2021 IEEE World Haptics Conference (WHC)
July 6-9, 2021. Montreal, Canada

cHand: Visualizing Hands in CHAI3D

Edoardo Battaglia and Ann Majewicz Fey

2021 IEEE World Haptics Conference (WHC) | 978-1-6654-1871-3/21/$31.00 ©2021 IEEE | DOI: 10.1109/WHC49131.2021.9517190

***Abstract*— Visualization of hand movement is an important part of many haptic experiences. While some existing simulators allow for hand kinematic visualization using a generic hand model, they target robotic grasp planning rather than haptic applications. We aim to fill this gap with cHand, an extension of the haptics software library CHAI3D, which augments it with built-in hand kinematic visualization capabilities. A representation of the hand can be achieved with elementary geometric elements, or with custom geometries loaded from STL files. A live data visualization demo is included, which can be used as a template for other applications. We release cHand as an open source contribution to keep with the open source nature of CHAI3D.**

I. Introduction

CHAI3D [1] was released in 2003, providing a platform for haptic researchers and developers, with a C++ API, graphic rendering through OpenGL, templates to help with rapid prototyping, built-in force feedback algorithms, hardware support for a variety of commercial haptic devices and the ability to integrate new devices easily. Despite its many features, CHAI3D does not provide an interface to visualize hand movement. We address this by introducing cHand, an extension of CHAI3D that allows users to define and visualize a generic hand model, and releasing it as an open source contribution on GitHub[1].

II. Overview and features

With cHand we aim to enable visualization of a generic hand model, building upon the existing framework in CHAI3D. In order to accomplish this goal we provide the following features:

- The ability for the user to define a generic hand model with any number of degrees of freedom;
- A way to visualize the hand kinematics (both through simple geometry and custom STL models) and update it based on changes of joint angle values (Figure 1);
- Contact detection between the rendered hand visualization and other objects in the virtual world;
- All of the above was accomplished by leveraging as much as possible upon the existing structures existing in CHAI3D and keeping compatibility with the rest of the library.

This work was partially supported by the NSF: NRI: grant FND: "Customizable Haptic Co-Robots For Training Emergency Surgical Procedures"

E.B. and A.M.F. are with the Department of Mechanical Engineering, The University of Texas at Austin, TX 78712, USA. edoardo.battaglia@austin.utexas.edu

A.M.F. is also with the Department of Surgery, UT Southwestern Medical Center, Dallas, TX 75390, USA

[1] https://github.com/ebattaglia/cHand/

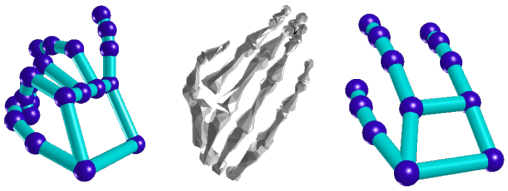

Fig. 1. Examples of visualization obtained with cHand. cHand can visualize models with any number of fingers and any d.o.f., either through simple shapes or custom geometry loaded from an .stl file.

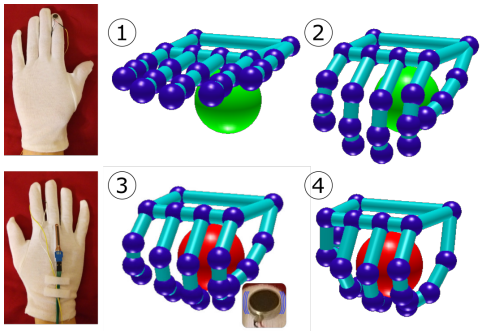

Fig. 2. Simulation of contact with an object based on vibrotactile feedback.

III. Visualizing Live Data With cHand

To showcase use of cHand in a live data acquisition context, we present a simple experimental scenario using a glove with a bend sensor and one small vibration motor, which is meant to provide a template that can be used to get started with other projects (Figure 2). The bend sensor is used to measure the overall level of closure of the user's hand, which commands the closure of the virtual hand in a synergistic way. When the virtual hand enters in contact with an object, the vibration motor is triggered to provide a tactile cue.

IV. Conclusions

The extension cHand augments CHAI3D with support for visualization of hand kinematics. Features include definition of a generic hand model, which can be defined in the code or loaded from file, visualization through both simple geometrical shapes and more complex custom geometries from STL models, and the possibility to detect contacts on the centers of rotation of the hand and the fingertips. The live data acquisition demonstration is included in the code and can serve as a template for projects involving other wearable haptic systems.

References

[1] F. Conti, F. Barbagli, R. Balaniuk, M. Halg, C. Lu, D. Morris, L. Sentis, J. Warren, O. Khatib, and K. Salisbury, "The chai libraries," in *Proceedings of Eurohaptics 2003*, Dublin, Ireland, 2003, pp. 496–500.

978-1-6654-1871-3/21/$31.00 ©2021 IEEE