR and AR contexts.

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