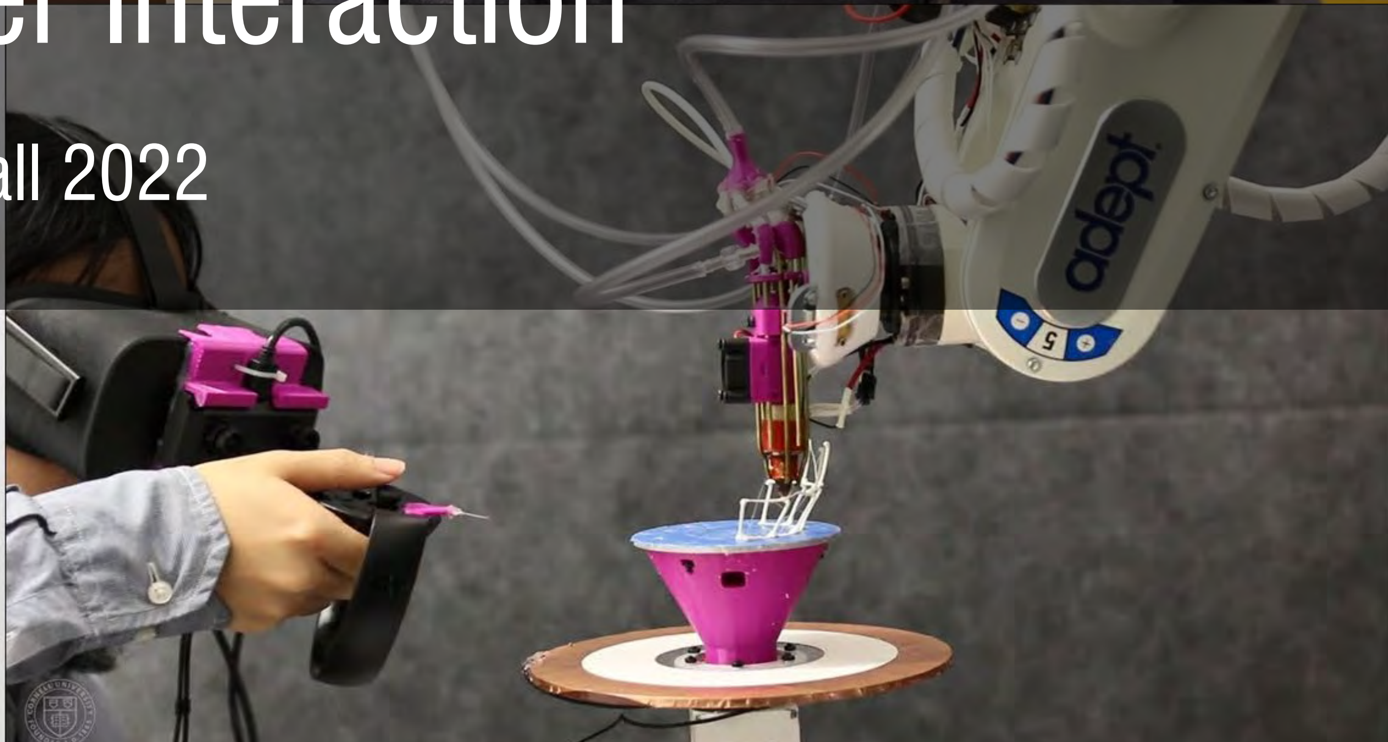
Interactive Technology for Human-Computer Interaction

Huaishu Peng | UMD CS | Fall 2022



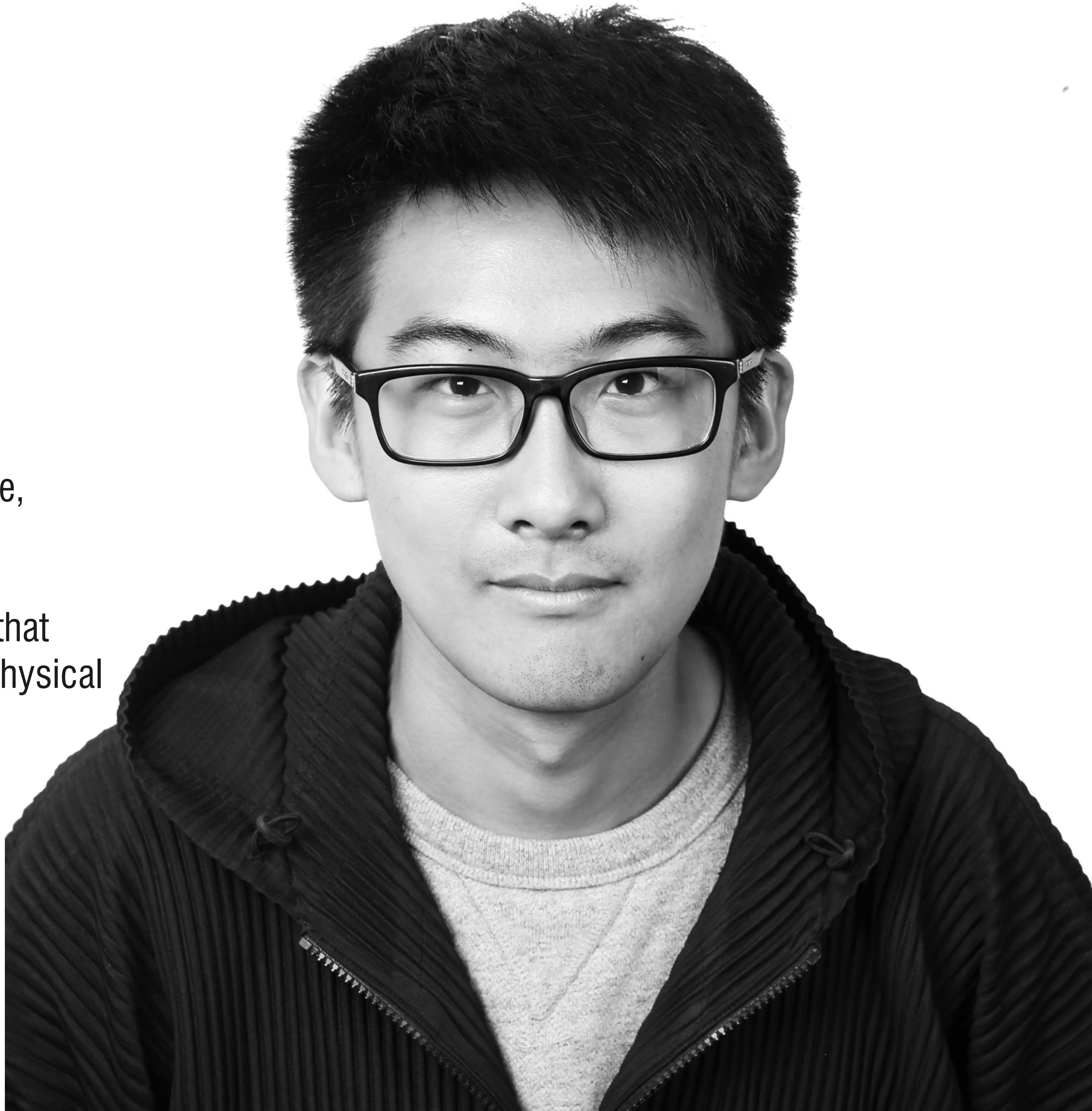
TA: Zeyu Yan

zeyuy@umd.edu

4-year PhD Student, CS

My research is in the field of HCI focusing on haptic interface, shape changing material and 3D printing.

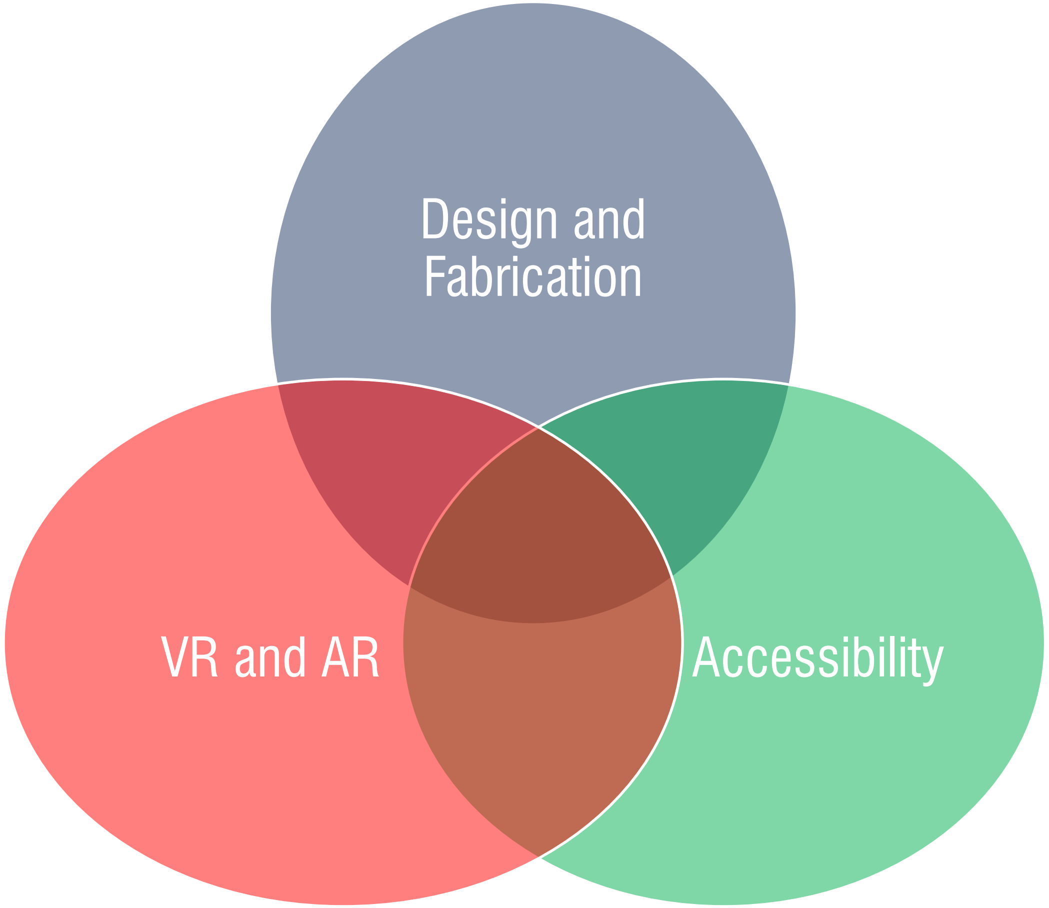
I work with Huaishu to build fictional physical HCI products that enriches haptic ways for people to interact with digital and physical world.



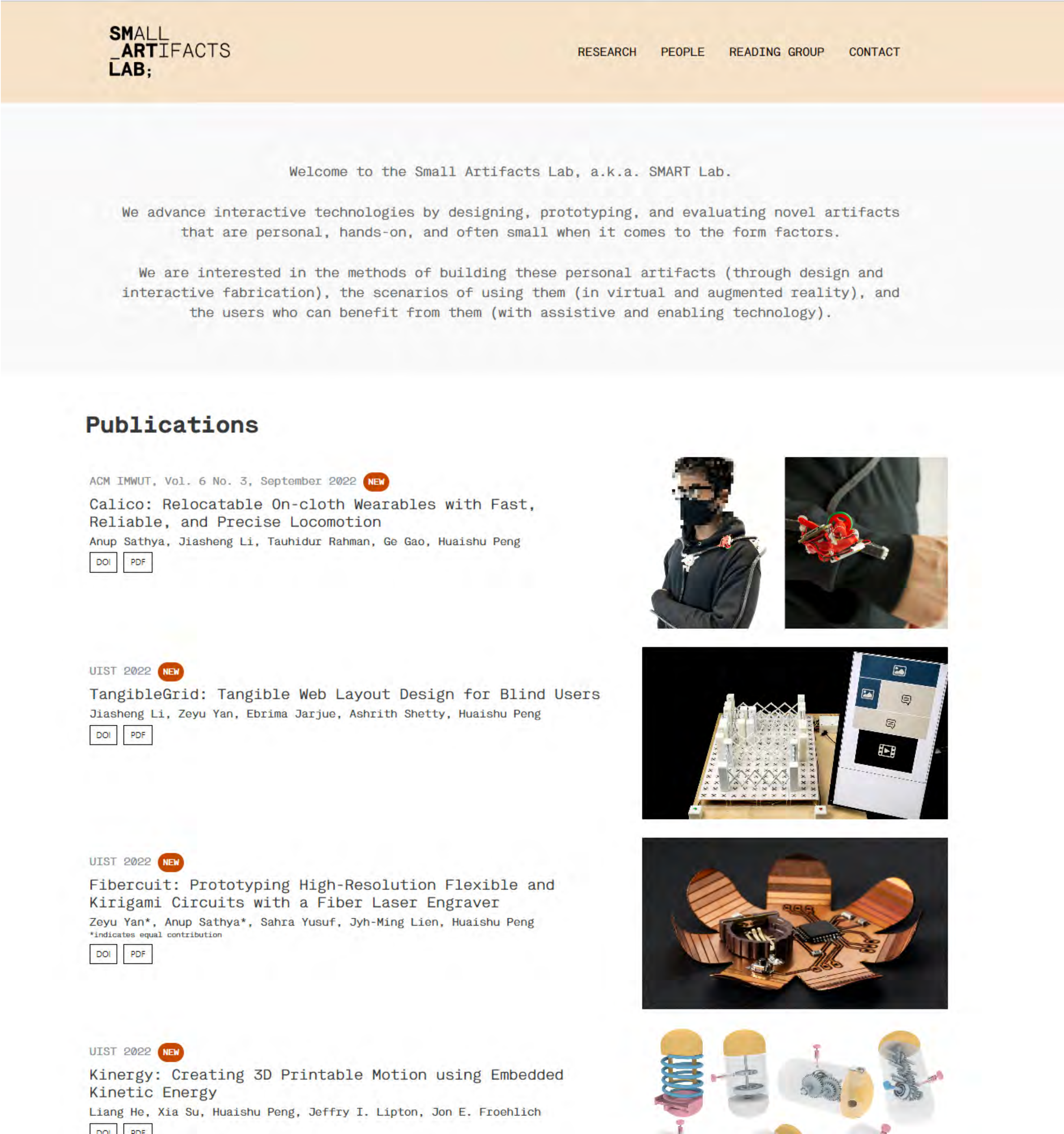
Huaishu Peng

Assistant Professor | UMD CS/UMIACS/HCIL

huaishu@cs.umd.edu



https://smartlab.cs.umd.edu/

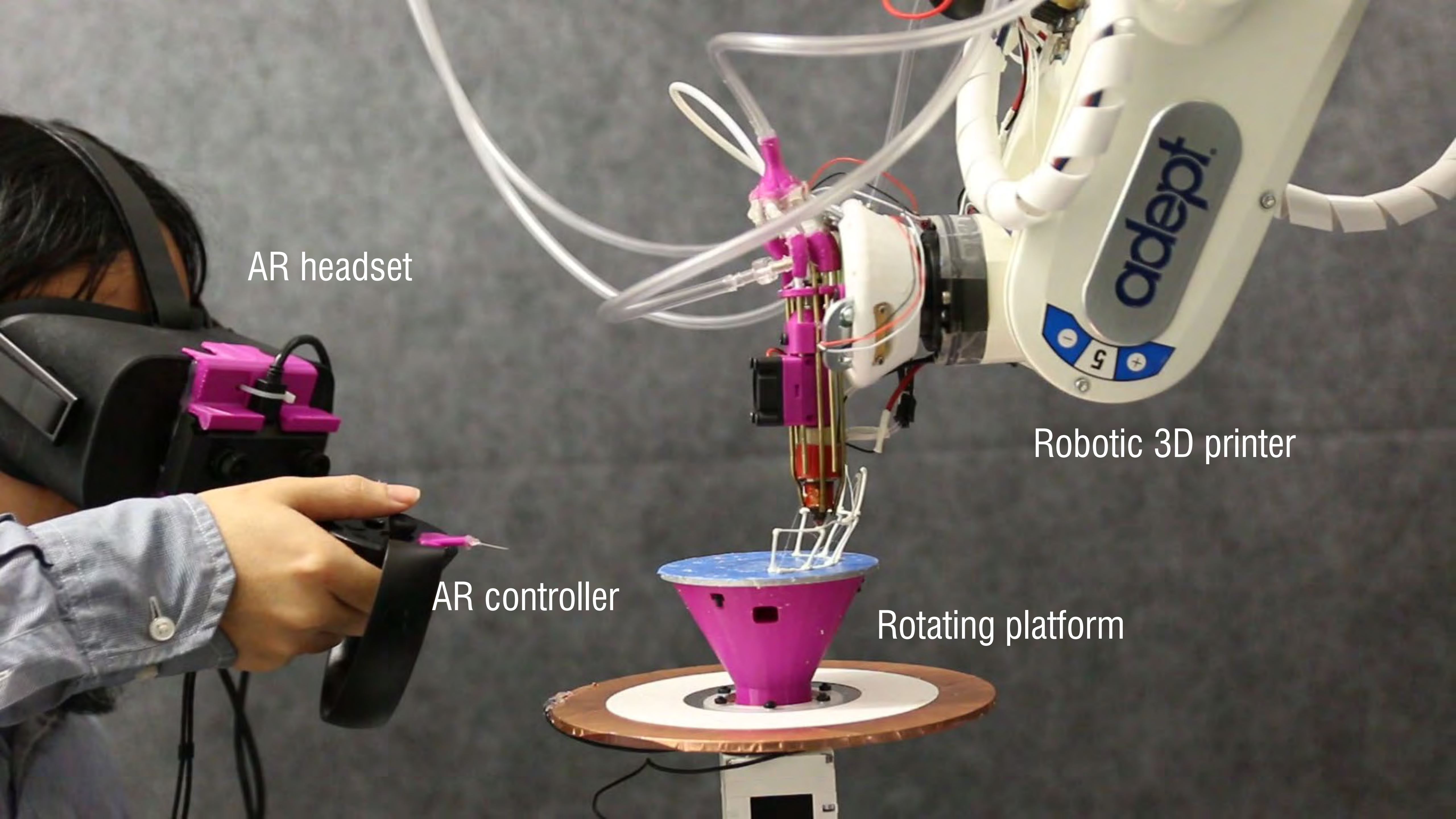


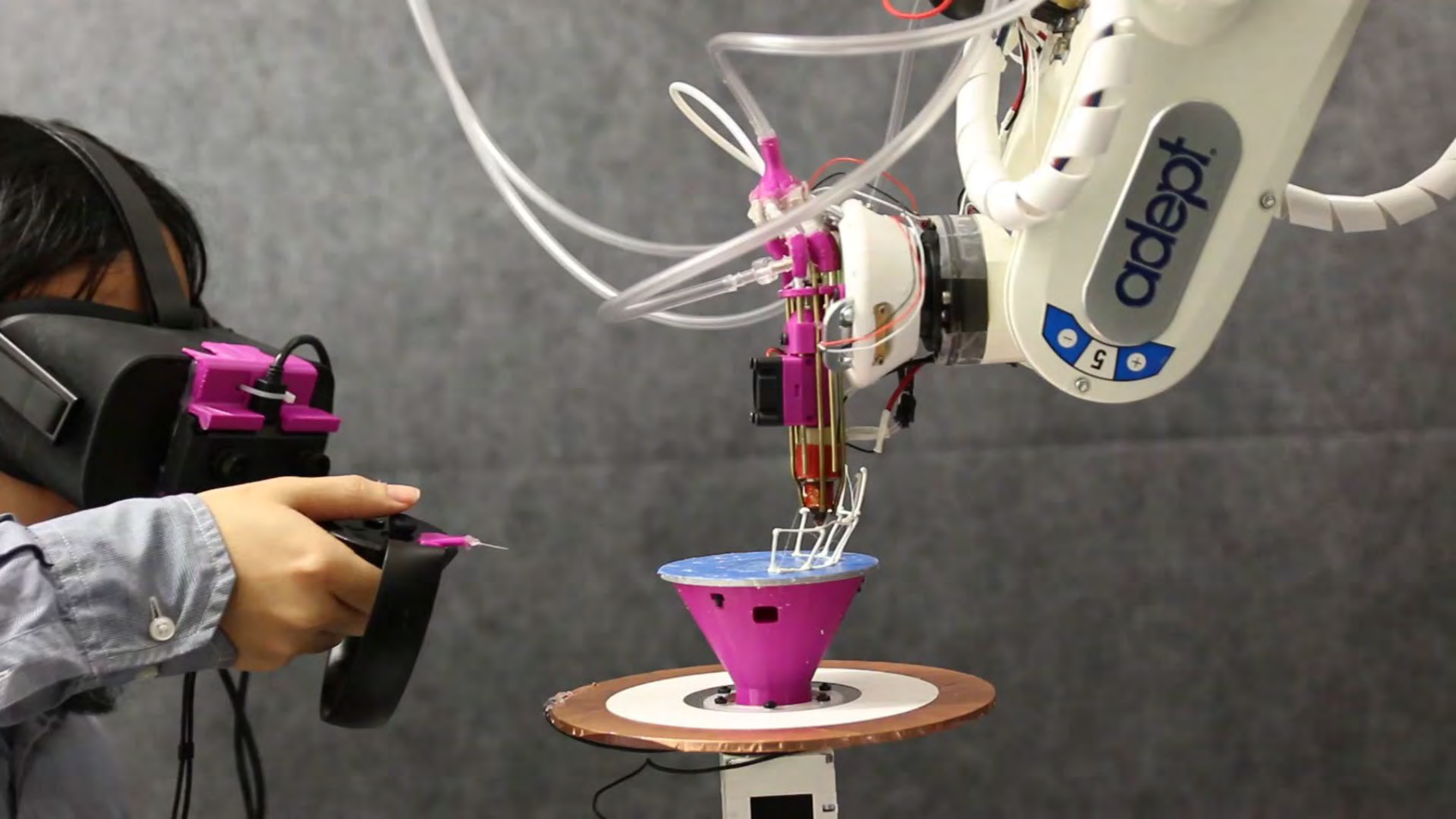
RoMA: Interactive Fabrication with Augmented Reality and a Robotic 3D Printer

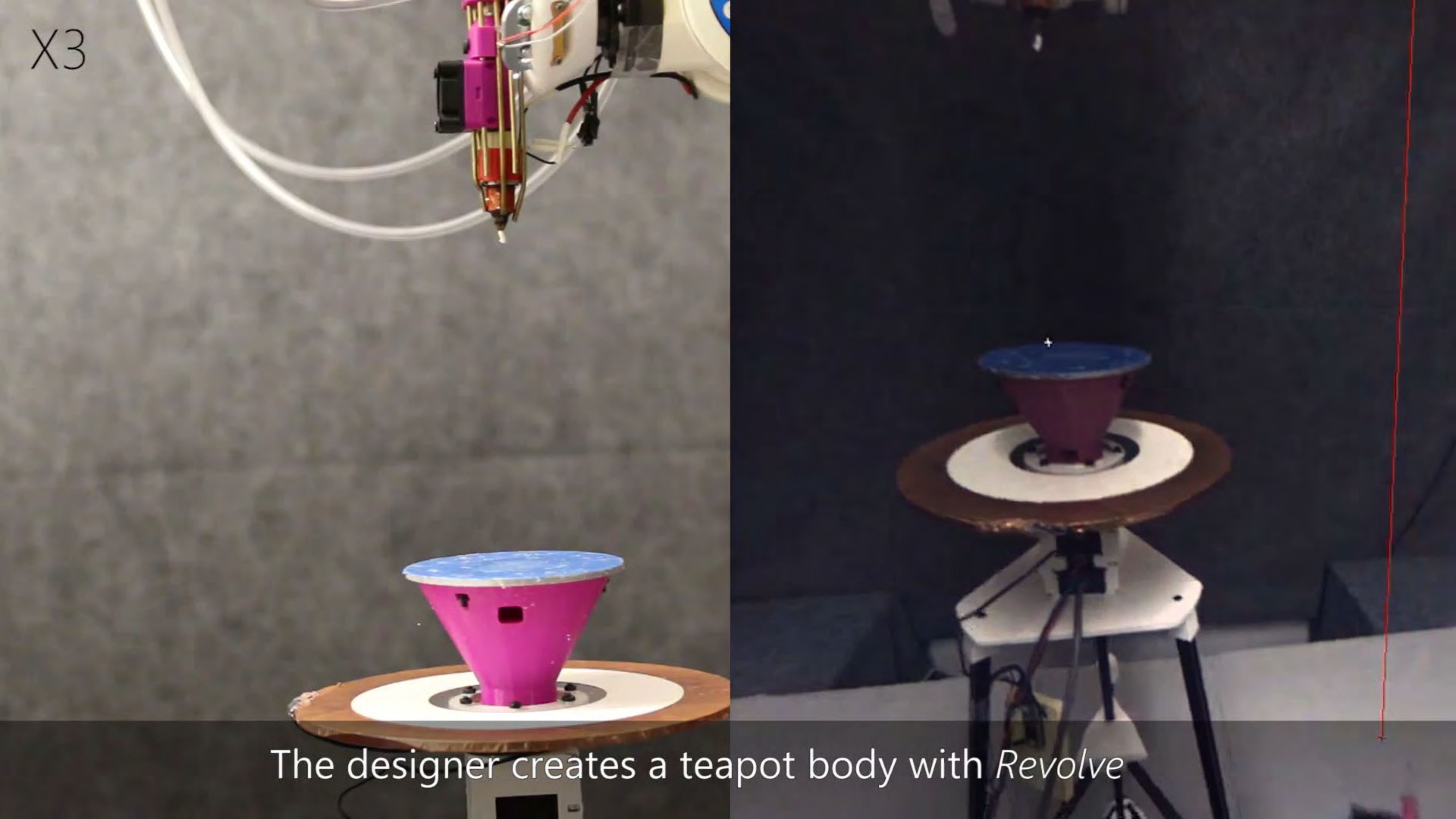
CHI 2018

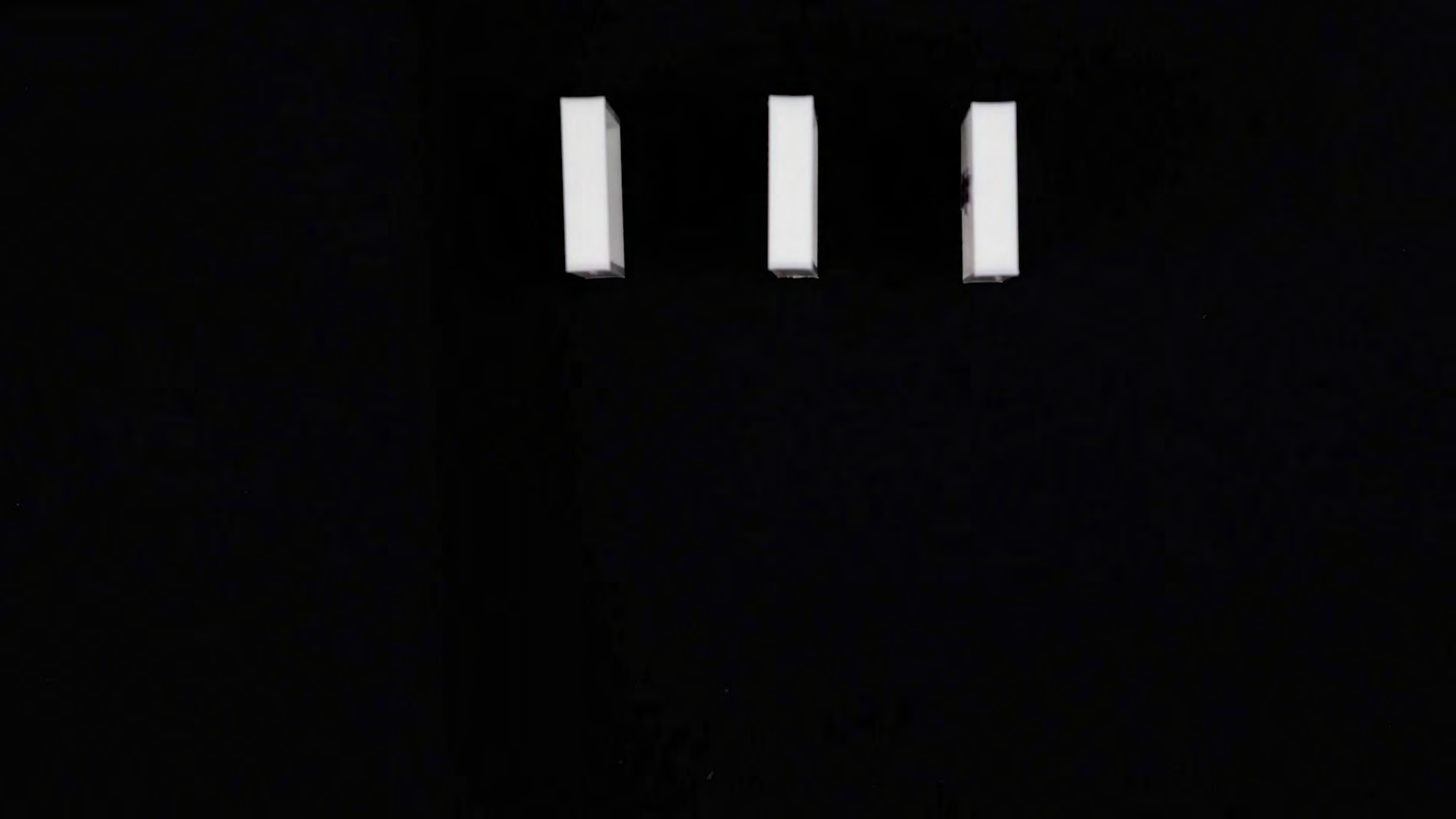
Huaishu Peng | Jimmy Briggs | Cheng-Yao Wang | Kevin Guo | Joseph Kider | Stefanie Mueller | Patrick Baudisch | François Guimbretière

Cornell University
Hasso Plattner Institut


AR headset
Robotic 3D printer
AR controller
Rotating platform
adept


adept
5


X3
The designer creates a teapot body with *Revolve*



Beyond Fabrication?

BVI and Accessibility

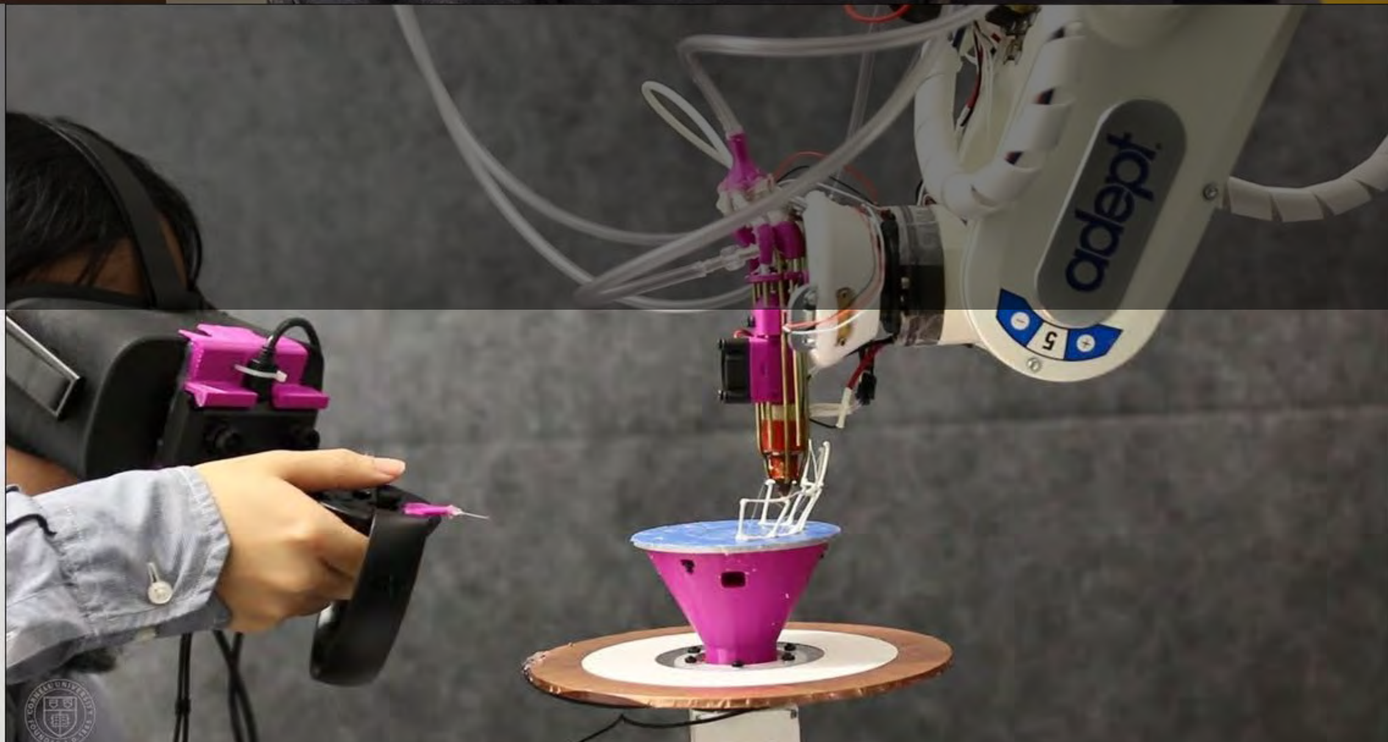
If you are interested in doing research with me, drop me a line.

Lab space

IRB 0102

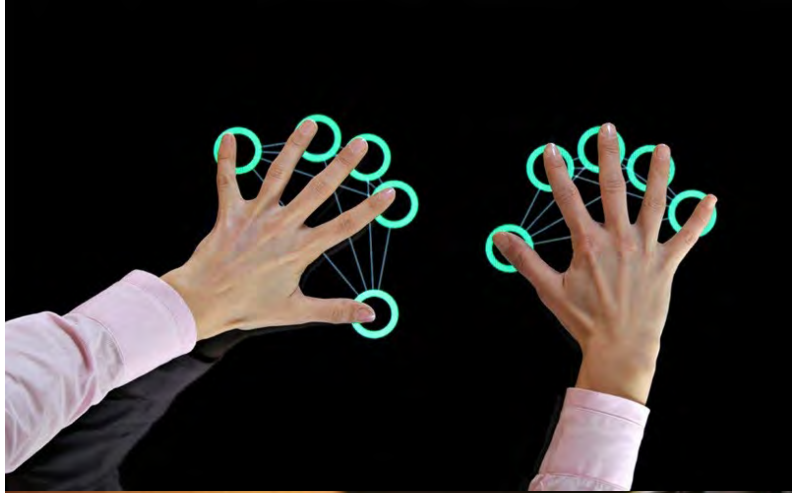
Now about this course

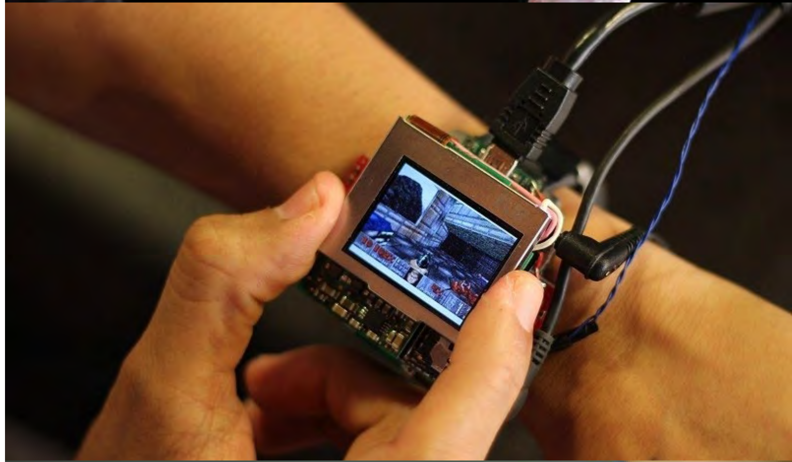
Course Overview

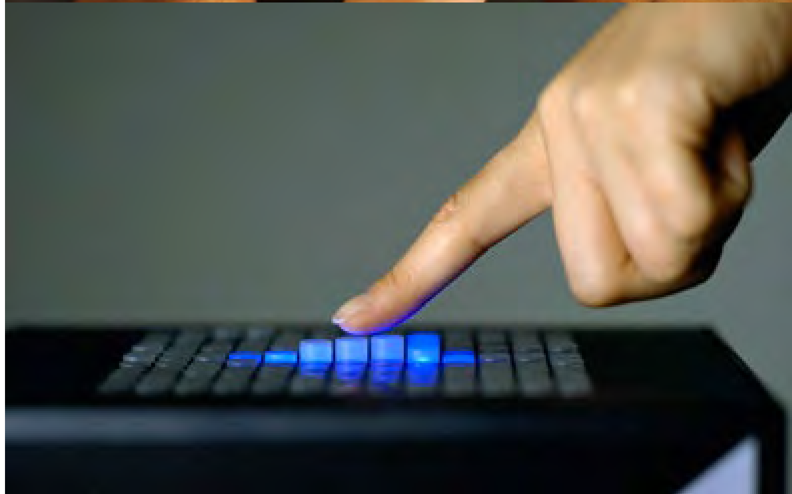


Learn

- Various interactive technologies
- Technologies behind the scene

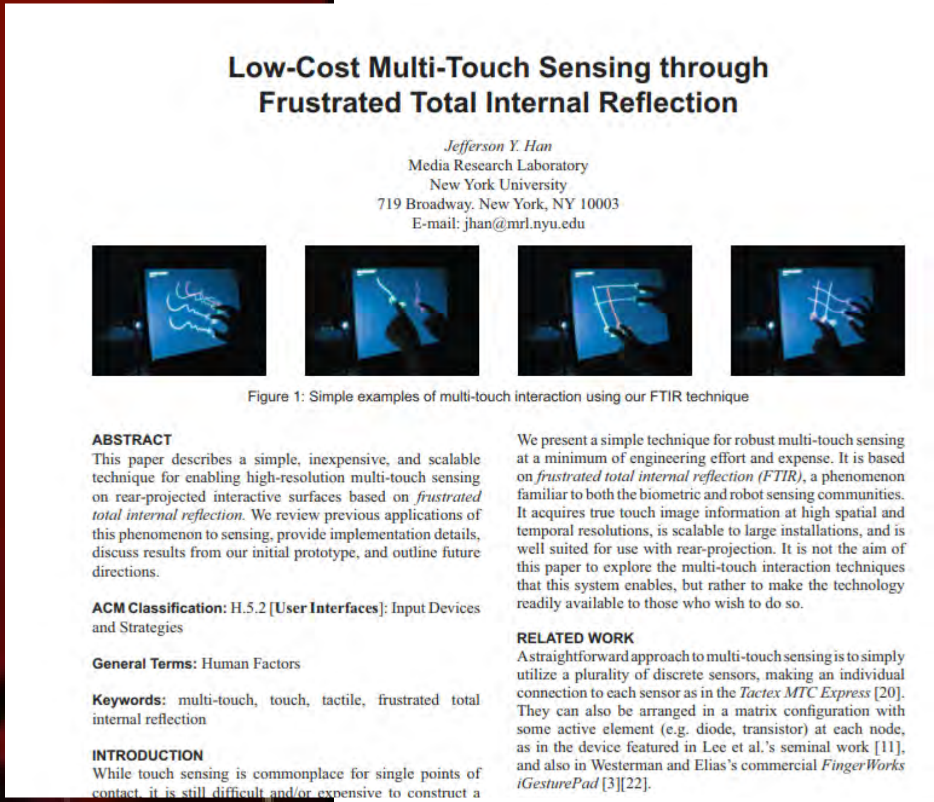






Multi-touch Display

"And we have **invented** a new technology called multi-touch, which is phenomenal." [0:33:33] - Steve Jobs



Low-Cost Multi-Touch Sensing through Frustrated Total Internal Reflection

Jefferson Y. Han
Media Research Laboratory
New York University
719 Broadway. New York, NY 10003
E-mail: jhan@mrl.nyu.edu

Figure 1: Simple examples of multi-touch interaction using our FTIR technique

ABSTRACT
This paper describes a simple, inexpensive, and scalable technique for enabling high-resolution multi-touch sensing on rear-projected interactive surfaces based on *frustrated total internal reflection.* We review previous applications of this phenomenon to sensing, provide implementation details, discuss results from our initial prototype, and outline future directions.

ACM Classification: H.5.2 [**User Interfaces**]: Input Devices and Strategies

General Terms: Human Factors

Keywords: multi-touch, touch, tactile, frustrated total internal reflection

INTRODUCTION
While touch sensing is commonplace for single points of contact, it is still difficult and/or expensive to construct a

We present a simple technique for robust multi-touch sensing at a minimum of engineering effort and expense. It is based on *frustrated total internal reflection (FTIR)*, a phenomenon familiar to both the biometric and robot sensing communities. It acquires true touch image information at high spatial and temporal resolutions, is scalable to large installations, and is well suited for use with rear-projection. It is not the aim of this paper to explore the multi-touch interaction techniques that this system enables, but rather to make the technology readily available to those who wish to do so.

RELATED WORK
A straightforward approach to multi-touch sensing is to simply utilize a plurality of discrete sensors, making an individual connection to each sensor as in the *Tactex MTC Express* [20]. They can also be arranged in a matrix configuration with some active element (e.g. diode, transistor) at each node, as in the device featured in Lee et al.'s seminal work [11], and also in Westerman and Elias's commercial *FingerWorks iGesturePad* [3][22].

UIST 2005

lasting impact award

Wearables

Best smartwatch 2020: the top wearables you can buy today

By James Peckham 7 hours ago

The absolute best smartwatches for your wrist

(Image credit: Samsung, Apple and Fossil)

Today's best smartwatch models can perform lots of tricks, like searching the internet with your voice, tracking your location with GPS or even monitoring your heart rate to protect your overall health. For some models, they can even do that without being paired to one of the best phones on the market.

We've tested the vast majority of the top-end wearables you can buy right now from the Apple Watch to Fitbits to Garmin watches to Tizen-sporting Samsung watches. There's also Wear OS (you may have known that in its previous incarnation called Android Wear) which is Google's own wearable operating system in the vein of Apple's watchOS - you'll see it show up in a lot of these devices.

MOST POPULAR MOST SHARED

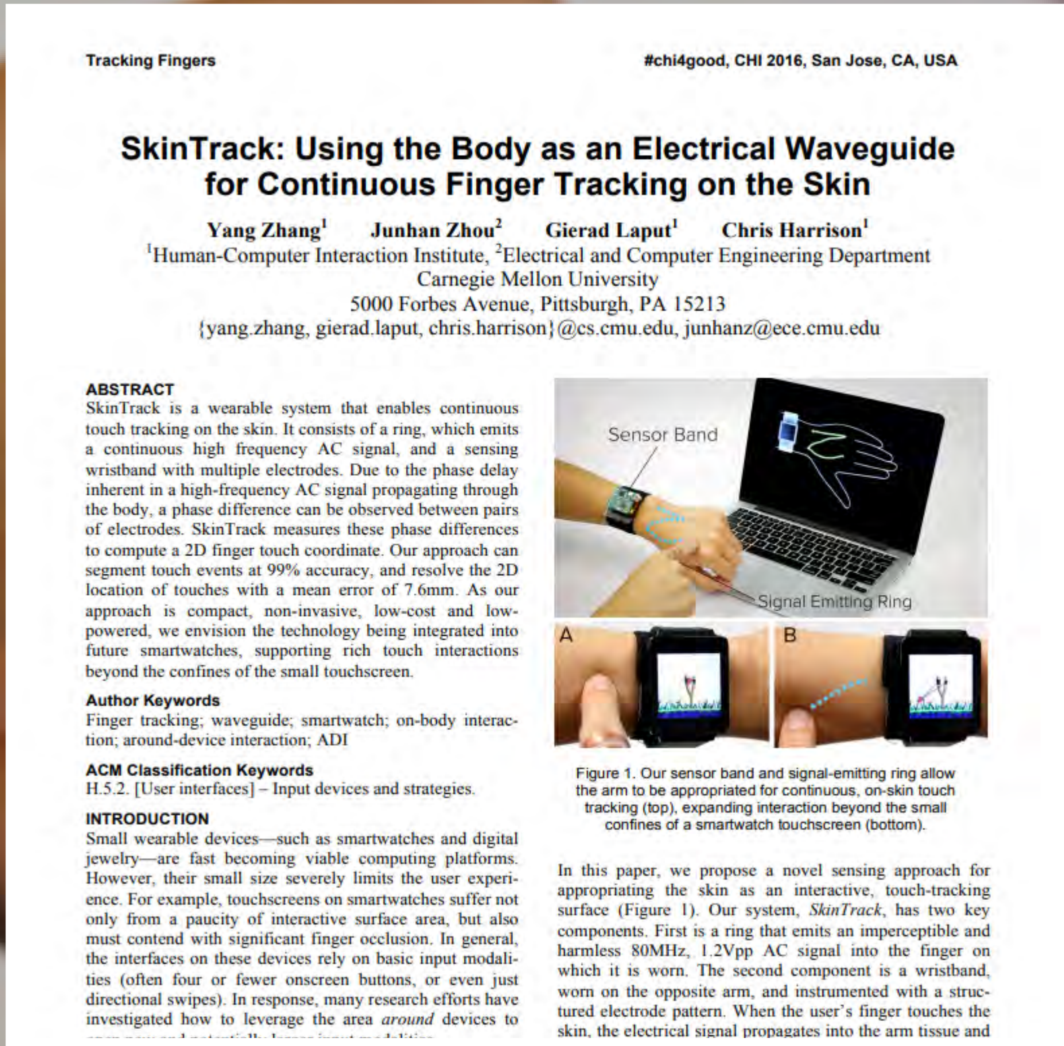
1 The best free YouTube to MP3 converter 2020: rip audio from videos

2 Switch Pro: developers tell us what they want from the rumored Switch upgrade

3 How to watch the Marvel movies in order

4 PS5 release date, specs, news and rumors for Sony's PlayStation 5

5 How to watch the Star Wars movies in order



SkinTrack: Using the Body as an Electrical Waveguide for Continuous Finger Tracking on the Skin

Yang Zhang[1] Junhan Zhou[2] Gierad Laput[1] Chris Harrison[1]
[1]Human-Computer Interaction Institute, [2]Electrical and Computer Engineering Department
Carnegie Mellon University
5000 Forbes Avenue, Pittsburgh, PA 15213
{yang.zhang, gierad.laput, chris.harrison}@cs.cmu.edu, junhanz@ece.cmu.edu

ABSTRACT
SkinTrack is a wearable system that enables continuous touch tracking on the skin. It consists of a ring, which emits a continuous high frequency AC signal, and a sensing wristband with multiple electrodes. Due to the phase delay inherent in a high-frequency AC signal propagating through the body, a phase difference can be observed between pairs of electrodes. SkinTrack measures these phase differences to compute a 2D finger touch coordinate. Our approach can segment touch events at 99% accuracy, and resolve the 2D location of touches with a mean error of 7.6mm. As our approach is compact, non-invasive, low-cost and low-powered, we envision the technology being integrated into future smartwatches, supporting rich touch interactions beyond the confines of the small touchscreen.

Author Keywords
Finger tracking; waveguide; smartwatch; on-body interaction; around-device interaction; ADI

ACM Classification Keywords
H.5.2. [User interfaces] – Input devices and strategies.

INTRODUCTION
Small wearable devices—such as smartwatches and digital jewelry—are fast becoming viable computing platforms. However, their small size severely limits the user experience. For example, touchscreens on smartwatches suffer not only from a paucity of interactive surface area, but also must contend with significant finger occlusion. In general, the interfaces on these devices rely on basic input modalities (often four or fewer onscreen buttons, or even just directional swipes). In response, many research efforts have investigated how to leverage the area *around* devices to

Figure 1. Our sensor band and signal-emitting ring allow the arm to be appropriated for continuous, on-skin touch tracking (top), expanding interaction beyond the small confines of a smartwatch touchscreen (bottom).

In this paper, we propose a novel sensing approach for appropriating the skin as an interactive, touch-tracking surface (Figure 1). Our system, *SkinTrack*, has two key components. First is a ring that emits an imperceptible and harmless 80MHz, 1.2Vpp AC signal into the finger on which it is worn. The second component is a wristband, worn on the opposite arm, and instrumented with a structured electrode pattern. When the user's finger touches the skin, the electrical signal propagates into the arm tissue and

CHI 2016

Zhang et.al. from CMU

XR

2012 Oculus Rift

XR

Haptic Turk: a Motion Platform Based on People

Lung-Pan Cheng, Patrick Lühne, Pedro Lopes, Christoph Sterz, and Patrick Baudisch
Hasso Plattner Institute, Potsdam, Germany
{firstname.lastname}@hpi.uni-potsdam.de

ABSTRACT
Motion platforms are used to increase the realism of virtual interaction. Unfortunately, their size and weight is proportional to the size of what they actuate. We present *haptic turk*, a different approach to motion platforms that is light and mobile. The key idea is to replace motors and mechanical components with humans. All haptic turk setups consist of a *player* who is supported by one or more *human-actuators*. The player enjoys an interactive experience, such as a flight simulation. The motion in the player's experience is generated by the actuators who manually lift, tilt, and push the player's limbs or torso. To get the timing and force right, timed motion instructions in a format familiar from rhythm games are displayed on actuators' mobile devices, which they attach to the player's body. We demonstrate a range of installations based on mobile phones, projectors, and head-mounted displays. In our user study, participants rated not only the experience as player as enjoyable (6.1/7), but also the experience as an actuator (4.4/7). The approach of leveraging humans allows us to deploy our approach anytime anywhere, as we demonstrate by deploying at an art festival in the Nevada desert.

Author Keywords
Haptics; force-feedback; motion platform; immersion.

ACM Classification Keywords
H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

INTRODUCTION
For a long time, the key to immersion in interactive experience and games was sought in photorealistic graphics [8]. More recently, game makers made games more immersive by requiring players to physically enact the game such as with Wii (http://wii.com) and Kinect [26]. With graphics and user interaction now part of many games, many researchers argue that *haptics and motion* are the next step

railing. Such events have been simulated using motion platforms [27]. Motion platforms are able to move one or more users around and have been used to add realism to flight simulators [22] and theme park rides.

Unfortunately, the size and weight of motion platforms tends to be proportional to what they actuate. As a result, motion platforms not only tend to be prohibitively expensive, but also large and heavy and thus stationary, limiting their use to arcades and lab environments.

Figure 1: Haptic turk allows producing motion experiences anywhere anytime. Here, the suspended player is enjoying an immersive hang gliding game. The four *actuators* create just the right physical motion to fill in the player's experience.

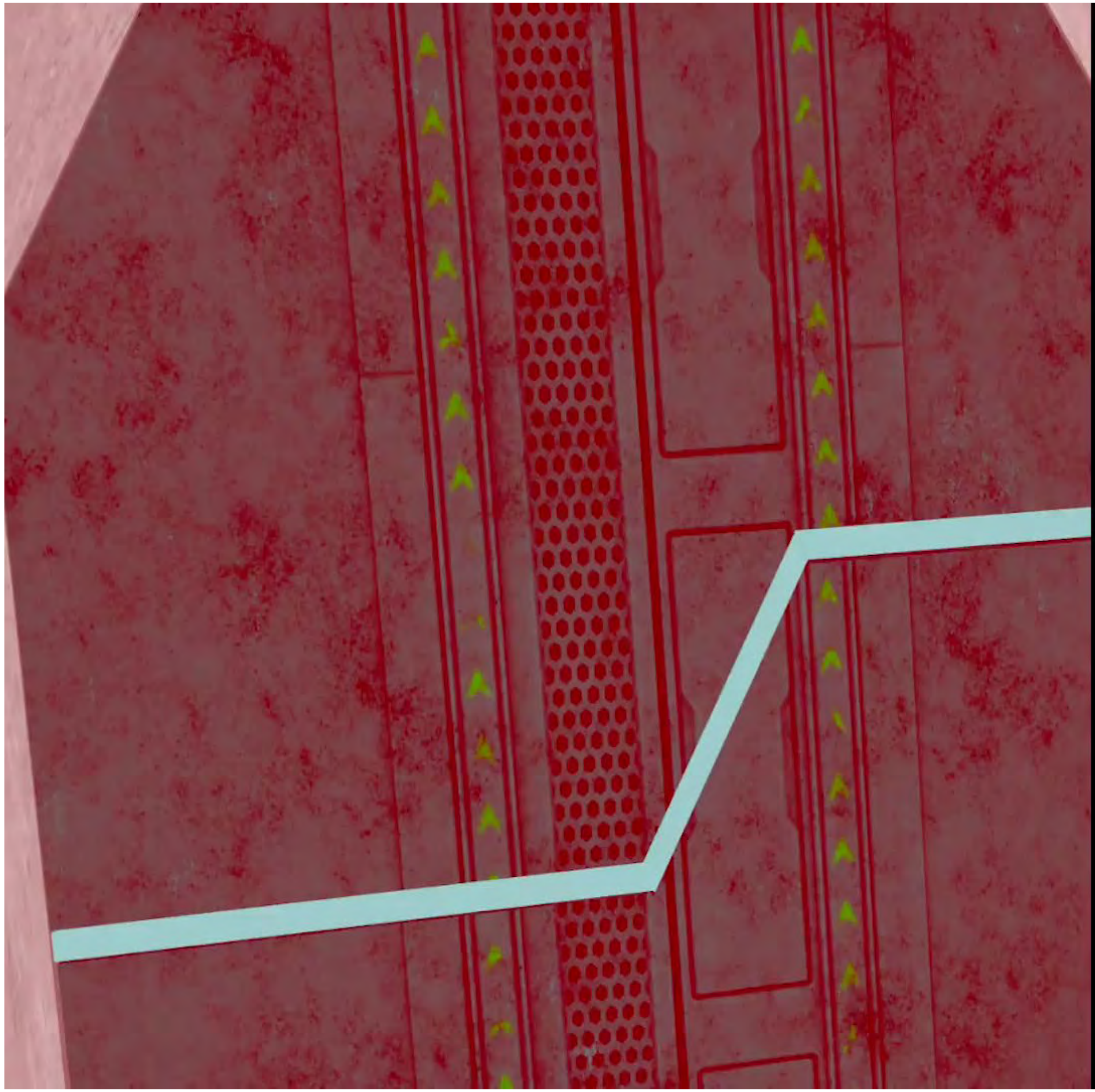
In this paper, we present *haptic turk*, a software platform that allows experiencing motion anywhere there is people. Its key idea is to substitute the motors and mechanical components of traditional motion platforms with humans.

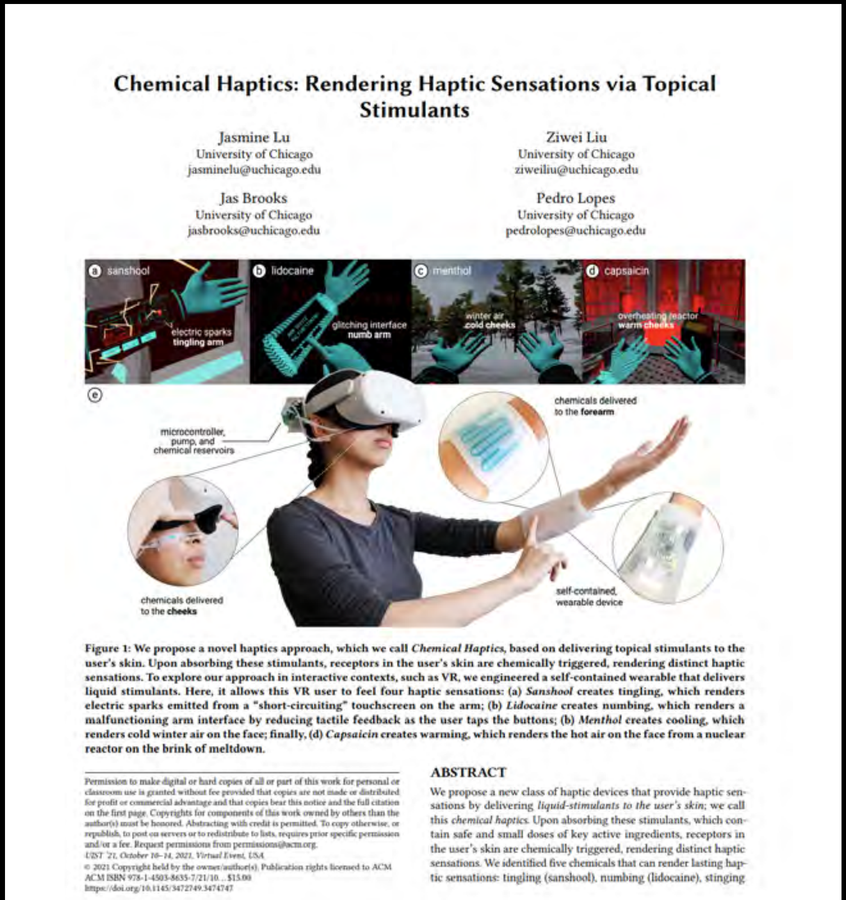
HAPTIC TURK
Haptic turk is a motion platform based on people. The name is inspired by the 18th century chess automaton "The Turk" [20] that was powered by a human chess master.

CHI 2014

Cheng et.al. from HPI

XR





Chemical Haptics: Rendering Haptic Sensations via Topical Stimulants

Jasmine Lu
University of Chicago
jasminelu@uchicago.edu

Ziwei Liu
University of Chicago
ziweiliu@uchicago.edu

Jas Brooks
University of Chicago
jasbrooks@uchicago.edu

Pedro Lopes
University of Chicago
pedrolopes@uchicago.edu

Figure 1: We propose a novel haptics approach, which we call *Chemical Haptics*, based on delivering topical stimulants to the user's skin. Upon absorbing these stimulants, receptors in the user's skin are chemically triggered, rendering distinct haptic sensations. To explore our approach in interactive contexts, such as VR, we engineered a self-contained wearable that delivers liquid stimulants. Here, it allows this VR user to feel four haptic sensations: (a) *Sanshool* creates tingling, which renders electric sparks emitted from a "short-circuiting" touchscreen on the arm; (b) *Lidocaine* creates numbing, which renders a malfunctioning arm interface by reducing tactile feedback as the user taps the buttons; (b) *Menthol* creates cooling, which renders cold winter air on the face; finally, (d) *Capsaicin* creates warming, which renders the hot air on the face from a nuclear reactor on the brink of meltdown.

UIST '21, October 10–14, 2021, Virtual Event, USA

ACM ISBN 978-1-4503-8635-7/21/10...$15.00
https://doi.org/10.1145/3472749.3474747

ABSTRACT

We propose a new class of haptic devices that provide haptic sensations by delivering *liquid-stimulants to the user's skin*; we call this *chemical haptics*. Upon absorbing these stimulants, which contain safe and small doses of key active ingredients, receptors in the user's skin are chemically triggered, rendering distinct haptic sensations. We identified five chemicals that can render lasting haptic sensations: tingling (sanshool), numbing (lidocaine), stinging

UIST 2021

Lu et.al. from UChicago

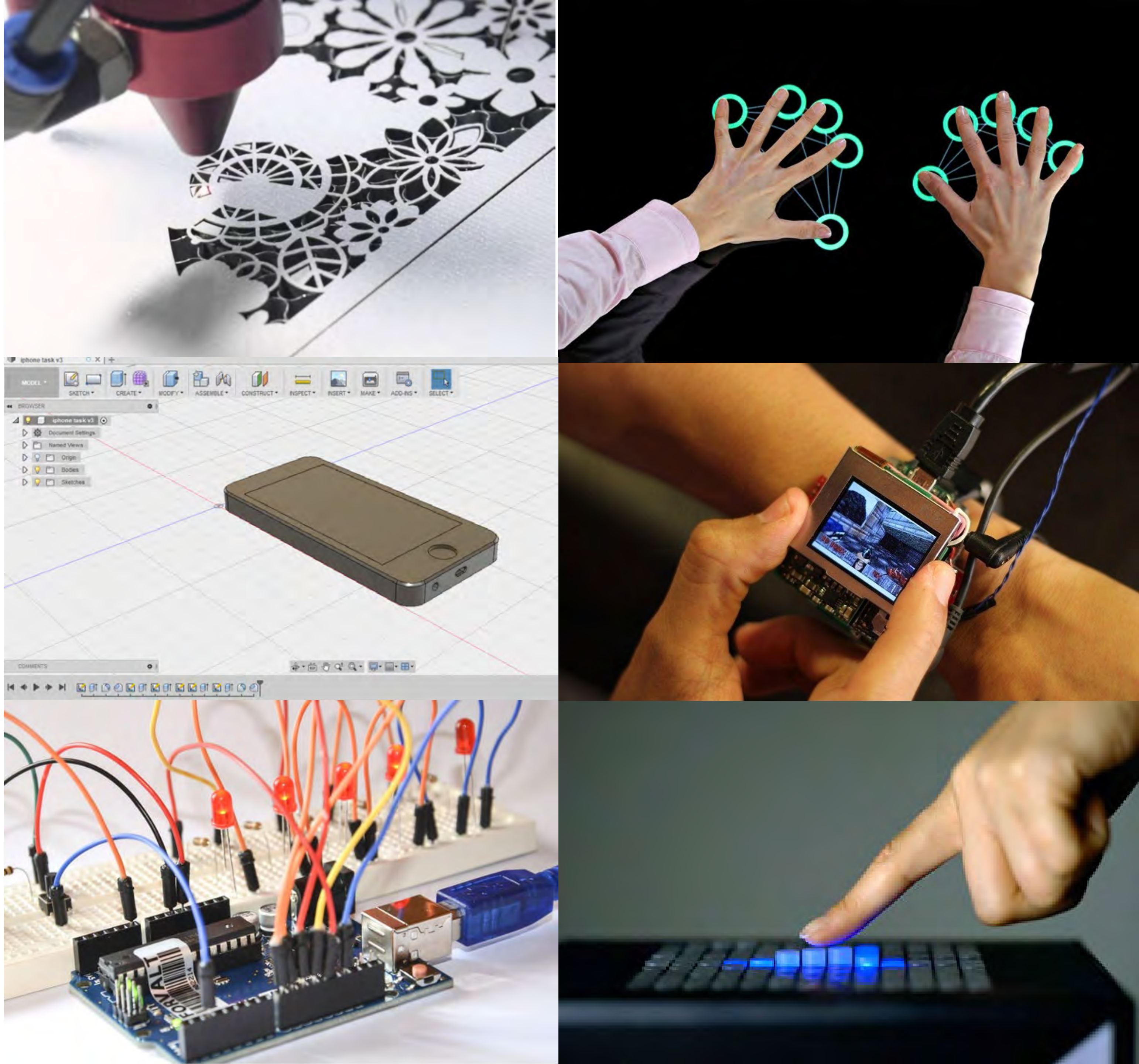
Haptics
Fabrication
Tangible Interface
Human-Robot Interaction

and more…
(well depends on the time we have)

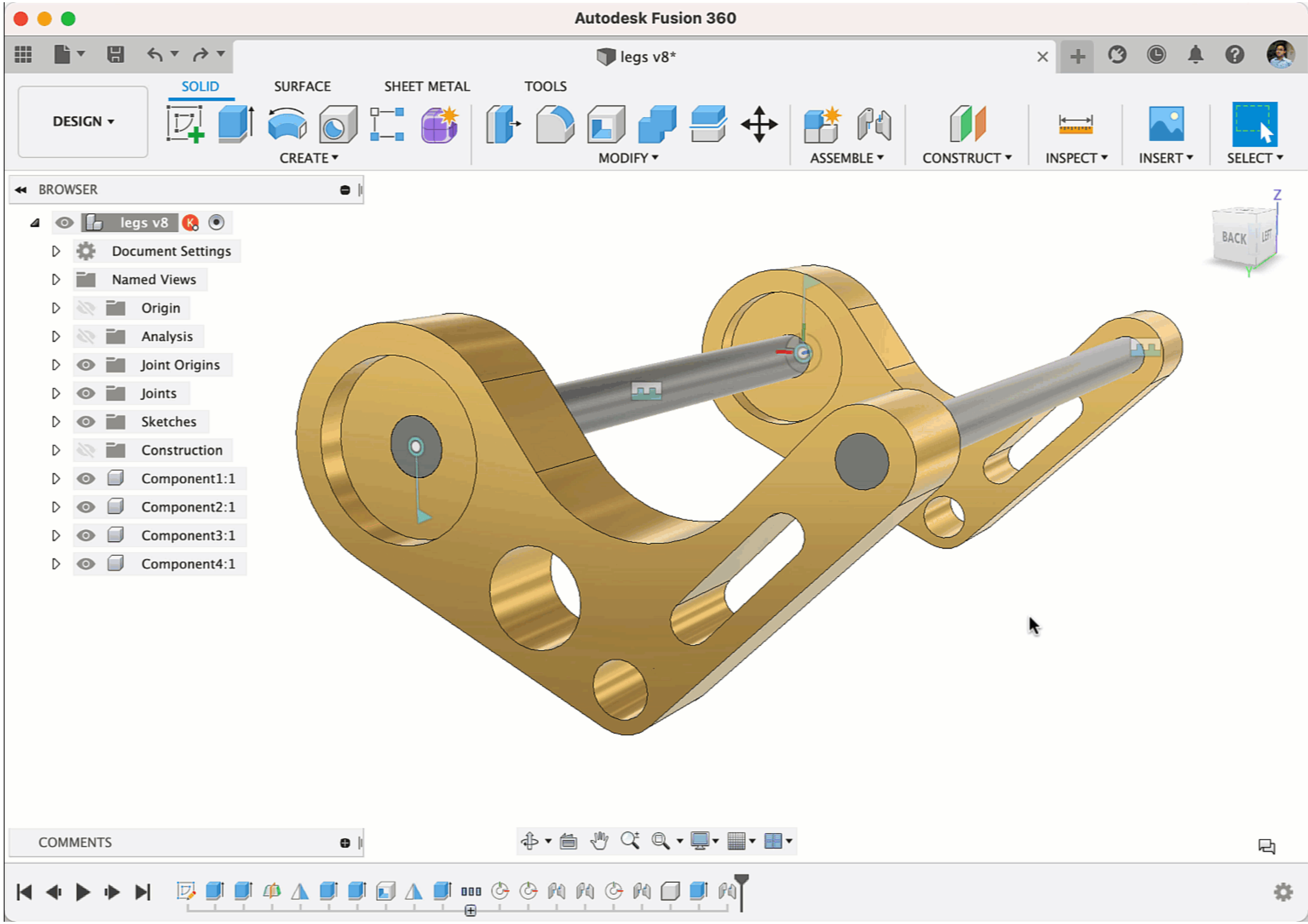
Learn

- Various interactive technologies
- Technologies behind the scene

- Hands-on building skills
- Build interactive gadgets

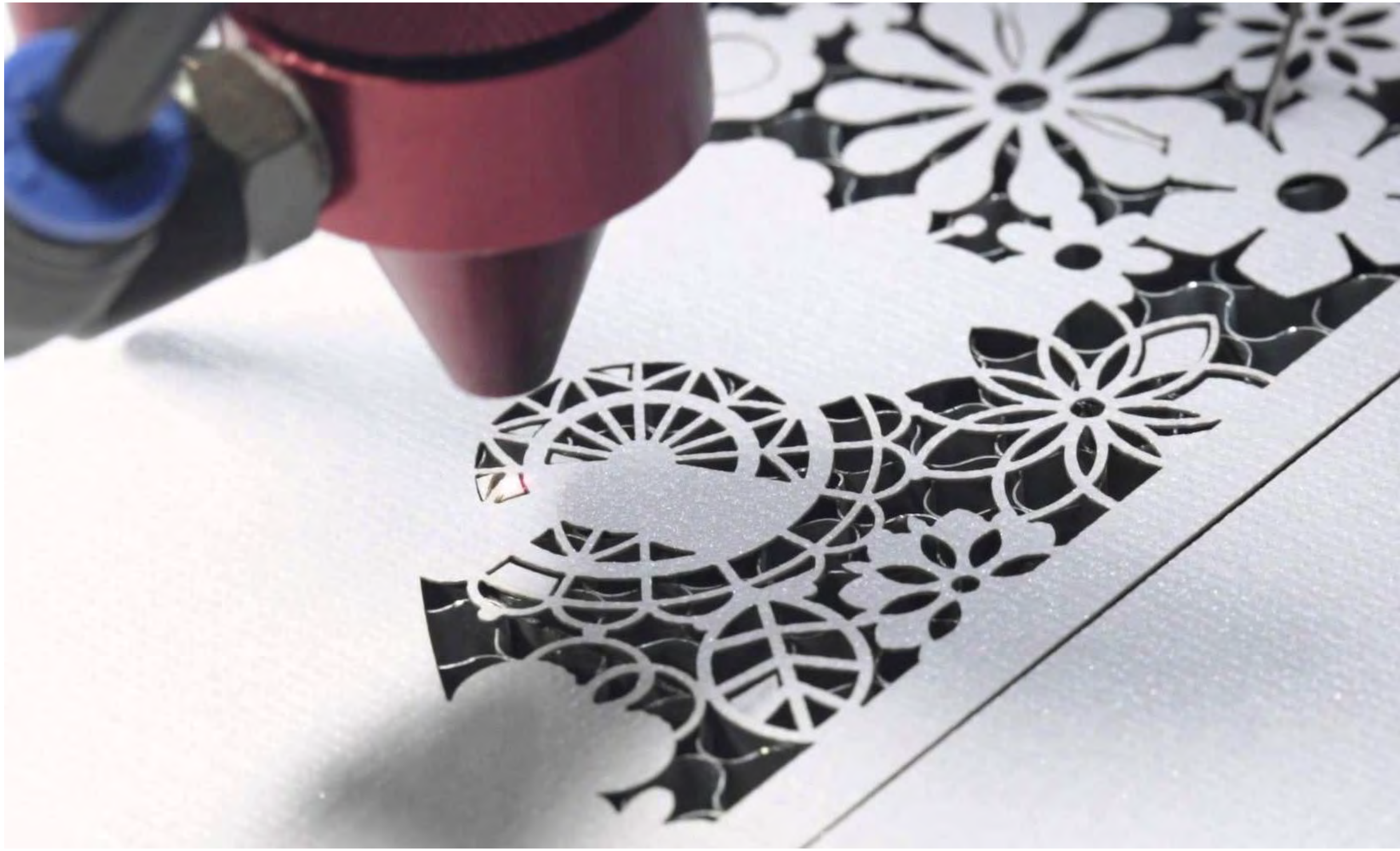


3D Modeling



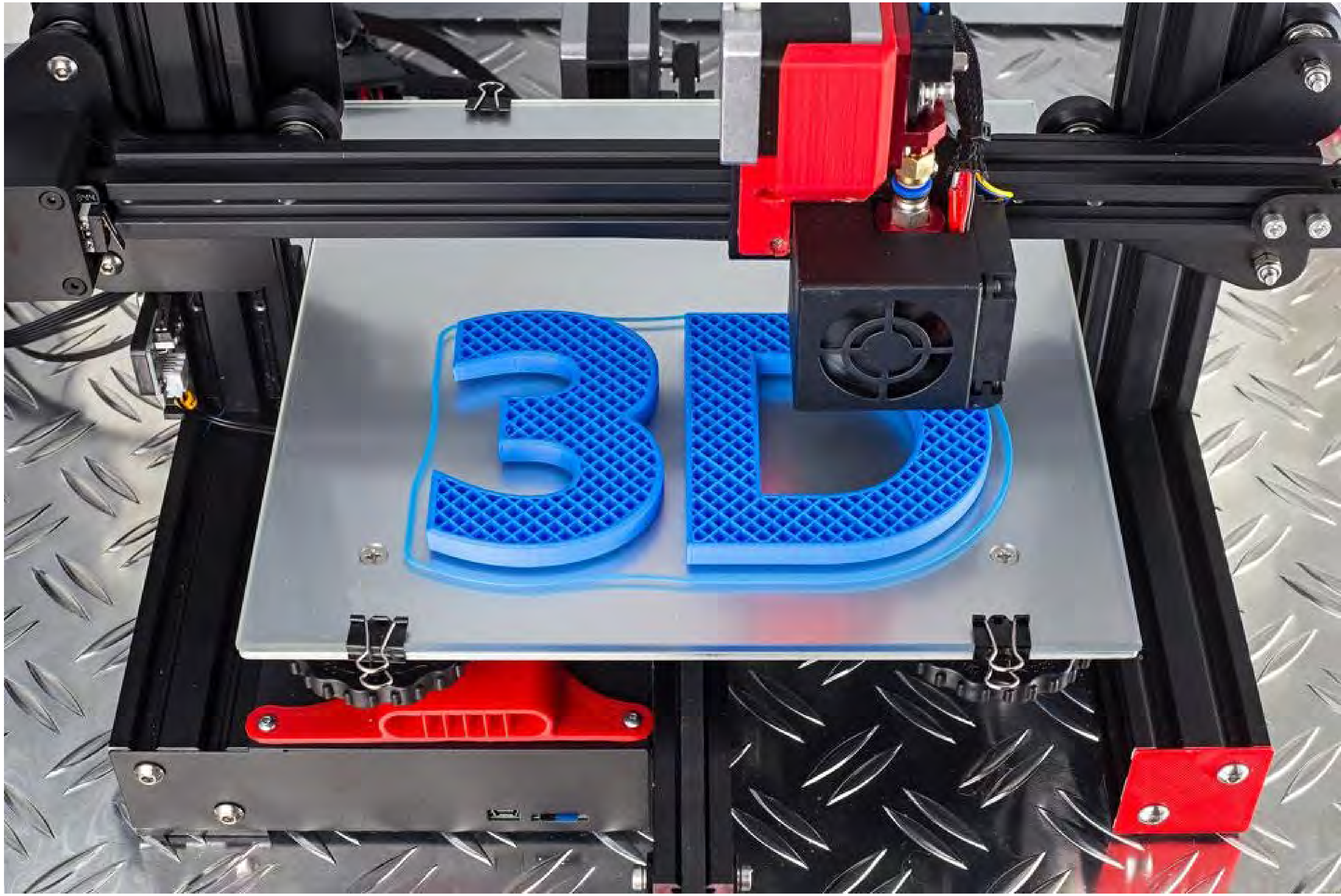
https://www.autodesk.com/products/fusion-360/blog/march-2021-product-update-whats-new/joint_new_position/

Laser cutting



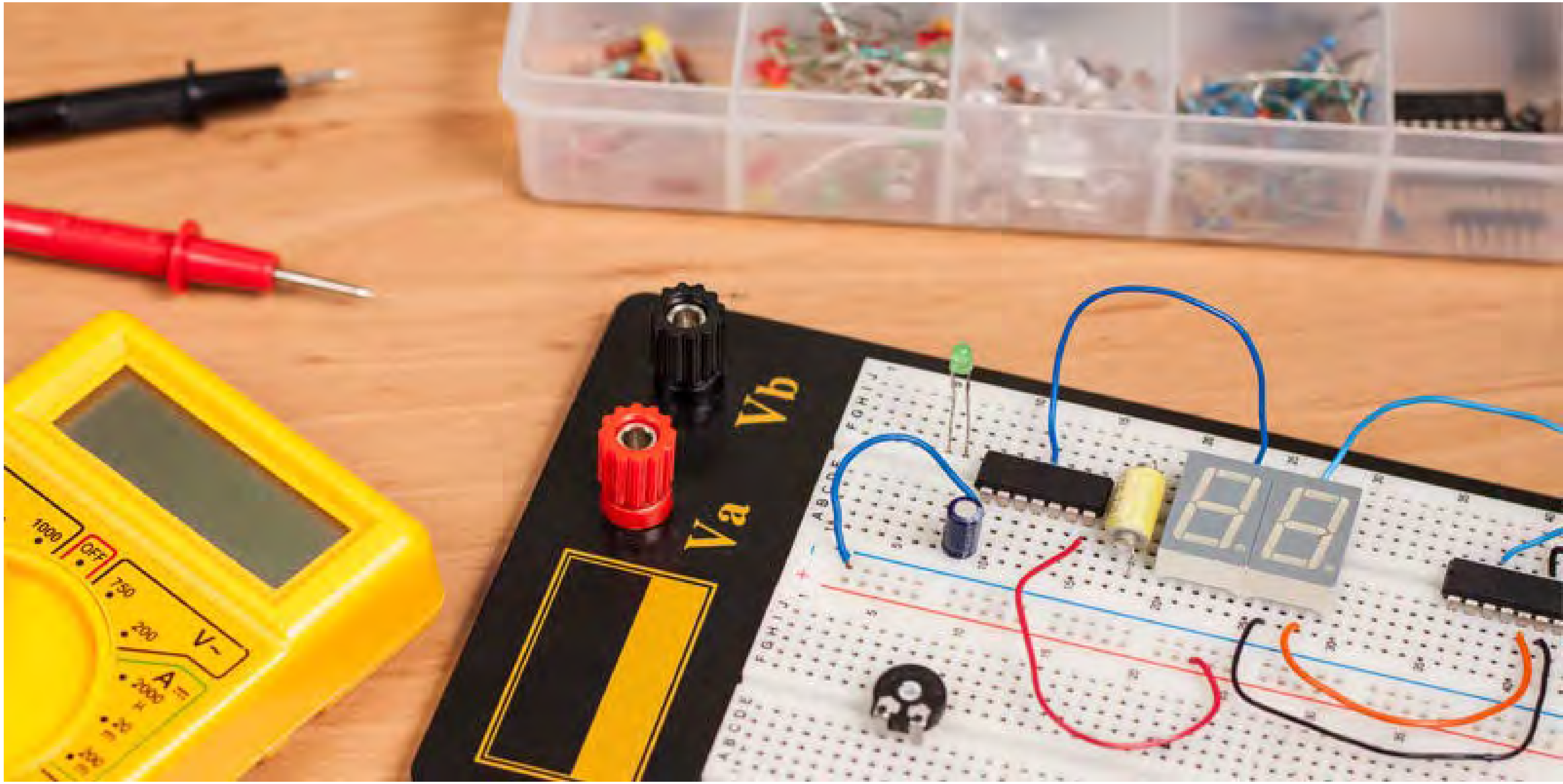
https://geekifyinc.com/services/laser-cutting/

3D Printing



https://www.forbes.com/sites/bernardmarr/2020/07/24/what-can-3d-printing-be-used-for-here-are-10-amazing-examples/?sh=2f19b9174d69

Electronics



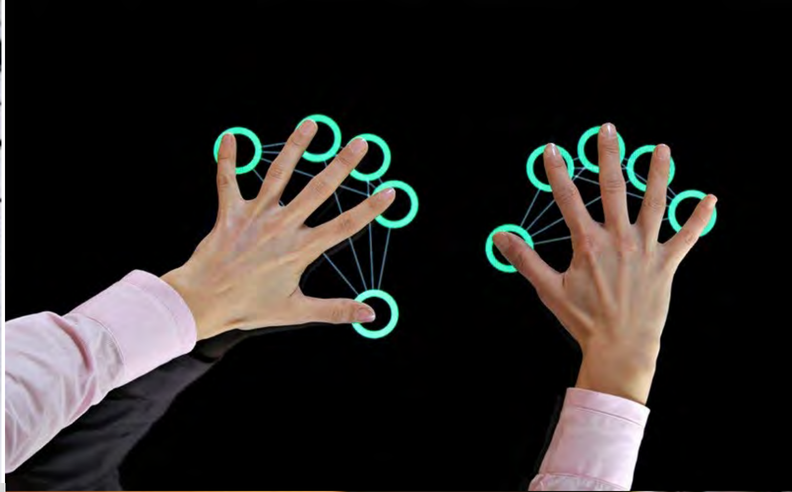
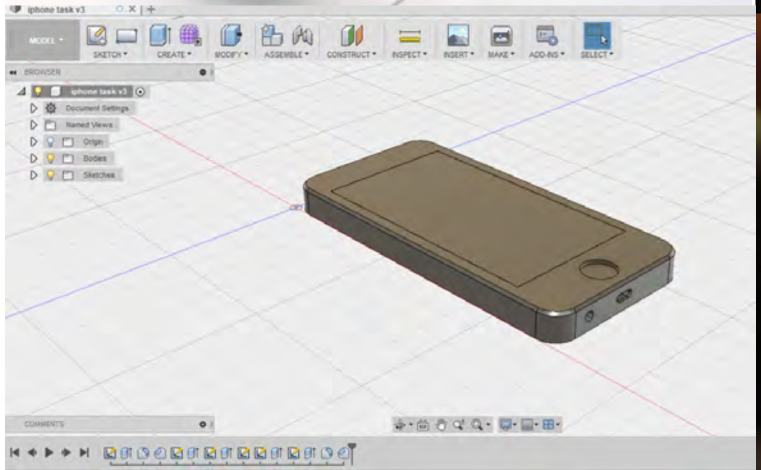
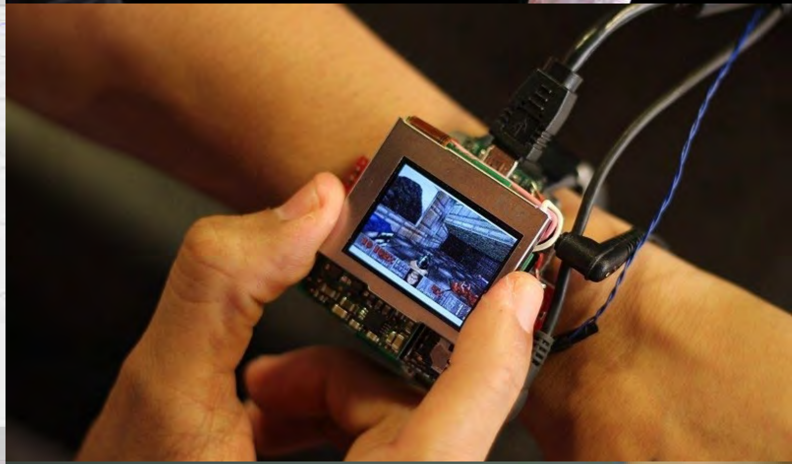
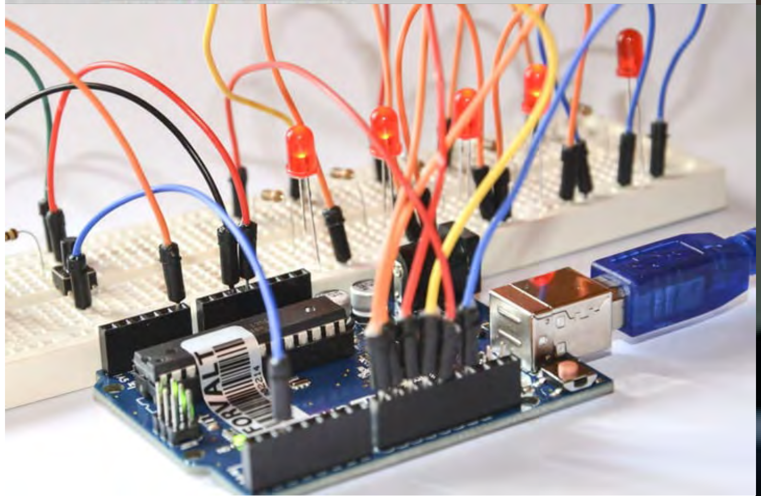
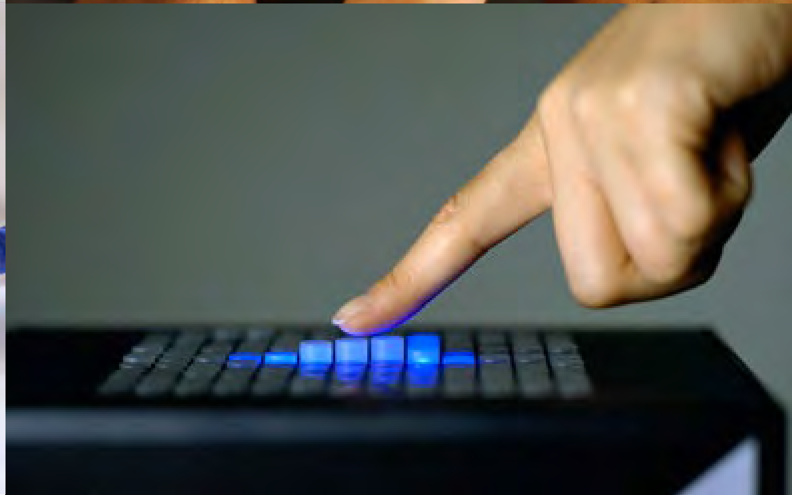
https://www.makerspaces.com/basic-electronics/

Learn

- Various interactive technologies
- Technologies behind the scene

- Hands-on building skills
- Build interactive gadgets

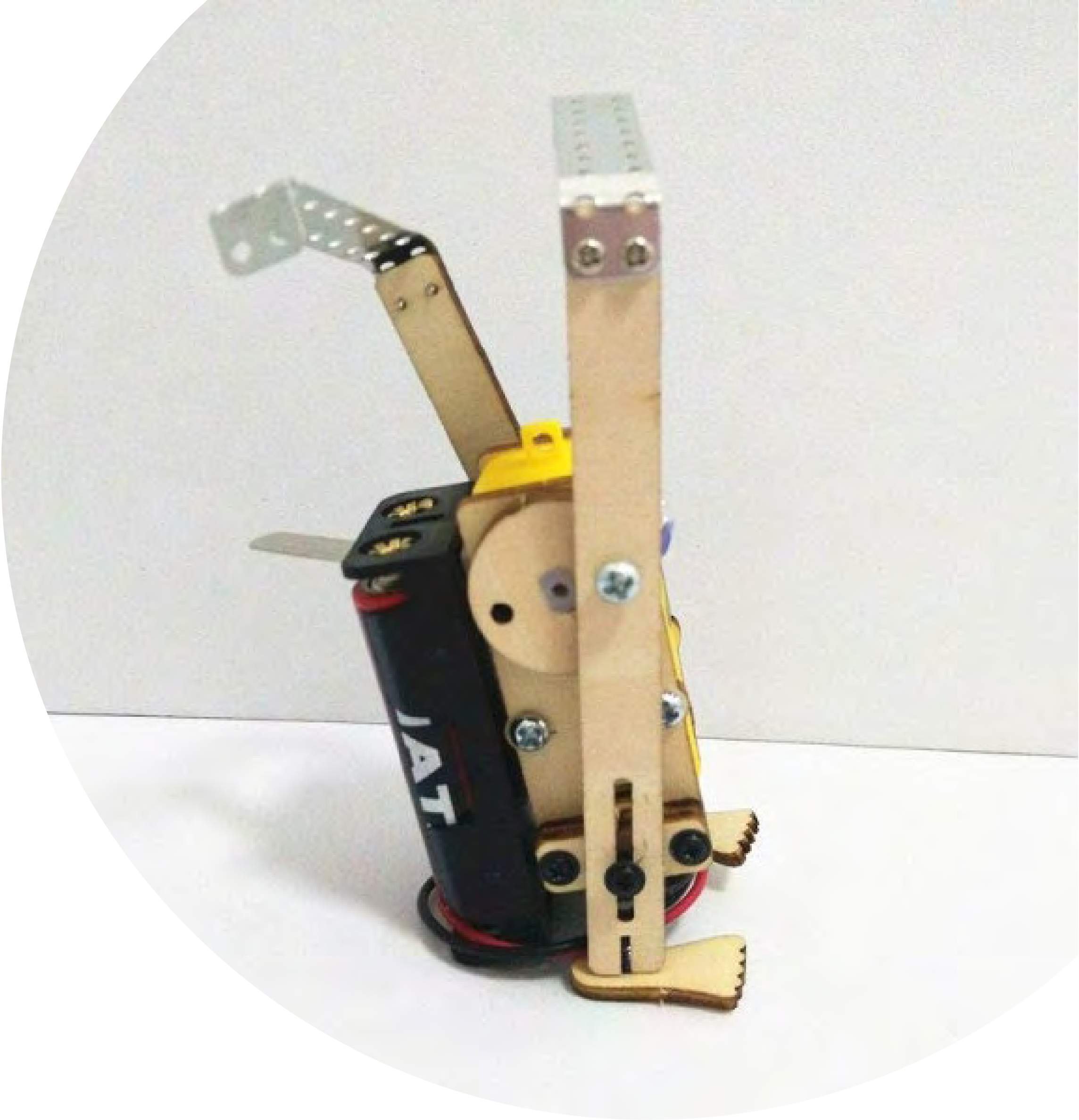
- Mini robot competition
- Semester-long team projects

Mini robot competition

A team of 2 people will build a pipe-climbing robot in the span of 3 weeks, and take part in a competition to see whose robot (climb to the tallest point of a pipe/overcome all the obstacles/is the fastest)

More to come once we go through most of the hands-on building components.



https://sciencealot.com/shop/rope-climbing-robot/

Semester-long team project

You – a group of four - will build
an **interactive** gadget/device/system/prototype
and present a **live** demo by the end of the semester

Semester-long team project

Requirement:

a) Involve both **hardware** + **software** components

b) Need to be **interactive**

c) Not strict replication – **novelty**

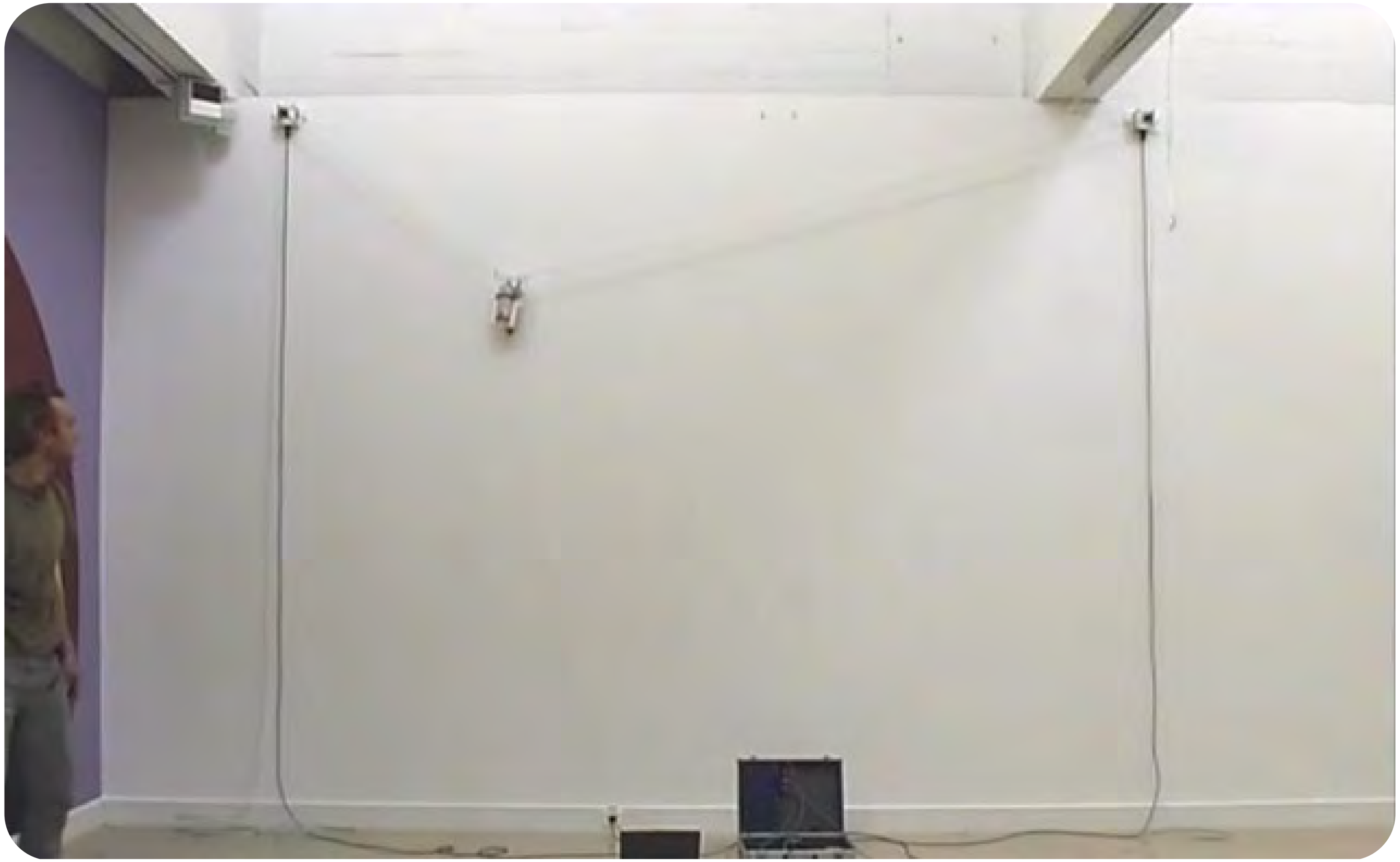
Semester-long team project

Deliveries:

a) Final project report written in the UIST paper format
(project descriptions + process + photos + drawings of the design)
b) Work-in-progress report
c) **Videos** on YouTube
d) Three milestone **presentations** (final presentation with **live** demo)

Possible topics

Drawing machine?



Jürg Lehni & Uli Franke 2002

Possible topics

Drawing machine?

MakrToolbox, 2017

Possible topics

Drawing machine?

le chocobot. Zhiyuan Teo, Jacqueline Chien, Xinyi Wang
Cornell INFO4320 Course Project 2014

Possible topics

Drawing machine?


Novel Hardware I — UIST'14, October 5–8, 2014, Honolulu, HI, USA

Graffiti Fur: Turning Your Carpet into a Computer Display

Yuta Sugiura[1], Koki Toda[1], Takayuki Hoshi[2], Youichi Kamiyama[1], Takeo Igarashi[3] and Masahiko Inami[1]

[1] Graduate School of Media Design, Keio University, 4-1-1 Hiyoshi, Kohoku, Yokohama, 223-8526 Japan
[2] Center for Innovative Young Researchers, Nagoya Institute of Technology, Gokiso, Showa, Nagoya, 466-8555 Japan
[3] Department of Computer Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo, 113-0033 Japan
{y-sugiura | kmd-std.8979 | kamiyama | inami}@kmd.keio.ac.jp, star@nitech.ac.jp, takeo@acm.org

ABSTRACT
We devised a display technology that utilizes the phenomenon whereby the shading properties of fur change as the fibers are raised or flattened. One can erase drawings by first flattening the fibers by sweeping the surface by hand in the fiber's growth direction, and then draw lines by raising the fibers by moving the finger in the opposite direction. These material properties can be found in various items such as carpets in our living environments. We have developed three different devices to draw patterns on a "fur display" utilizing this phenomenon: a roller device, a pen device and pressure projection device. Our technology can turn ordinary objects in our environment into rewritable displays without requiring or creating any non-reversible modifications to them. In addition, it can be used to present large-scale image without glare, and the images it creates require no running costs to maintain.

Author Keywords
Fur Display; BRDF; Living Environment;

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Computer displays play an important role in connecting the information world and the real world. In the era of ubiquitous computing, it is essential to be able to access information in a fluid way and non-obstructive integration of displays into our living environment is a basic requirement to achieve it. However, common displays such as LCDs are not ideal for continuous use in living environments; they occupy considerable space, emit glaring light that disturbs human vision and consume electric power.

Figure 1: The devices convert your carpet into a computer display.

On the other hand, projection-type displays are suitable for ubiquitous environments because they can project images onto any surface in the living environment [4, 12, 24]. Accordingly, the environment does not require large-scale modifications. In addition, it is possible to switch the projection rapidly and project colorful images. However, projectors have disadvantages. For example, the projected images cause glare and are hard to see in a bright room. In addition, the electricity costs of continuously projecting images are quite high.

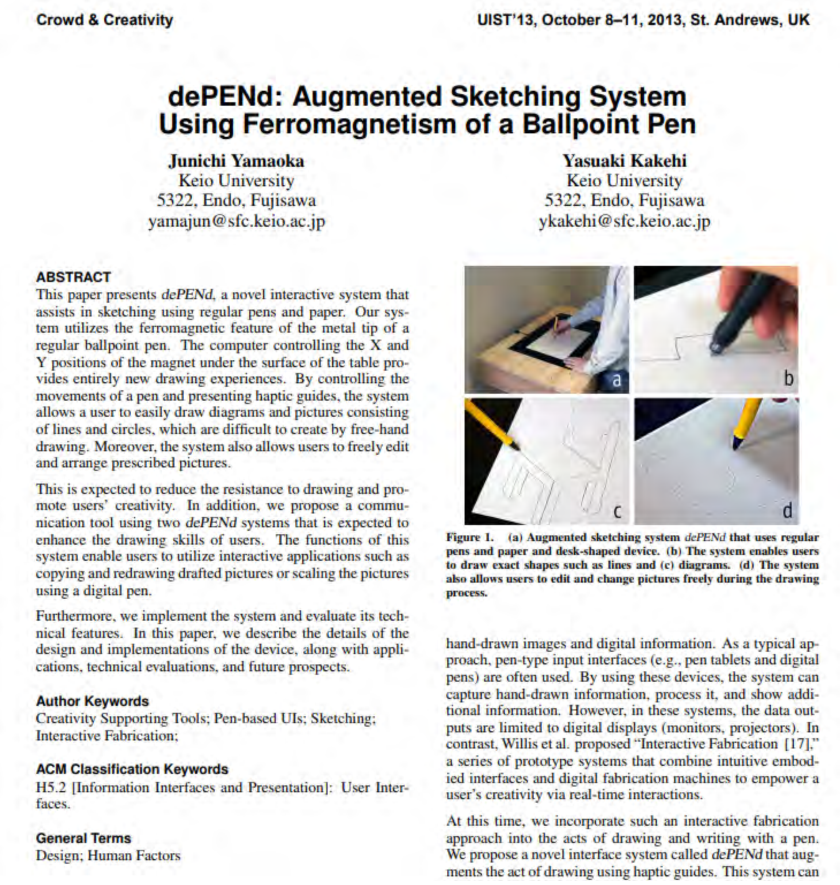
There have been many proposals and implementations of non-emissive displays that can easily be integrated into living environments without causing any glare, such as E-ink [1] and wooden displays [18]. They do not require

UIST 2014

Sugiura et.al.

Possible topics

Drawing machine?



dePENd: Augmented Sketching System Using Ferromagnetism of a Ballpoint Pen

Junichi Yamaoka
Keio University
5322, Endo, Fujisawa
yamajun@sfc.keio.ac.jp

Yasuaki Kakehi
Keio University
5322, Endo, Fujisawa
ykakehi@sfc.keio.ac.jp

ABSTRACT

This paper presents *dePENd*, a novel interactive system that assists in sketching using regular pens and paper. Our system utilizes the ferromagnetic feature of the metal tip of a regular ballpoint pen. The computer controlling the X and Y positions of the magnet under the surface of the table provides entirely new drawing experiences. By controlling the movements of a pen and presenting haptic guides, the system allows a user to easily draw diagrams and pictures consisting of lines and circles, which are difficult to create by free-hand drawing. Moreover, the system also allows users to freely edit and arrange prescribed pictures.

This is expected to reduce the resistance to drawing and promote users' creativity. In addition, we propose a communication tool using two *dePENd* systems that is expected to enhance the drawing skills of users. The functions of this system enable users to utilize interactive applications such as copying and redrawing drafted pictures or scaling the pictures using a digital pen.

Furthermore, we implement the system and evaluate its technical features. In this paper, we describe the details of the design and implementations of the device, along with applications, technical evaluations, and future prospects.

Author Keywords

Creativity Supporting Tools; Pen-based UIs; Sketching; Interactive Fabrication;

ACM Classification Keywords

H5.2 [Information Interfaces and Presentation]: User Interfaces.

General Terms

Design; Human Factors

Figure 1. (a) Augmented sketching system *dePENd* that uses regular pens and paper and desk-shaped device. (b) The system enables users to draw exact shapes such as lines and (c) diagrams. (d) The system also allows users to edit and change pictures freely during the drawing process.

hand-drawn images and digital information. As a typical approach, pen-type input interfaces (e.g., pen tablets and digital pens) are often used. By using these devices, the system can capture hand-drawn information, process it, and show additional information. However, in these systems, the data outputs are limited to digital displays (monitors, projectors). In contrast, Willis et al. proposed "Interactive Fabrication [17]," a series of prototype systems that combine intuitive embodied interfaces and digital fabrication machines to empower a user's creativity via real-time interactions.

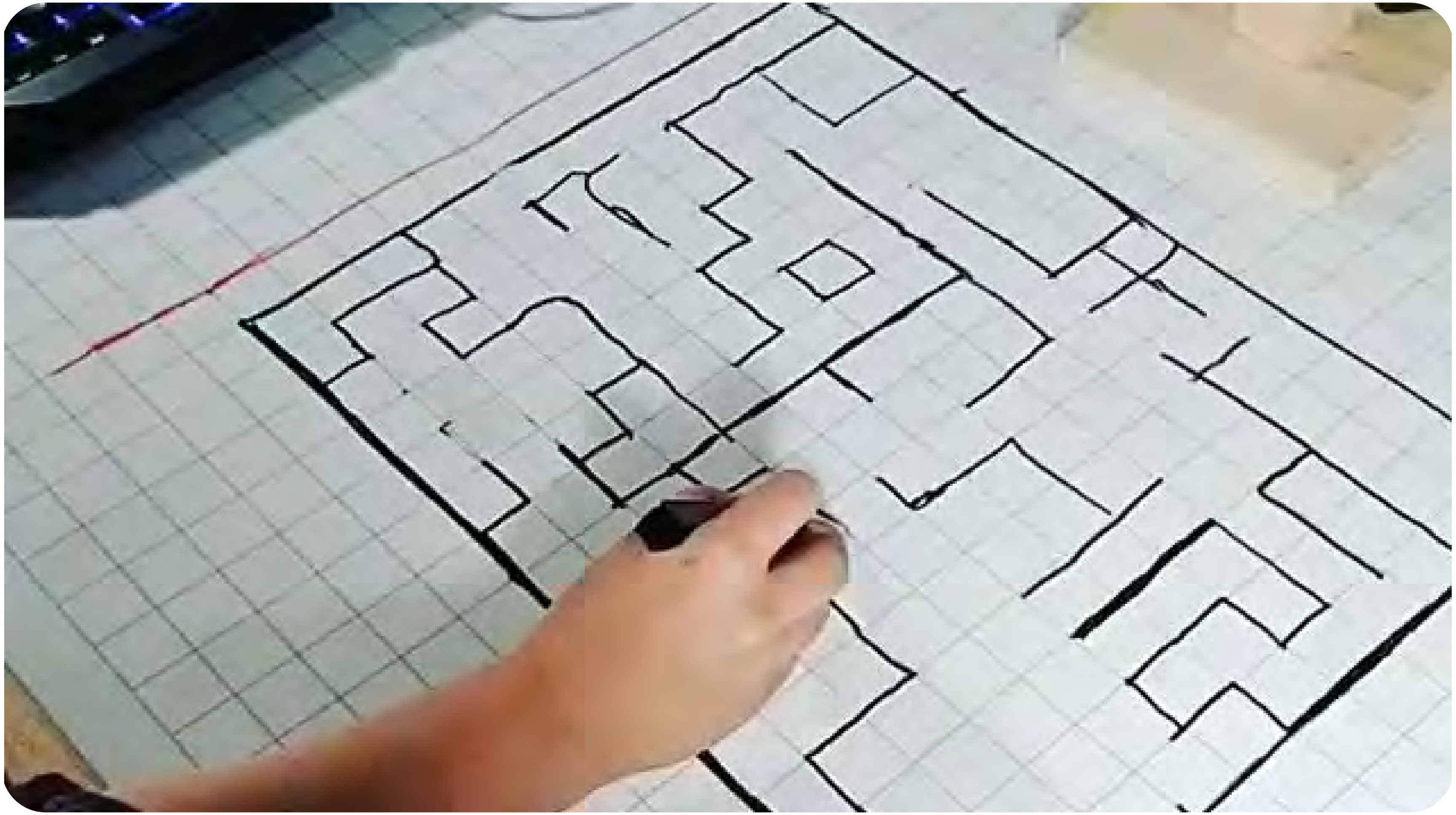
At this time, we incorporate such an interactive fabrication approach into the acts of drawing and writing with a pen. We propose a novel interface system called *dePENd* that augments the act of drawing using haptic guides. This system can

UIST 2013

Yamaoka et.al.

Possible topics

XR?



Virtual maze. Wylie Wells, and Brandon Boylan-Peck
Course Project@CU Boulder with Prof. Daniel Leithinger, 2018

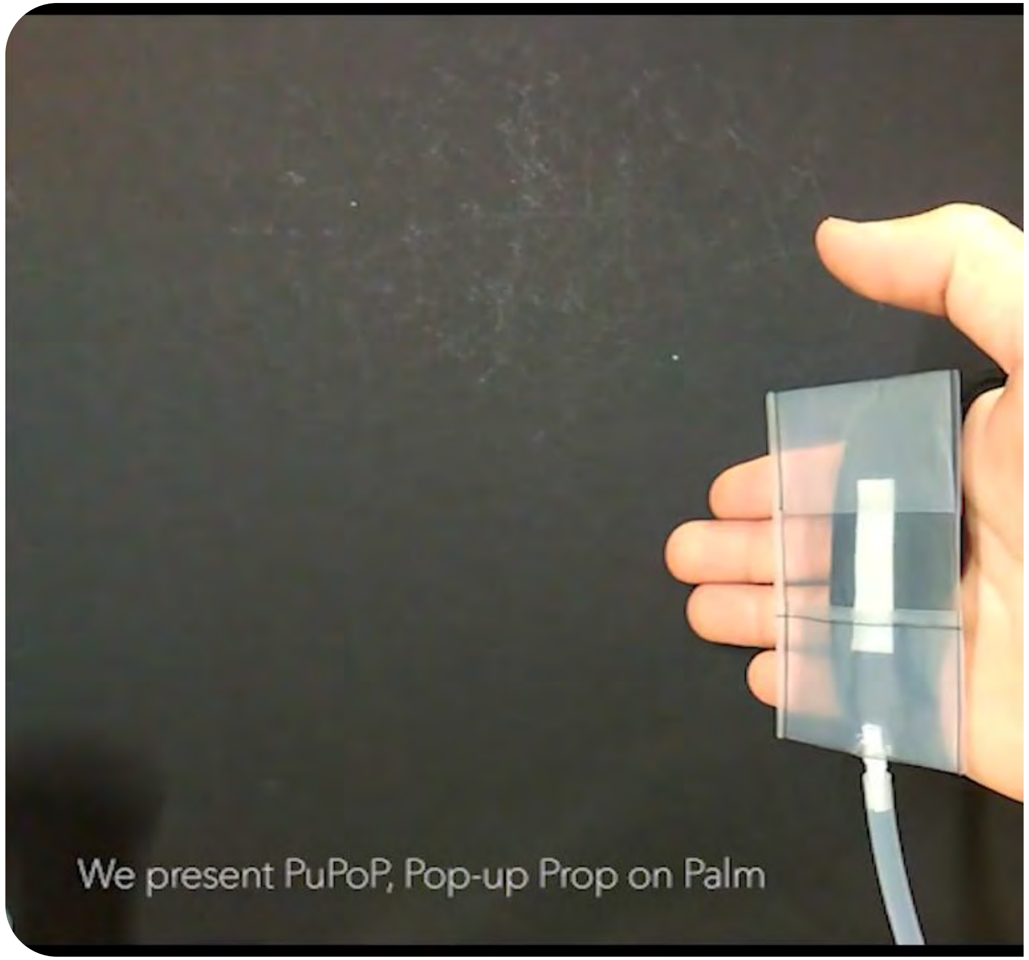
Possible topics

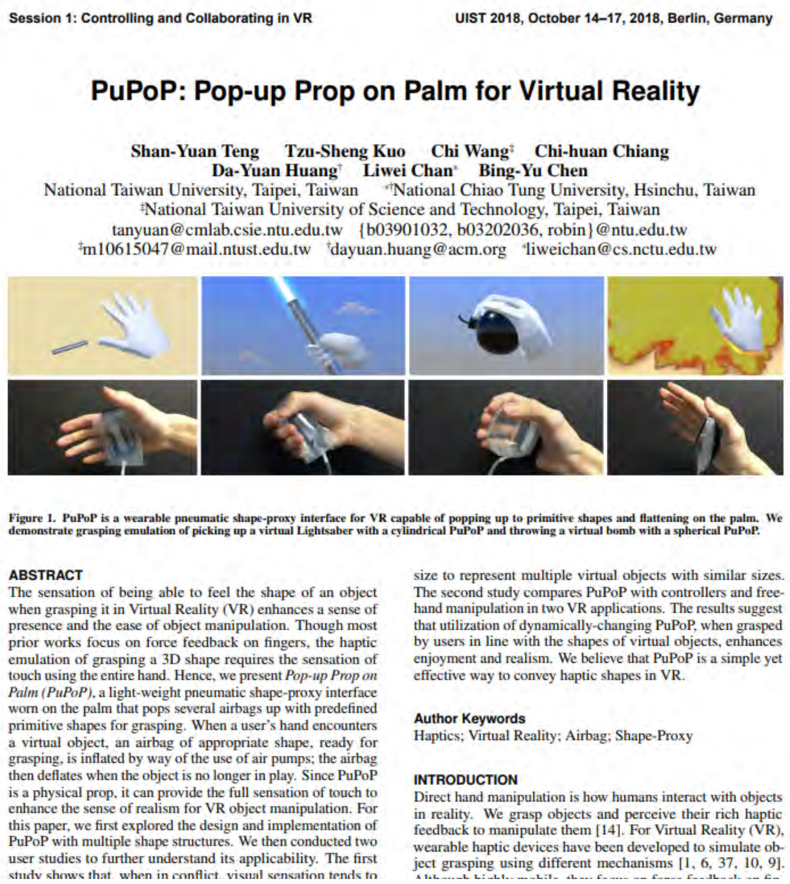
XR?

Flying simulator with haptic feedback. Cade Haley, Madison Razook and Kyle Gronberg
Course Project@CU Boulder with Prof. Daniel Leithinger, 2018

Possible topics

XR?





PuPoP: Pop-up Prop on Palm for Virtual Reality

Shan-Yuan Teng Tzu-Sheng Kuo Chi Wang[‡] Chi-huan Chiang
Da-Yuan Huang[†] Liwei Chan[*] Bing-Yu Chen
National Taiwan University, Taipei, Taiwan [*†]National Chiao Tung University, Hsinchu, Taiwan
[‡]National Taiwan University of Science and Technology, Taipei, Taiwan
tanyuan@cmlab.csie.ntu.edu.tw {b03901032, b03202036, robin}@ntu.edu.tw
[‡]m10615047@mail.ntust.edu.tw [†]dayuan.huang@acm.org [*]liweichan@cs.nctu.edu.tw

Figure 1. PuPoP is a wearable pneumatic shape-proxy interface for VR capable of popping up to primitive shapes and flattening on the palm. We demonstrate grasping emulation of picking up a virtual Lightsaber with a cylindrical PuPoP and throwing a virtual bomb with a spherical PuPoP.

ABSTRACT
The sensation of being able to feel the shape of an object when grasping it in Virtual Reality (VR) enhances a sense of presence and the ease of object manipulation. Though most prior works focus on force feedback on fingers, the haptic emulation of grasping a 3D shape requires the sensation of touch using the entire hand. Hence, we present *Pop-up Prop on Palm (PuPoP)*, a light-weight pneumatic shape-proxy interface worn on the palm that pops several airbags up with predefined primitive shapes for grasping. When a user's hand encounters a virtual object, an airbag of appropriate shape, ready for grasping, is inflated by way of the use of air pumps; the airbag then deflates when the object is no longer in play. Since PuPoP is a physical prop, it can provide the full sensation of touch to enhance the sense of realism for VR object manipulation. For this paper, we first explored the design and implementation of PuPoP with multiple shape structures. We then conducted two user studies to further understand its applicability. The first study shows that, when in conflict, visual sensation tends to ... size to represent multiple virtual objects with similar sizes. The second study compares PuPoP with controllers and free-hand manipulation in two VR applications. The results suggest that utilization of dynamically-changing PuPoP, when grasped by users in line with the shapes of virtual objects, enhances enjoyment and realism. We believe that PuPoP is a simple yet effective way to convey haptic shapes in VR.

Author Keywords
Haptics; Virtual Reality; Airbag; Shape-Proxy

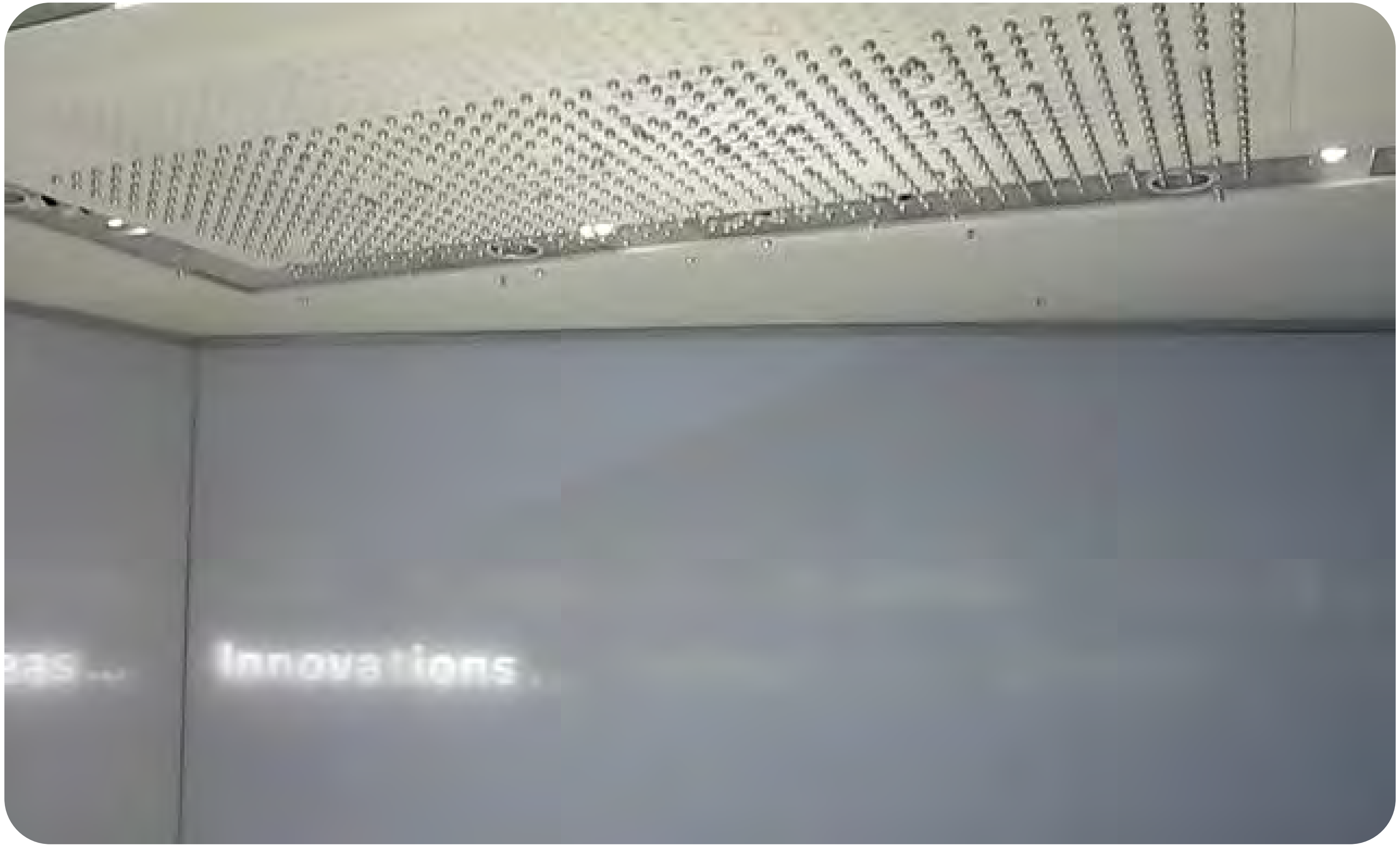
INTRODUCTION
Direct hand manipulation is how humans interact with objects in reality. We grasp objects and perceive their rich haptic feedback to manipulate them [14]. For Virtual Reality (VR), wearable haptic devices have been developed to simulate object grasping using different mechanisms [1, 6, 37, 10, 9].

UIST 2018

Teng et.al.

Possible topics

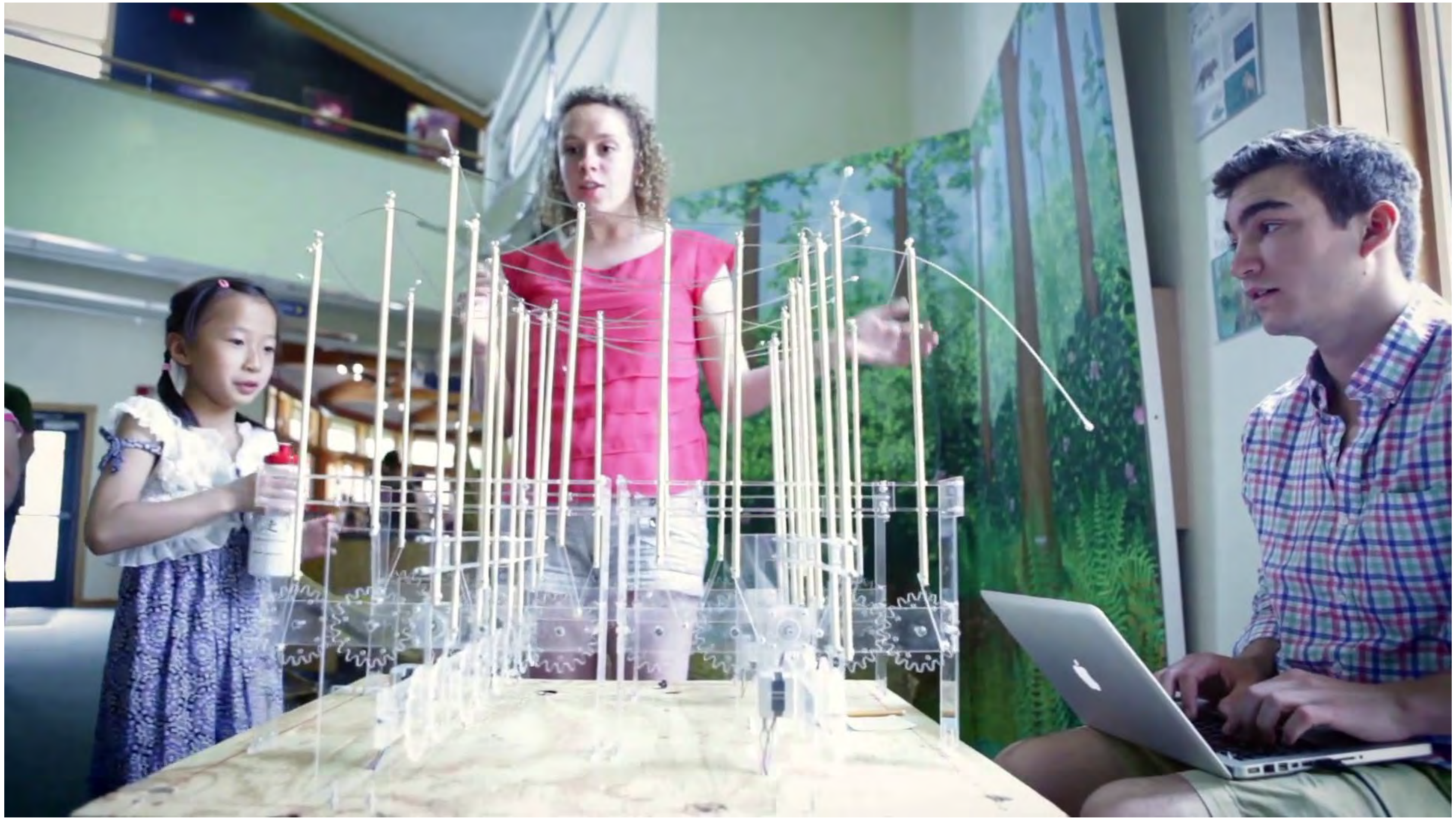
Kinetic Display?



Kinetic Sculpture BMW. JOACHIM SAUTER
2008

Possible topics

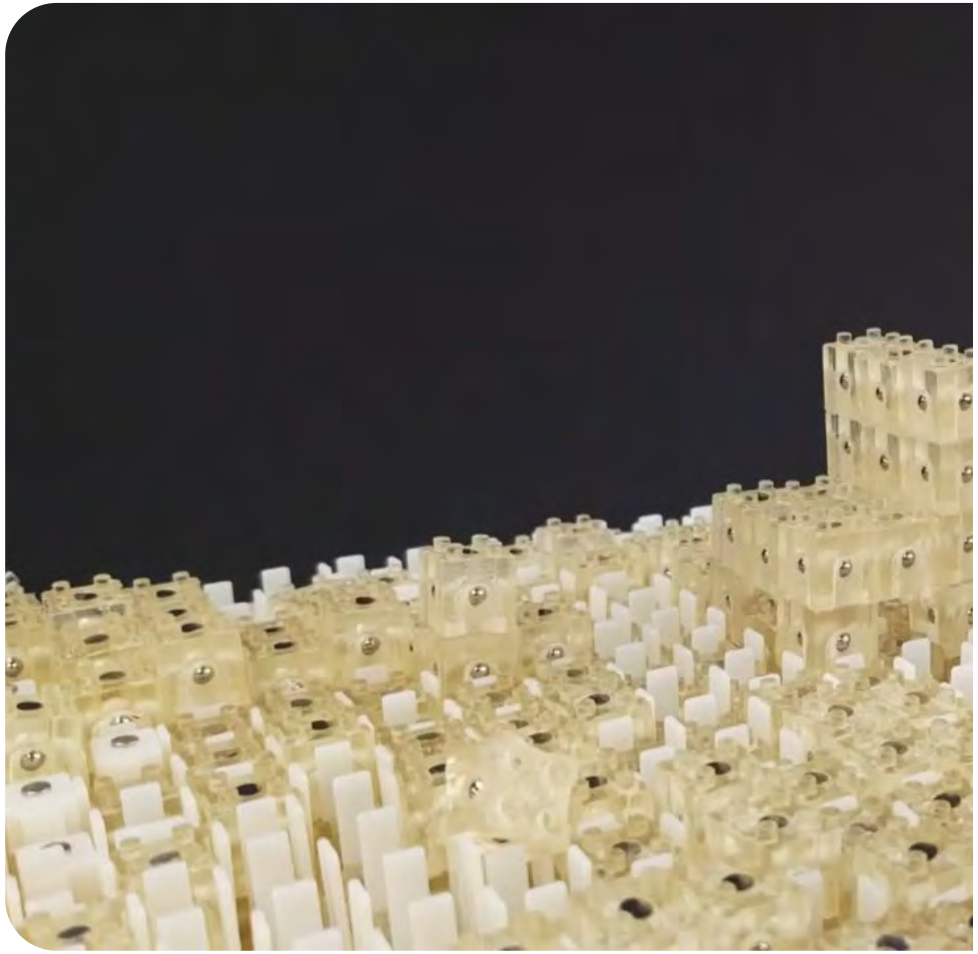
Kinetic Display?

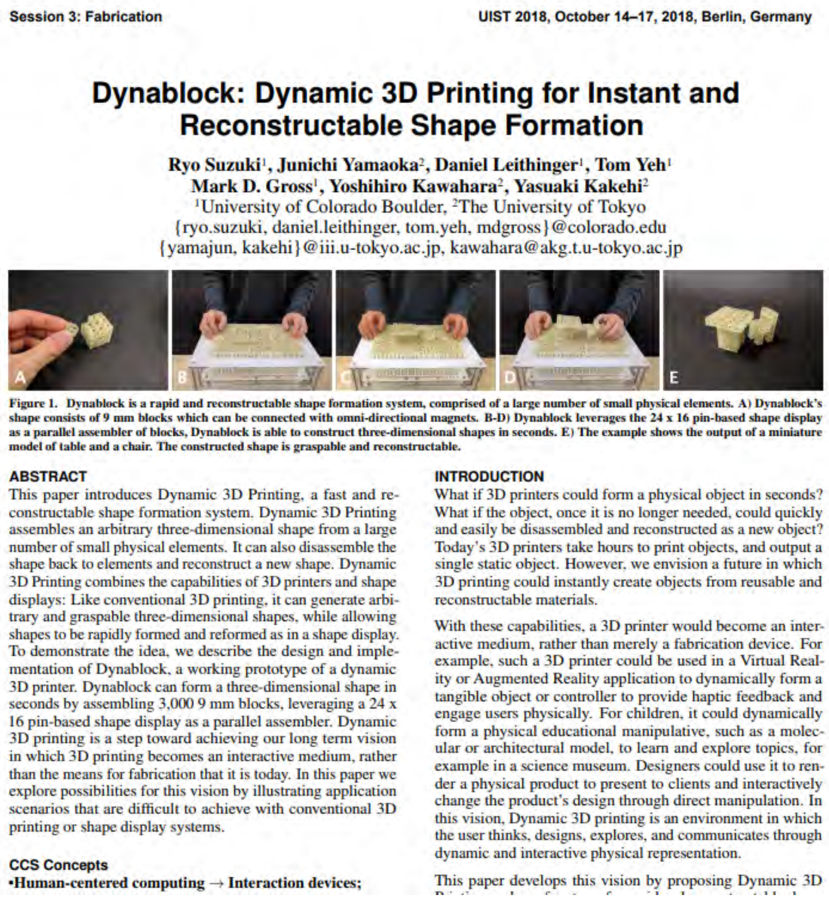


Kinetic Sculpture. Megan Baker, Andrea Cameron and Aleksey Polesskiy.
Cornell INFO4320 Course Project 2014

Possible topics

Kinetic Display?





Dynablock: Dynamic 3D Printing for Instant and Reconstructable Shape Formation

Ryo Suzuki[1], Junichi Yamaoka[2], Daniel Leithinger[1], Tom Yeh[1]
Mark D. Gross[1], Yoshihiro Kawahara[2], Yasuaki Kakehi[2]
[1]University of Colorado Boulder, [2]The University of Tokyo
{ryo.suzuki, daniel.leithinger, tom.yeh, mdgross}@colorado.edu
{yamajun, kakehi}@iii.u-tokyo.ac.jp, kawahara@akg.t.u-tokyo.ac.jp

Figure 1. Dynablock is a rapid and reconstructable shape formation system, comprised of a large number of small physical elements. A) Dynablock's shape consists of 9 mm blocks which can be connected with omni-directional magnets. B-D) Dynablock leverages the 24 x 16 pin-based shape display as a parallel assembler of blocks, Dynablock is able to construct three-dimensional shapes in seconds. E) The example shows the output of a miniature model of table and a chair. The constructed shape is graspable and reconstructable.

ABSTRACT

This paper introduces Dynamic 3D Printing, a fast and reconstructable shape formation system. Dynamic 3D Printing assembles an arbitrary three-dimensional shape from a large number of small physical elements. It can also disassemble the shape back to elements and reconstruct a new shape. Dynamic 3D Printing combines the capabilities of 3D printers and shape displays: Like conventional 3D printing, it can generate arbitrary and graspable three-dimensional shapes, while allowing shapes to be rapidly formed and reformed as in a shape display. To demonstrate the idea, we describe the design and implementation of Dynablock, a working prototype of a dynamic 3D printer. Dynablock can form a three-dimensional shape in seconds by assembling 3,000 9 mm blocks, leveraging a 24 x 16 pin-based shape display as a parallel assembler. Dynamic 3D printing is a step toward achieving our long term vision in which 3D printing becomes an interactive medium, rather than the means for fabrication that it is today. In this paper we explore possibilities for this vision by illustrating application scenarios that are difficult to achieve with conventional 3D printing or shape display systems.

CCS Concepts

•Human-centered computing → Interaction devices;

INTRODUCTION

What if 3D printers could form a physical object in seconds? What if the object, once it is no longer needed, could quickly and easily be disassembled and reconstructed as a new object? Today's 3D printers take hours to print objects, and output a single static object. However, we envision a future in which 3D printing could instantly create objects from reusable and reconstructable materials.

With these capabilities, a 3D printer would become an interactive medium, rather than merely a fabrication device. For example, such a 3D printer could be used in a Virtual Reality or Augmented Reality application to dynamically form a tangible object or controller to provide haptic feedback and engage users physically. For children, it could dynamically form a physical educational manipulative, such as a molecular or architectural model, to learn and explore topics, for example in a science museum. Designers could use it to render a physical product to present to clients and interactively change the product's design through direct manipulation. In this vision, Dynamic 3D printing is an environment in which the user thinks, designs, explores, and communicates through dynamic and interactive physical representation.

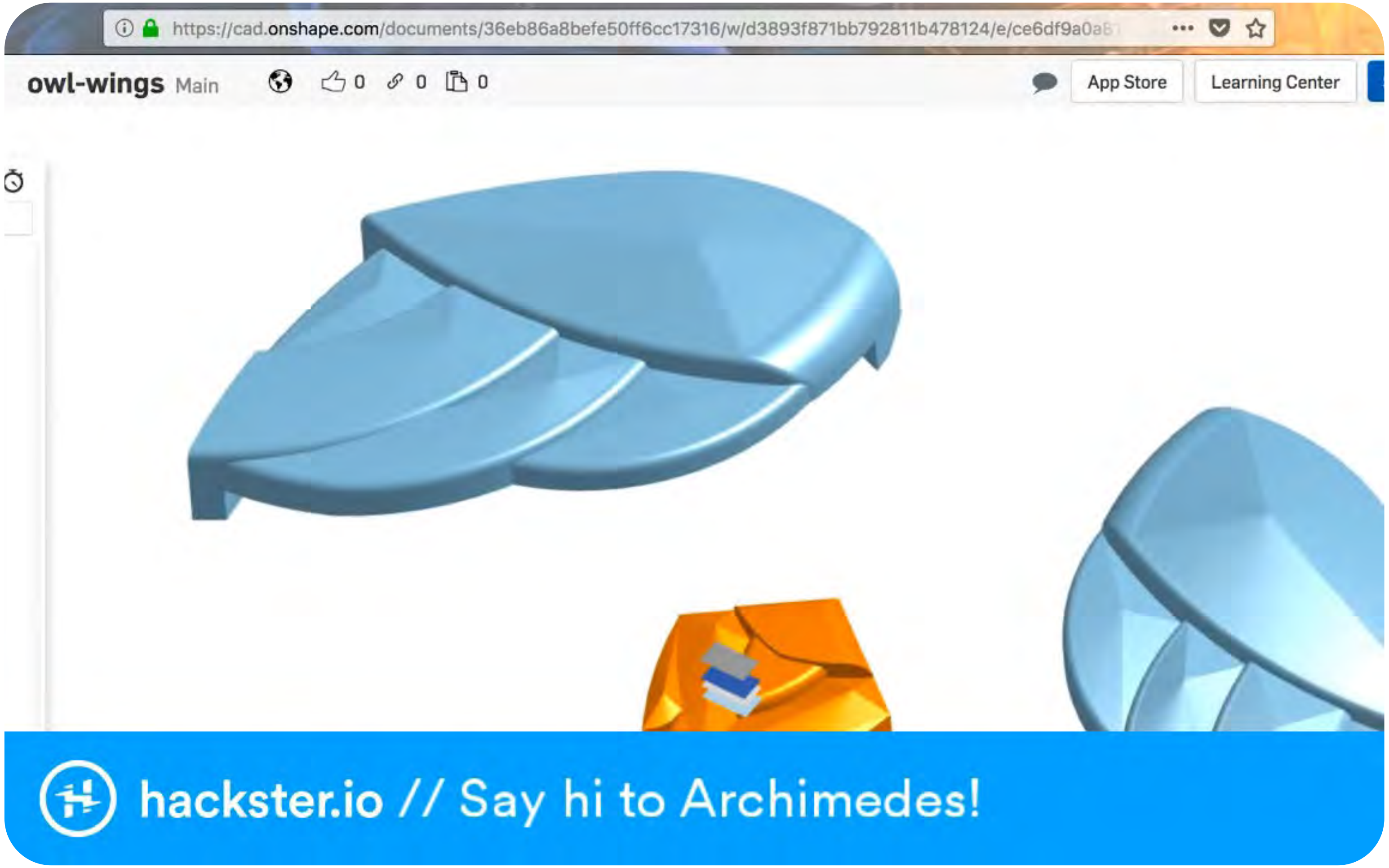
This paper develops this vision by proposing Dynamic 3D

UIST 2018

Suzuki et.al.

Possible topics

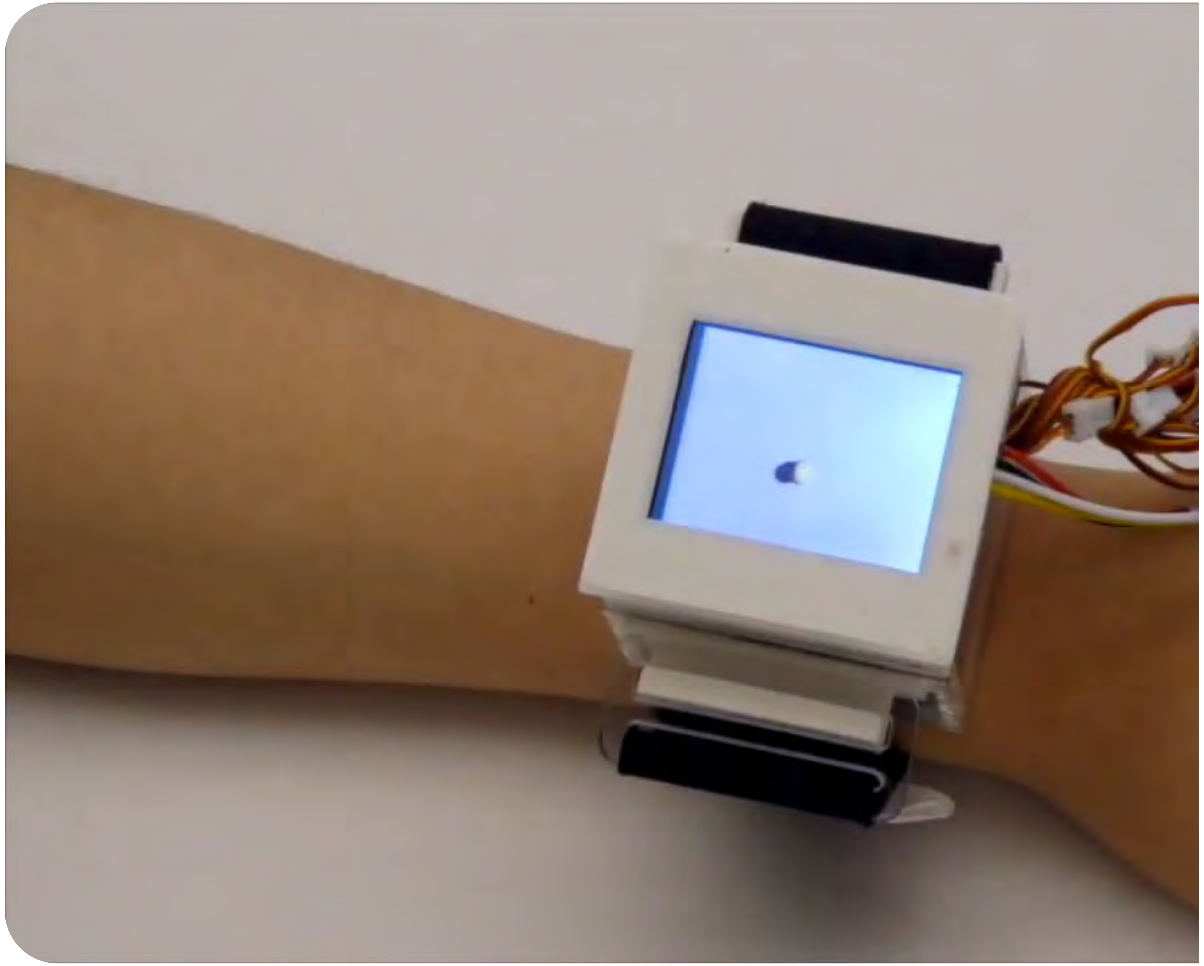
Wearables?



Archimedes: The AI Robot Owl.
Alex Glow.
2018

Possible topics

Wearables?



RetroShape: Leveraging Rear-Surface Shape Displays for 2.5D Interaction on Smartwatches

Da-Yuan Huang[1,2], Ruizhen Guo[1], Jun Gong[1], Jingxian Wang[1,4], John Graham[1], De-Nian Yang[3], Xing-Dong Yang[1]
Dartmouth College[1], NTUST[2], Academia Sinica[3], Carnegie Mellon University[4]
{ruizhen.guo.gr; jun.gong.gr; jack.m.graham.iii.gr; xing-dong.yang}@dartmouth.edu
dayuan.huang@csie.ntust.edu.tw, dnyang@iis.sinica.edu.tw, jingxian@cmu.edu

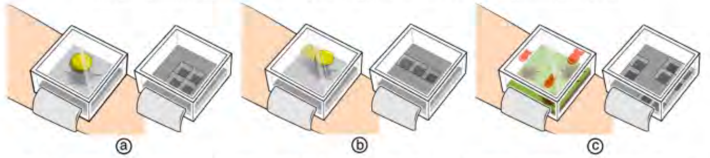


Figure 1. RetroShape aims to extend the visual scene to 2.5D physical space by a deformable display on its rear surface. Our RetroShape prototype equips 4×4 taxels, which can simulate (a) a bouncing ball on an elastic surface, (b) ball rolling, or (c) multiple strikes on the ground.

ABSTRACT

The small screen size of a smartwatch limits user experience when watching or interacting with media. We propose a supplementary tactile feedback system to enhance the user experience with a method unique to the smartwatch form factor. Our system has a deformable surface on the back of the watch face, allowing the visual scene on screen to extend into 2.5D physical space. This allows the user to watch and feel virtual objects, such as experiencing a ball bouncing against the wrist. We devised two controlled experiments to analyze the influence of tactile display resolution on the illusion of virtual object presence. Our first study revealed that on average, a taxel can render virtual objects between 70% and 138% of its own size without shattering the illusion. From the second study, we found visual and haptic feedback can be separated by 4.5mm to 16.2mm for the tested taxels. Based on the results, we developed a prototype (called RetroShape) with 4×4 10mm taxels using micro servo motors, and demonstrated its unique capability through a set of tactile-enhanced games and videos. A preliminary user evaluation showed that participants welcome RetroShape as a

Author Keywords

Mobile haptics; Shape-changing display; Taxel; Smartwatch

ACM Classification Keywords

H.5.2. [Information interfaces and presentation]: User Interfaces – Haptic I/O

INTRODUCTION

Smartwatches provide quick access to short-time entertainment applications, especially when users are on-the-move, e.g. in a bus or train. However, user experience in such applications is limited due to the small screen area and limited input and output options. While smartwatch visual and auditory technologies have improved substantially, the potential of smartwatch-enabled haptics in video and game applications remains to be exploited.

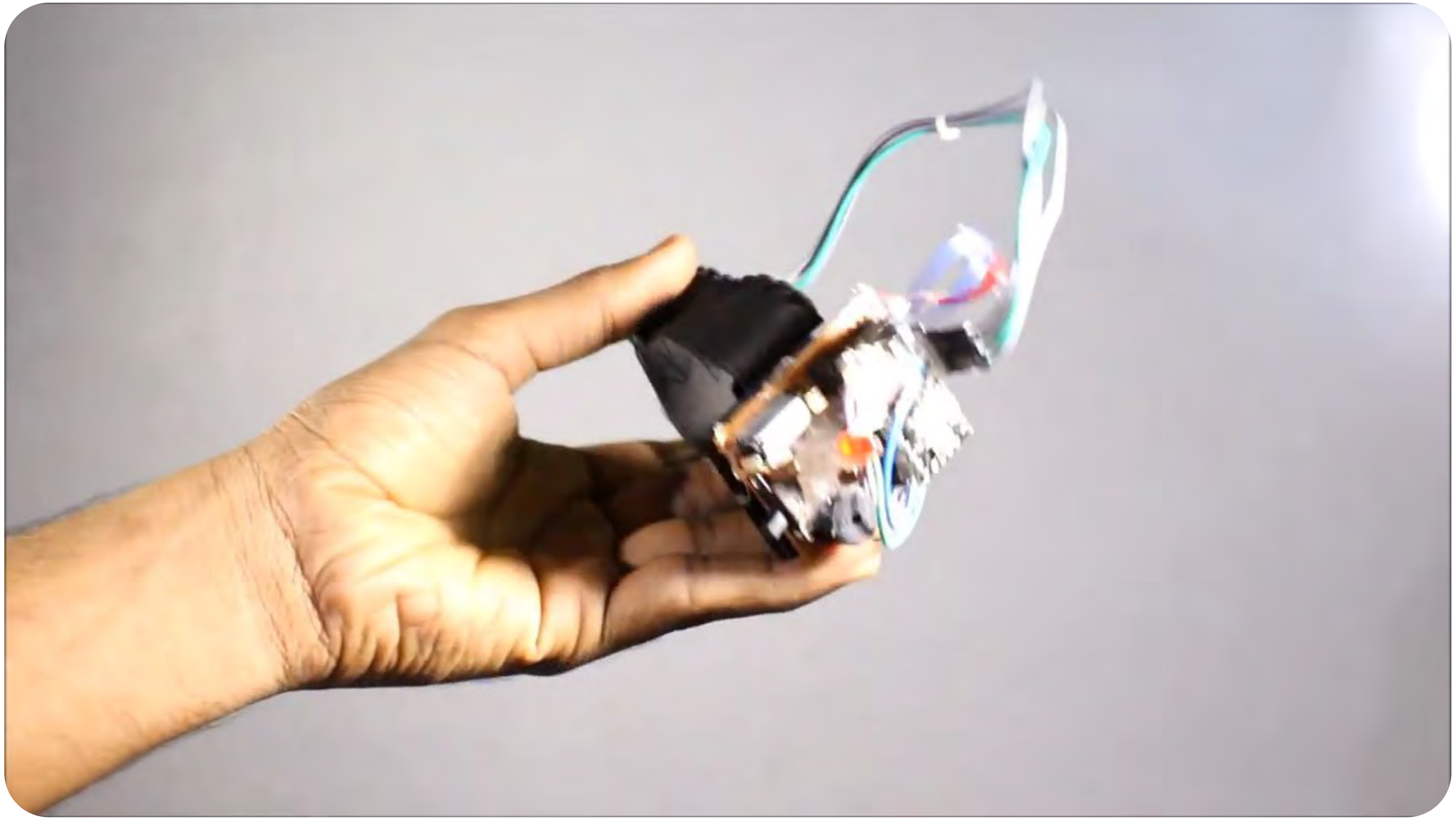
We leverage the user's skin under the watch face for sensing haptic output with collocated visual content. Our approach enhances the viewing experience on a smartwatch using a shape-changing tactile display on the rear surface of the smartwatch. Each pixel on the screen has a corresponding tactile pixel (or *taxel*) on the back of the watch face, allowing

UIST 2017

Huang et.al.

Possible topics

Accessible tech?



Third Eye for the Blind. RobotechMaker. 2017

Possible topics

Accessible tech?

Xbox Adaptive Controller

Possible topics

Accessible tech?

Eye Play the Piano

From the students

Drawing Beyond Touch: A Multi-user Collaborative Drawing System

Group 9

Biao Jia, Yue Jiang, Zehua Zeng, Yuheng Lu


LANDFILL
terpsrecycle
RECYCLING


BROOKLYN
NYC
pozyx

MaSketch

Andreas Verdelis, Kelsey Rassmann, Samuel Lam,
Srivatsan Srinivasan, and Sumbul Zehra

Semester-long team project

Requirement:

a) Involve both **hardware** + **software** components
b) Need to be **interactive**
c) Not strict replication – **novelty**
d) In one of the following topics: Wearable/Accessibility/XR/Fabrication/Art Installation

We will cover basic techniques, but you will most likely to **learn many new skills yourself**

Don’t be afraid of making mistakes,
TA and I are here to help

That’s all very exciting but…

how much will it cost?

Do I need to pay a material fee?

Material fee

~~We charge you $30 material fee~~

Material fee

Gift from Brin Family
(If you don’t know who he is, **google** it)

Material fee

We will provide you $**30-worth** basic electronic components

Each **team** will also receive up-to $**50** project budget (and you can recycle components from your individual parts)

Addition devices you can use from the SMART lab:

1 raspberry pi 4

2 snaptchat spectacles 4 AR glasses

1 4DOF basic robotic arm toy

360 Degree 12 Meters Scanning
Radius LIDAR

If your team project require something beyond the budget, talk to me

I will purchase it can be reused for future classes

If all sounds good ->
Declare your group by **Mon next week**

Find your peers here:
piazza.com/umd/fall2022/cmsc730

Class website

CMSC730

- Home
- Schedule
- Syllabus

Welcome!

This is a graduate-level, research-oriented course covering broad areas of interactive technology and human-computer interaction (HCI) topics, *e.g.*, ubiquitous computing, wearables, virtual/augmented reality, haptics, tangible UIs, accessibility, and Interactive fabrication.

The course consists of four modules. (1) **lectures**, through which we will examine major research topics in technical HCI; (2) **labs**, with which students will be equipped with a set of skills to make rapid and interactive physical prototypes, (3) **mini competition**, which require student dyad to use skills learned from the series of labs to design and build a rope climbing robot for a climbing competition, and (4) **semester-long project**, where students form a team of 3 to 4 and build a working prototype that solve one of the HCI/interation challenges.

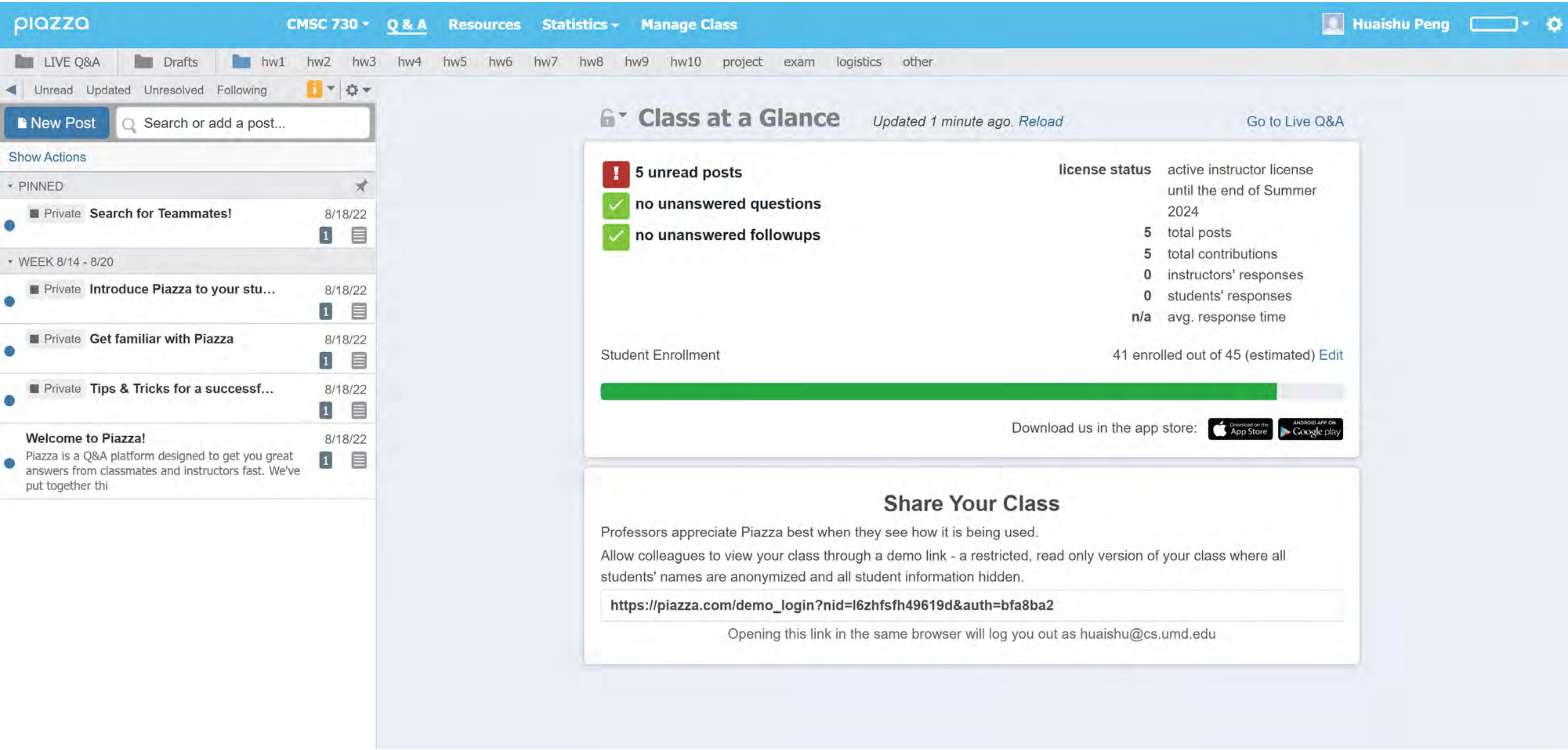
Course Resources

ELMS Page | Piazza Page | Contact TA | Contact Instructor

LOCATION AND TIME	Monday & Wednesday, 3:30-4:45, IRB2207
INSTRUCTOR OFFICE HOURS	Wednesday, 2:00-3:00, IRB4206 or Zoom
TA OFFICE HOURS	Monday, 2:00-3:00, IRB0102

https://smartlab.cs.umd.edu/CMSC730/

Piazza



piazza.com/umd/fall2022/cmsc730

How you will be evaluated

Gradings	Category Weight
Assignments: 2D/3D drawing, laser cutting/3D printing, circuit, etc.	10%
Mini Robot Competition	15%
Semester-Long Project:	
Milestone 1	5%
Milestone 2	10%
Milestone 3	25%
Participation	5%
Final Exam	30%
100%	

Final exam (30)

Required for graduate courses
Will cover basic topics from the course and it will be open-book

Small assignments (10)

Help you go through the skills we taught in class

Will not take much of your time, but **you need to submit on time** (via ELMS)
You need to contact TA and CC me **at least 24h** before the deadline if you need an extension. Late assignment will be deducted 5% each day. See Late Assignments section in the Syllabus.

Participation (5)

Show up on time
Install required software before the class
Participate in discussion

Mini Robot Competition (15)

No need for detailed documentation. You will submit 3D drawing and schematics of your design. You will be graded based on the technical design and your robot performance.

Team Projects (5+10+25)

Milestone 1: Present 3 best project ideas + part list for the final decision
Milestone 2: First working prototype and demo/video at class
Milestone 3: Final working prototype + presentation

Enrollment

We will use both ELMS and Piazza. The class website is a good one-place entry for everything.

Piazza would be easier for you to post questions and talk to each others.

ELMS for uploading assignments.

Resources

Course material will be given to you 2 weeks after the semester starts

All lectures will be recorded in case you run into difficulties

Piazza (Mainly for discussion and Q&A.)

Office hours:

Wed 2:00-3:00 pm and by appointment – IRB4206

Resources

LAB IRB 0102 – TA resource

IRB Sandbox (1st floor)
https://sandbox.iribe.umd.edu/

Singh Sandbox
Makerspace

sandbox.iribe.umd.edu

Wednesday?

Bring your laptop with Fusion360 installed.

Slides are inspired by Prof. Francois Guimbretiere and Prof. Cheng Zhang@Cornell and Prof. Stefanie Mueller@MIT

For the rest of this class

Complete this online survey so that I can better know you and know what you would like to learn from this class (will not use for grading)

tinyurl.com/22fallcmsc730