ligeti center: Scientists and Artists in Residency-Program
Call for Applications: Where Haptics meet the Arts
Application Deadline: 04.05.2025
ligeti-zentrum.de

The *ligeti center's* “Artists and Scientists in Residence” program is embarking on its fourth iteration. We welcome artists and scientists to undertake an interdisciplinary art-science project at the *ligeti center* from mid-July until mid-September. Working closely with the center’s Haptic Lab and other labs, the program will emphasize experimental engagement with technologies being worked on at the *ligeti center*. Residents are invited to develop an interactive installation for public spaces, with the aim of stimulating public interest in engineering and inviting physical interaction. Preference will be given to projects that allow the collection of data from interactions for scientific, statistical, and artistic purposes.

In the decision-making process, the jury will consider the innovative quality of the project proposal, the potential for collaboration with the various labs of the *ligeti center*, and the professional competence of the applicants. We only accept applications from individuals. Residents are expected to give a talk and to present their work and results at the end of the residency period.

On Tuesday, April 22nd at 5:00 PM there will be an info call via Zoom where the following technologies will be presented, and questions can be asked.

The Technologies

The following information gives an overview of projects a residency proposal could build upon. Serving as a source of inspiration, the selected technologies have been chosen due to practical considerations: These projects are equipped with material and human resources to support the residency. However, a residency proposal may also go beyond the selected technologies or explore the main theme, “Where Haptics meet the Arts”, from a different approach.

“The Painting Robot”: Exploring the Multimodality of Arts with the Help of Robotics

Within the vision of the *ligeti center*, this project aims to bridge the gap between the arts and sciences. At its core is a robot capable of interpreting music through predefined parameters and transforming it into visual interpretations. The project combines the mechatronic aspects of engineering—building the robot, developing electronics for sensors and actuators, and programming the control system—with the theory of music analysis and interpretation.

So far, a robotic arm that can move across a canvas in a single plane has been developed. At the end effector, a rotatable brush is attached, allowing for adjustments in its orientation. Additionally, the brush can be raised or lowered to regulate pressure on the canvas. Six compartments hold water and paint—including the three primary colors as well as black and white—which can be mixed to create a nearly unlimited color palette.

The robot’s control is based on various musical parameters, such as BPM, loudness, centroid, genre, and mood, which are mapped onto specific control parameters of the robot, including speed, color, pressure, and shape. Future developments could take the project in several directions: for example, drawings made by children while listening to music could serve as input for a machine learning algorithm that guides the

robot's painting process. Another promising approach is the integration of dancers into the interpretation loop, allowing them to control the robot through gestures.

These different approaches result in diverse control algorithms, leading to a variety of artistic compositions. In interactive workshops with children, participants have engaged in painting challenges with the robot, interpreting and comparing the resulting artworks. By analyzing and contrasting these results with human processes of music interpretation, the project seeks to deepen our understanding of how humans visually translate music.

Contact person: Dr. Ornella Tortorici - ornella.tortorici@tuhh.de

Motion-Capture Systems

Our lab is equipped with multiple systems and sensors for motion tracking. One of them is the Qualisys camera-based motion tracking, which captures precise movements of objects or bodies (up to 0.5 mm of motion accuracy) with low latency (5 ms) thanks to small trackers. The Haptic Lab is equipped with 7 of these cameras, easily covering the volume of the *ligeti center*'s Production Lab.

So far, the team has been working with **inertial tracking technologies**, which enable the capture of gestures and basic movements using **IMUs (Inertial Measurement Units)**. These technologies can be applied, for example, in contexts involving people with disabilities.

[1] Qualisys Miqus Product Sheet, link: https://cdn-content.qualisys.com/2020/01/PI_Miqus.pdf

Contact person: Dr. Mohammad Sadeghi - mohammad.sadeghi@uhh.de, Dr. Ornella Tortorici - ornella.tortorici@tuhh.de

Mechanical Impedance: Body Tension and Gamification

Mechanical impedance is a dynamic property that plays a crucial role in understanding how a system responds to vibrations. It is defined as the ratio of the force applied to a system to the velocity at which the system reacts to that force. Essentially, mechanical impedance does not describe a body's resistance to vibrations but rather its response to them, depending on its specific characteristics. This property is particularly useful for assessing the damping of a system—its ability to absorb energy. Higher damping generally results in higher mechanical impedance, indicating that the system can more effectively counteract movements caused by vibrations.

ligeti center: Scientists and Artists in Residency-Program
Call for Applications: Where Haptics meet the Arts
Application Deadline: 04.05.2025
ligeti-zentrum.de

Understanding the mechanical impedance of the hand is essential for analyzing how it interacts with various systems, such as tools, controls, or user interfaces. Measuring this impedance requires detailed analysis and precise measurements, which can often be complex and time-consuming. The process involves capturing extensive data on how the hand reacts to different forces and velocities—a task that, under normal circumstances, may feel tedious and exhausting. Therefore, there is a need to transform these measurements into an engaging and motivating activity to improve both participant involvement and data accuracy.

Gamification offers an innovative approach in this context: by integrating game-like elements into non-game scenarios, routine tasks can be made more engaging and enjoyable. Applying gamification principles can turn the measurement of hand impedance from a monotonous procedure into a motivating experience. Real-time measurements could directly influence gameplay, creating an interactive dimension that enhances participant engagement. Additionally, the development of a multiplayer mode is conceivable, making the process of measuring hand impedance not only more effective but also a rewarding and collaborative experience.

Contact person: Ali Elnwegy - ali.el-nwegy@tuhh.de, Juliana Lüer - juliana.lueer@tuhh.de, Dr. Ornella Tortorici - ornella.tortorici@tuhh.de, Prof. Dr. Thorsten A. Kern - t.a.kern@tuhh.de

Cutaneous Feedback

The sense of touch is not only specialized in perceiving the physical boundaries of the body but also in analyzing the immediate surroundings, including the objects contained within and their properties. Our ancestors had to be able to distinguish the structure of fruits and leaves by touch, for example, to assess their ripeness or whether they were edible—like identifying a furry berry among smooth ones. Similarly, the haptic sense enables us to recognize potentially harmful structures, such as a spiny shell, and to handle it carefully to obtain its contents despite the dangerous thorns.

Cutaneous feedback offers a unique way to convey information, extending beyond traditional auditory and visual methods. It stands out for its directness and ability to be personalized, allowing users to receive information through tactile sensations that can be adjusted to individual preferences and specific contexts. Due to its multidimensional nature, cutaneous feedback can be highly expressive, offering various textures, pressure levels, and vibration patterns that can convey both complex information and emotional nuances. These characteristics make it a promising tool for enhancing user experiences and creating more immersive and nuanced interactions.

To effectively deliver cutaneous feedback, a form of actuation is required to generate tactile sensations. In our Haptic Lab, we have a variety of actuators differing in size, power, and tactile sensation. These actuators are primarily classified into two categories: Eccentric Rotating Motors (ERM) and Linear Resonating Actuators (LRA). ERMs are simple DC motors that allow basic control over frequency and intensity. In contrast, LRAs function similarly to speaker drivers and require specific control mechanisms. They offer greater precision, as both frequency and intensity can be regulated independently. This level of

control makes LRAs highly responsive to input signals, enabling a more refined haptic experience. Both types of actuators generate distinct vibration characteristics, which can be used to convey specific forms of cutaneous feedback, embedding information within the tactile experience. By strategically combining these actuators, cutaneous feedback can be designed to deliver rich, informative sensations to the user.

[2] Kern, T. A., & Hatzfeld, C. (2022). Motivation and application of haptic systems. In Engineering Haptic Devices (pp. 3-33). Cham: Springer International Publishing. link: https://library.oapen.org/bitstream/handle/20.500.12657/59318/1/978-3-031-04536-3.pdf#page=30

Contact person: Juliana Lüer - juliana.lueer@tuhh.de, Ali Elnwegy - ali.el-nwegy@tuhh.de, Prof. Dr. Thorsten A. Kern - t.a.kern@tuhh.de

Application

What do we expect?

- Continuous artistic and/or scientific activities in fields related to the selected technologies (documented in a portfolio and/or CV)
- A coherent project proposal that has the potential to be finalized within the proposed time frame of 3 months and with the available technical possibilities
- The project proposal should open the mind for getting in touch with engineering disciplines
- The preferred artistic outcome is an installation that can be used in indoor-exhibitions or outdoor-public spaces
- Willingness to cooperate with the various labs on-site (letter of motivation)

What do we offer?

- A scholarship totaling 1.200 € net per month for one individual

ligeti center: Scientists and Artists in Residency-Program
Call for Applications: Where Haptics meet the Arts
Application Deadline: 04.05.2025
ligeti-zentrum.de

- Accommodation in the city of Hamburg
- Expertise in Haptics, Robotics, Electronics and Mechanical Engineering
- A motivating working environment and creative exchange
- Professional documentation of the residency

Application process

- Applications can be submitted in German or English.
- Application form
- A submission must be handed in between April 7th, 2025, and May 04th, 2025 (deadline at midnight (CET)). Applications received after this deadline will not be considered
- The authors are responsible for the application's content; incomplete applications cannot be considered
- All submitted documents will be treated confidentially and will not be used by the *ligeti center* or third parties without the applicant's consent
- All applicants will be informed by the end of May of the outcome of the selection process.
- Applications must contain the following elements
    - Completed application form
    - A project description (max. 4,000 characters)
    - Description of the technologies to be used in the installation
    - A letter of motivation (max. 4,000 characters) outlining the interest to work with at least one of the technologies provided or the potential for collaboration with other labs at the *ligeti center*
    - A short proposal for a potential workshop for students and/or interested individuals in Hamburg. Workshop formats may include, but are not limited to, performative lectures, software tutorials and introductions to new technologies
- All of the above texts must be submitted in one application form. Applications submitted by other means will not be considered.

For any questions, please partake in our residency info call via Zoom on **Tuesday, April 22nd, at 5:00 PM**. For further questions, please contact our residency coordinator, Nadine Schwalb, at ligetizentrum.residencies@hfmt-hamburg.de.