New & Ongoing Projects
Sensory Perception and Interaction Lab (SPIN)
University of British Columbia

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1 Prototyping Applications for Novel Polymer-based Tactile Displays

Synopsis: This NSERC / Qualcomm-funded project is lead by John Madden (UBC ECE) whose group has invented a family of electronically driven polymers that can be used as tactile shape displays. SPIN’s role is to prototype applications for this cutting-edge and potentially game-changing technology.

This recently-funded project is available immediately (as of January 2016).

Madden’s group will create several demonstration devices (e.g., flexible keypads, armband input device, robot finger ‘skin’/proximity sensor, a transparent stretchable touch interface); and SPIN will contribute additional concept ideas based on our investigations. We will evaluate both real functional prototypes (made from the new polymer technology) and mockups of their functionality, as appropriate, to assess both psychophysics and functional possibilities. A particular interest is wearable biomedical applications.

Opportunities:

- **Grad: Prototyping and evaluation interface concepts** (co-supervised with Madden).
  Requires:
  - HCI: excellent performance in undergrad-level HCI courses (CPSC 344/544, CPSC 444, or equivalent) including at least course-level experience in studying users and modular prototype development and user-centered evaluation.
  - Demonstrated creativity and skill in physical prototyping (e.g., haptic sketching); CPSC 543 or arts background a plus.
  - Programming: Strong and extendable programming abilities.

2 CyberHap: Web Tools for learning Physics thru Haptics

Synopsis: This NSF-funded project aims to learn whether the embodied, tangible aspects of an engaged haptic (force feedback) experience can contribute to learning of physical concepts, such as force-motion relationships as taught in high school physics courses.

With Stanford robotics and education experts, Ron Garcia (Programming Languages/PL) from UBC CS, and Susan Gerofsky (UBC Education), we will use a Stanford-designed low-cost 1-dimensional haptic display (DIY 3D-printed) to evaluate this question in an educational context – high school students from the Bay Area and Metro Vancouver within a classroom context.

At UBC, we’re contributing is graphical programming tools, and pedagogical strategies. Learners who are not expert programmers will be distracted by the arduous task of constructing haptic simulations. Instead, we are building a visual interface to allow students to construct haptic simulations in support of team-designed lessons and learning goals about physics concepts, while developing a transparent, hands-on and extendable connection to the haptic hardware. We will explore using alternative “handles” for simulation construction and idea exploration: what aspects need to be controlled, and how can these be transparently wired to the haptic device? The tool design has two primary components – visual interface design and underlying programming language implementation.

We’ve already built a first pass on the visual interface design, which is currently being evaluated with students in a larger study at Stanford. In a second phase of the research, we’re focusing on: the robust, flexible programming environment, more engaging, design-oriented lessons, and larger workspaces w/ handmounted displays.

We are inspired by Victor's Live Programming, a conceptual sketch where slider-type controls can dynamically connect types of code to aspects of a graphical animation:


The programmer can quickly generate these new ‘handles' onto behavior, and use them to interactively observe the result of her code manipulations. The PL part of this project is needed to make this happen.

Opportunities:
The following are both for a Master’s (grad) or 1-year postdoc level of commitment, with possible extension to longer roles depending on spring funding results. All involve close collaboration with one another and with the Stanford team. The ideal postdoc candidate would be expert in both HCI and Programming languages.

- **Grad or Postdoc: Design / Testing of Visual Interface (potentially co-supervised with Gerofsky).**
  Build on our first-pass interface, and extend to support more open-ended design-based tasks within one or more physics learning contexts. Draw requirements from a set of team-designed lesson plans and a pool of target student users and their teachers; prototype several variants of a front-end of a graphical programming environment, and work with the PL individual in creating deployable versions suitable for larger scale evaluation. Assist in deploying and analyzing the Stanford-lead in-situ high school studies them with students and with our Stanford team. As project scope permits, iterate. 
  
  Requires (also see “All” below):
  - HCI: excellent performance in undergrad-level HCI courses (CPSC 344/544, CPSC 444, or equivalent) including at least course-level experience in studying users and modular prototype development and user-centered evaluation.
  - Programming: Strong and extendable programming abilities.
  - A plus: at least introductory programming languages (PL) knowledge (CPSC 311 or equivalent)
  - Demonstrated creativity and skill in interface design.

- **Grad or Postdoc: Reactive Programming Implementation (co-supervised with Garcia).** To connect the student- or teacher-facing dynamic visual environment to the underlying haptics hardware and general-purpose computer hardware, we will develop a high-level middleware interface as a programming language that directly embodies and interprets visual blocks as reactive program components. Requires (also see “All” below):
  - PL: excellent performance in at least undergraduate level programming language course.

All roles require:
- Physics: A good grasp of basic concepts.
- Interest in education research
- Comfortable with hardware tinkering
- Good work management, team collaboration and problem solving skills
3 CuddleBot/Bit Project

Background: The CuddleBot is a haptic affective robot developed in SPIN for research in affective touch, and therapeutic applications. This project has many aspects:

- The “Bot” is the size of a furry cat, designed to sit in your lap, with custom touch sensing and ability to breath, purr and arch its back under program control; it operates under battery power and can run either autonomously or in a wireless puppetry mode. The current version needs further mechatronic work to be robust for clinical trials with children.
- Our “Bits” are simple 1-DF versions that we use for rapid iteration on behavior elements.
- Touch sensing is provided with a custom fabric sensor, where we are currently innovating on recognition algorithms.

Extensions for sound, vision etc. are possible but not currently implemented. The lab has several copies of these robots that we plan to use for monitored studies with children and others,

3.1 Technology: CuddleBot Computational Architecture

Synopsis: The Bot has several embedded computers and wireless connectivity to a host; it will be able to run autonomously or in a puppet mode, in terms of motion control, sensing and interactive loops (feedback control implemented as robot responses to user input). While its basic computational architecture has been designed and implemented, many elements remain to be developed and tested.

Opportunities:
- Graduate or talented Undergraduate: software architecture and robot control, in collaboration with graduate students.

3.2 Application & Study: Calming Kids Before Surgery

Synopsis: Develop and help run a two-part study with CuddleBot targeting state anxiety in children, as they await anesthetization prior to undergoing surgery in a pediatric hospital waiting room. This application targets “state” anxiety, i.e. anxiety arising from a specific stressful situation.

Hypothesis: use of bot will help calm pre-surgical children in one-time interactions more than other conventional non-pharmacological approaches.

Outside collaborators: BC Children’s Hospital anesthesiologists, supported by pediatric psychologist, statistician and other BCCH team members.

Opportunities:
- Graduate student: Interaction design and experiment support
- Postdoc: Interaction design (major effort); experiment design/support, potential business opportunity development.

3.3 Technology: Gesture Recognition on Bots, Bits and – what else?

Synopsis: The CuddleBot is equipped with a novel flexible low-cost fabric sensor that detects position and pressure of touches at fingerpad resolution. The challenge is to use this sensor to detect different kinds of touches and extract emotional meaning and intent from them

Opportunities: We’ve had great initial success with lots more to do, including exploring other interactive applications for this technology.

- Graduate or talented Undergraduate: sensor design, machine learning analysis, tricky experiment design; integration of sensor directly into Bot architecture for interactive behaviors.
3.4 Application: CuddleBot in the Classroom

Synopsis: Develop/run an observational study in VSB classrooms, with potential collaboration in UBC Education Department. This application targets coping skills for “trait” anxiety, i.e. anxiety that is part of a child’s emotional makeup but may be exacerbated by specific situations.

Hypothesis: use of bot will help children develop self-calming, learning-readiness strategies.

Opportunities:
- **Graduate student**: Interaction design and experiment support
- **Postdoc**: Interaction design, experiment design/support, grant writing support (possibly in conjunction with other application projects).

3.5 Application: CuddleBot assisting learning by Children with ASD

Synopsis: Explore the use of CuddleBot with children learning to live with ASD. Initial contacts have been made and possibilities established, but a first step will be to deepen our collaborative network. Secondly, to get to know a group of ASD children and their therapists, and jointly with a caregiver team develop possibilities for therapeutic interactions.

Hypothesis: use of bot will help children develop mindfulness skills and other self-calming, learning-readiness strategies.

Opportunities:
- **Graduate student**: Interaction design and experiment support
- **Postdoc**: Interaction design, experiment design/support, grant writing support (possibly in conjunction with other application projects).

3.6 CuddleBit

Synopsis: How does a handheld CuddleBit impact people – children and adults? We’ve developed a handheld version of the CuddleBot, ~one degree of freedom, as an easy-to-evolve study-ready prototype, and have already done some studies with it that show us it’s capable of expressing quite a lot of emotion. We’ll continue this work, including a formal study that compares its emotive impact with that of the full Bot.

Opportunities:
- **Undergrad or Grad, appropriately scaled**: An individual comfortable with mechatronics (e.g. simple motor behavior and embedded systems, such as Arduino) for initial interaction design steps; experiment development requires HCI background and probably grad student level of time and commitment.
4 On the back burner:

4.1 Cookie Monster

Synopsis: Karon has long wanted to build some kind of tool that helps instructors learn their students names, ideally usable on the bus. Then she discovered (duh) when trying out the idea with 344 students, that they are kind of creeped out and annoyed by the idea of a teacher wanting to collect data that helps her learn about them, like little details about them together with their photos. THEN, she found that Ron Garcia (UBC CS) has been taking a different tactic which students DO like, with amazing success in a large class (110). Why it’s called Cookie Monster will have to wait for another time.

We hope to unite ideas and come up with something good. But … maybe it will have to wait a little while, until the list of projects gets shorter.