MINJOO CHO

www.minjoocho.com

I'm a creative technologist specialized in the **IoT proof-of-concept prototyping** and interactive installation conceptualization and development. My technical focus is in the **seamless integration of physical experience into digital** with web-based technical approaches.

INTERACTIVE PROJECT

BRAIN PIANO

The interplay of artificial Intelligence with human brain in the form of musical expressions

HOW WILL AI CHANGE YOU

An artificial intelligence driven 3D distortion of human portraits

RATCHAIR

Furniture move itself with vibration

CALM AUTOMATON

A DIY toolkit for ambient displays

CLIENT PROJECT

SMART TROLLEY

Can we track food inventory without RFID tags?

DIGITAL STEAM

Can we make the steamer more smart and connected?

AR FOR FOOD INNOVATION

How to estimate weight of the ingredient without any external sensors?

ABOUT ME

PROFESSIONAL EXPERIENCE

Creative Technologist, Indeed Innovation
Hamburg, Germany
May, 2017 - Present

Fast HW/SW Prototyping and PoC implementation
- Liaison of developers and designer throughout the conceptual stage of the project and help implementing proof-of-concept prototype to validate the generated ideas.

Installation development / demonstration
- Full implementation of interactive installation from concept development to delivery
- Concept development, full technical implementation (SW, HW, System integration), demonstration guideline
- On-site/Remote demonstration support

Creative Strategist, Samsung Creative Lab
Suwon, South Korea
Jun 2013 — Oct 2014

Samsung Creative Lab is a Samsung's incubation program for Samsung employees to incubate creative ideas into real project. My role in the team included:

- Proposed the winning idea to gain entry in C-Lab
- Product Strategy and development: product features definition, fast-prototyping (Android SW), in charging of user research with the hearing-impaired community
- Regular progress report to the C-level representatives

Product Manager, Samsung Electronics HQ
Suwon, South Korea
Jan 2011 — Dec 2014

- Responsible for Samsung Galaxy Tablet Series, and Google Nexus 10
- Solving procedural issues during the entire product life cycle development stage to the end of the production
- Regular VP/C-level issue reports on the project status
- Responsible for the communication with the cross functional departments.
- Building a product strategy for the sustainable sales growth, defining USPs for the market communication

EDUCATION

M.S in Industrial Design, KAIST
Daejeon, South Korea
Mar 2015 — Feb 2017

- Mater's thesis: Calm Automaton, A DIY Toolkit for Ambient Displays
- A previous research member of myDesignLAB (Prof. Daniel Saakes)
- Full year scholarship : National Science and Technology Scholarship

B.S in Electrical Engineering, KAIST
Daejeon, South Korea
Mar 2006 — Feb 2011

- Major in Electrical Engineering and minor in Business Economics
- Full year scholarship: National Science and Technology Scholarship

2017

HOW WILL AI CHANGE YOU

An artificial intelligence driven 3D distortion of human portraits

ROLE
Concept development , SW/HW development, demonstration

DEVELOPMENT PLATFORM
Processing (HeMesh.lib), Google Cloud Platform (NLP, Sentiment Analysis)

TEAM
Creative Technologist 1, Graphic Designer 1

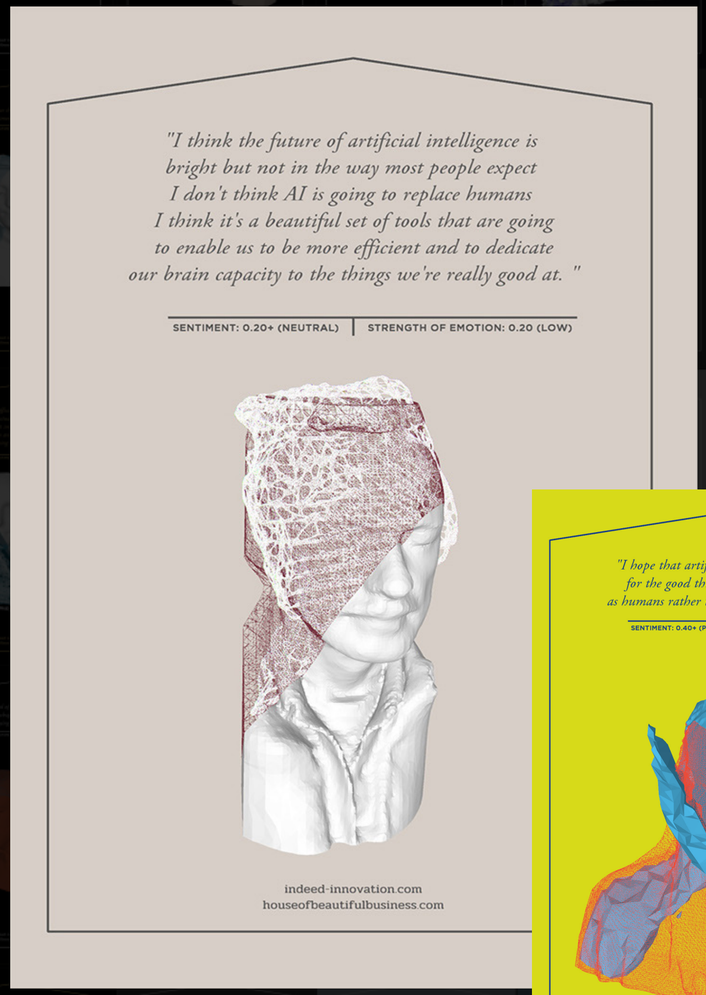
EXHIBITION
House of Beautiful Business (2017)

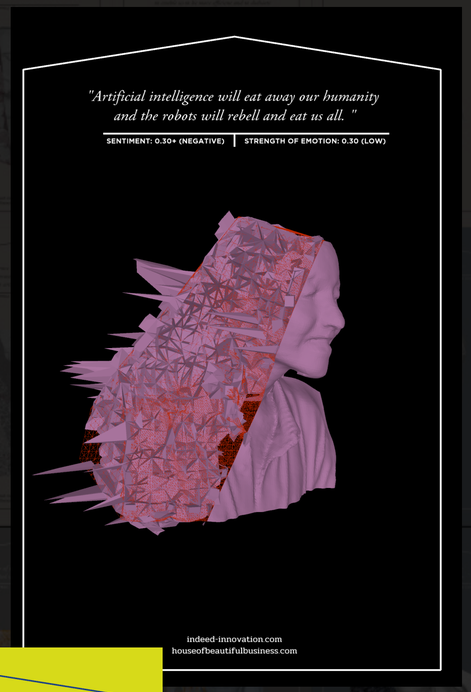
How will AI Change You provides participants an opportunity to be “A Thinker”, reflecting on personal and collective futures with intelligent machines. During the experience, scanned digital fascimilies of the participants is altered using data inputs from the artificial intelligence engine.

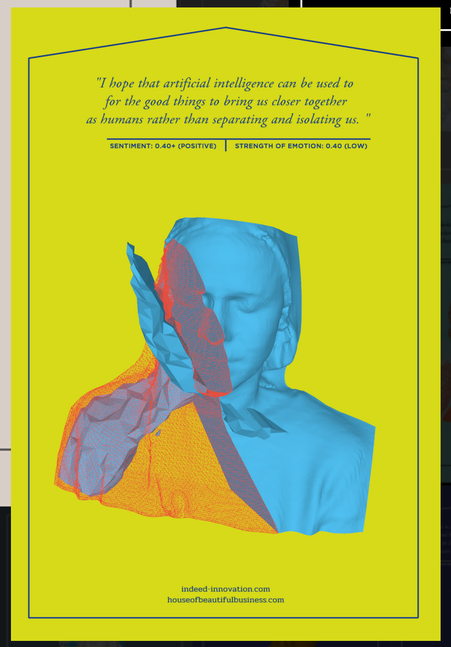
PORTRAIT OF HUMAN ON THE VERGE OF SIGULARITY

Today, we humans are standing on the verge of a major technological shift. Scientists, technologists, and others are developing deep learning machine intelligence to boost our intelligence and help streamline processes, yet these developments could also have uncontrollable consequences.

Where this could be drawing us is up for contemplation and this installation gives its participants an opportunity to be “The Thinker“, reflecting on personal and collective futures, as AI’s are driving us to transition to a new reality.







"AI is very amusing but I really look forward to is the day when we develop artificial stupidity "

Jonathan Cook, Ethnographer

"AI has the power to be the most creative tool or the biggest threat for Humanity. It's up to us as humans how we choose to use it. "

Kim Arazi, Founder and CEO of IN3

"AI creates a mirror forcing us to reflect on who we really are and why are here since human progress depends upon self-knowlege. Unlike in Blade Runner, it will help us to achieve our full potential "

Martin Reeves, Chairman of BCG Henderson Institute

3D SCAN

A mesh data from 180 degree scan of the user is imported to the system

MESH OPTIMIZATION

Mesh structure is cut into half and simplified for better graphical performance

EMOTIONAL ANALYSIS

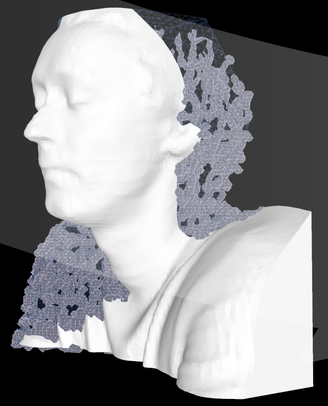
Emotional states of users are analyzed from their comments with AI Engine from Google Cloud Platform

TYPE

positive / neutral / negative

STRNEGTH

0 - Infinity



MESH DISTORTION

A mesh goes through distortion scheme depending on the result from emotional analysis

Dev. Platform : Processing 3 with Hemesh, Toxilib library

CARD GENERATION

The program generates graphical card presented with distinctive color palette within emotional values

EMOTIONAL 3D MESH DISTORTION

The output from the AI analysis drives the visual distortion of the participants 3D scanned geometry. Different sets of visual distortions are triggered based on how the AI understood the users sentiment.

COLLABORATIVE INTERACTIVE ART

The portraits are made from generative 3D mesh distortions, which always results in the distinct portraits for each participant. Not only the distortion schemes but also the colour combinations differ within emotional categories (positive, neutral, negative).

As more people participated, the growing collective portrait reflected the current emotional state of all the participants as they contemplated the “AI future“.

STEP 1

CONTEMPLATION & 3D SCAN

"Please close your eyes and think about the future with artificial intelligence for a while"

As a participant ponders, a 3D scanner moves along a semi-circular rail, in order to capture their thinking face.

STEP 2

INTERVIEW

"Please let us hear what you feel"

The voice of the participant is automatically transcribed and analyzed for its sentiment, using an actual AI Engine.

STEP 3

AI DRIVEN MESH DISTORTION

The output from the AI analysis drives the visual distortion of the participants 3D scanned geometry.

STEP 4

POST CARD GENERATION

A postcard is generated according to the emotional qualities. The post card is then handed to the participant.

Click to watch the demonstration video

SHOWCASE EXHIBITION

The installation was showcased in 2017, at the Business Romantic Societies “house of Beautiful Business“, a pop-up community for discussion in the age of Artificial Intelligence in Lisbon.

More than one hundred participants experienced the installation over six days, which resulted in the massive collage of portraits of people of the age.

2019

BRAIN PIANO

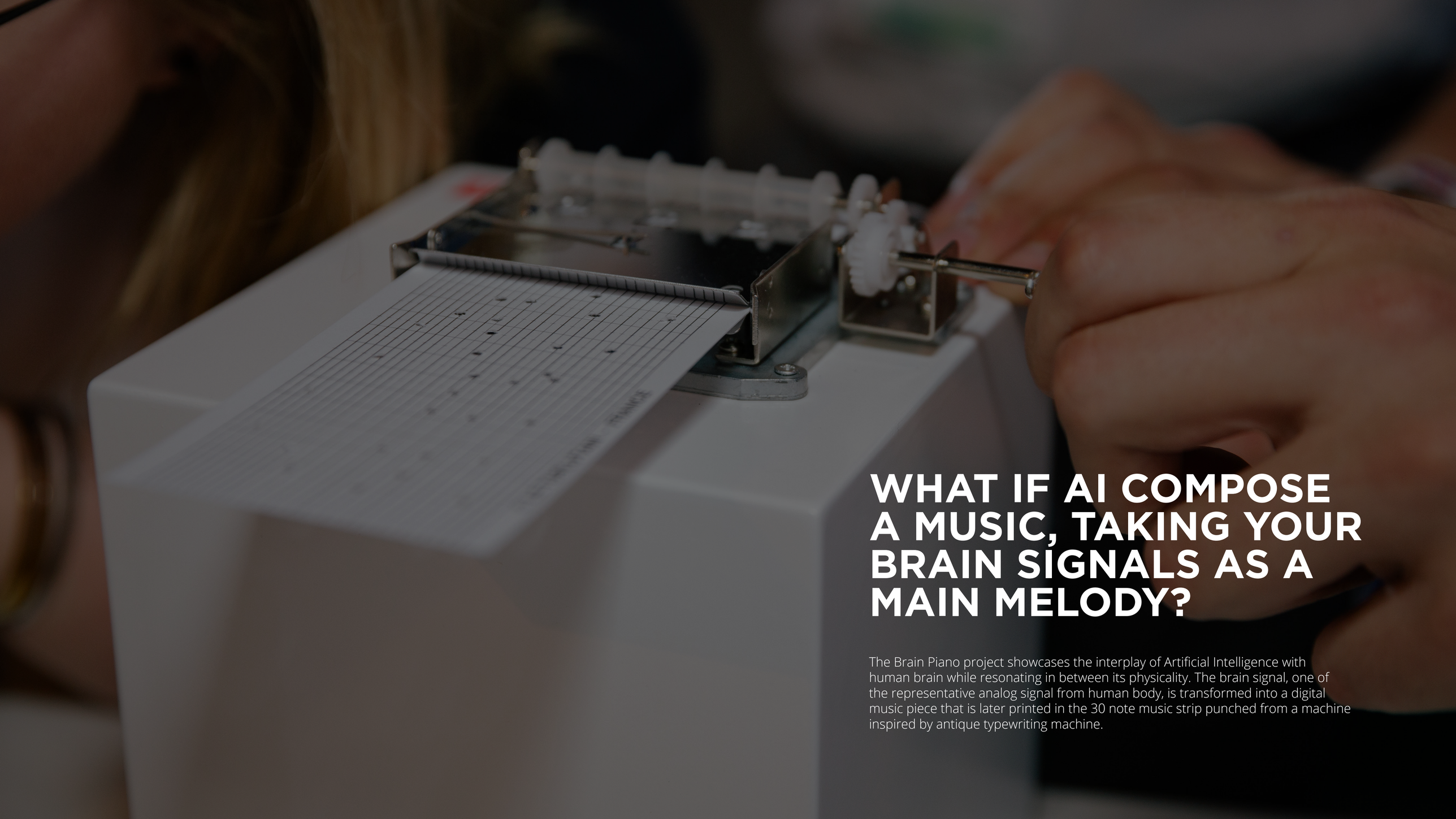
The interplay of artificial Intelligence with human brain in the form of musical expressions

ROLE
Concept development , SW/HW development, demonstration

DEVELOPMENT PLATFORM
Embedded (Arduino), Frontend (Javascript), Engine (Magenta.js)

TEAM
Creative Technologist 1, mechanical engineer 2

EXHIBITION
House of Beautiful Business (2019)



WHAT IF AI COMPOSE A MUSIC, TAKING YOUR BRAIN SIGNALS AS A MAIN MELODY?

The Brain Piano project showcases the interplay of Artificial Intelligence with human brain while resonating in between its physicality. The brain signal, one of the representative analog signal from human body, is transformed into a digital music piece that is later printed in the 30 note music strip punched from a machine inspired by antique typewriting machine.

STEP 1

RECORD YOUR BRAIN SIGNALS IN MELODY

As you concentrate, we measure the electrical activity of your cerebral cortex. Each electro-chemical discharge will produce 8 different raw brain signals become your finger to play a virtual piano.

STEP 2

LET AI COMPOSE MUSIC OUT OF THE MELODY

Based on your vibrational profile, our creative code creates a unique piece of music: Inspired by Bach's works, and your melody immediately becomes part of our digital music library.

STEP 3

MAKE YOUR MELODY TANGIBLE

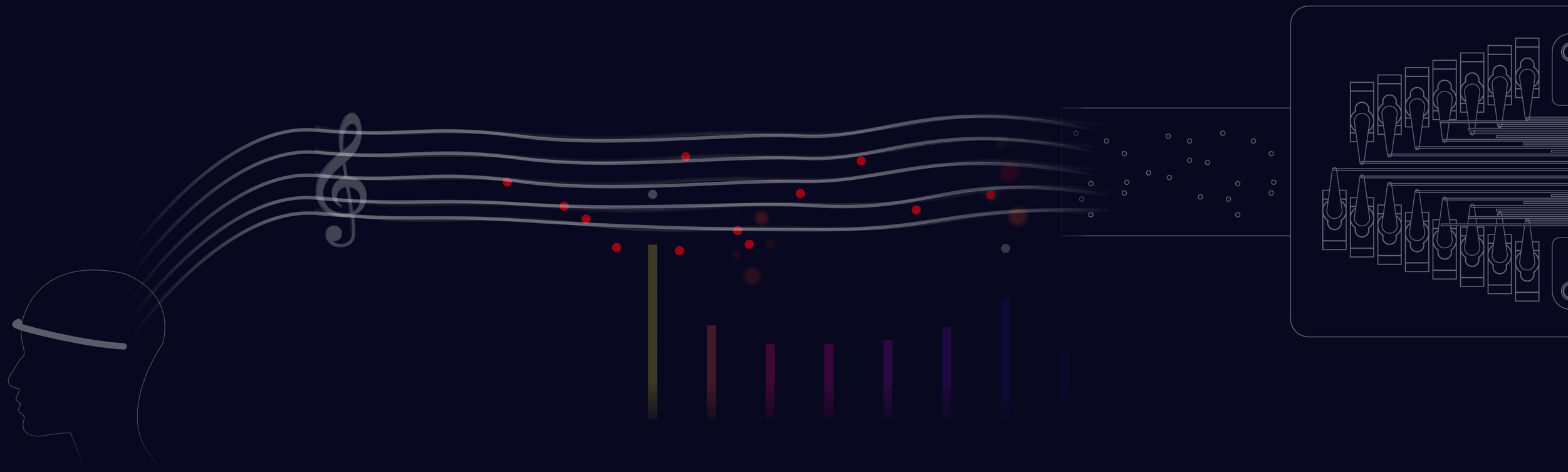
The puncher makes your music audible and tangible outside of the digital. Thanks to the 3D printer, ingenuity and engineering, the puncher is virtually a polaroid of your mental vibration profile.

STEP 4

REVISIT YOUR MUSIC ANYWHERE

As individual as each of your thoughts is your melody. Digital as well as analog. Listen to the songs of the other thinkers or play your own tune anytime from here.

SYMPHONY OF HUMAN AND AI RESONATING IN PHYSICALITY



READ BRAIN SIGNAL FROM A PARTICIPANT

A brain interface with EEG sensors reads brain signals from a participant

BRAIN INTERFACE

CONVERT BRAIN SIGNALS INTO A MELODY LINE

Eight raw brain signals act as a finger and generate melody by hitting the hidden piano on the web interface.

CLIENT (HTML/CSS/Javascript)

AI TAKING THE MELODY LINE AND COMPOSE POLYPHONIC MUSIC

Artificial Intelligence engine takes the melody line and compose music in the style of Bach.

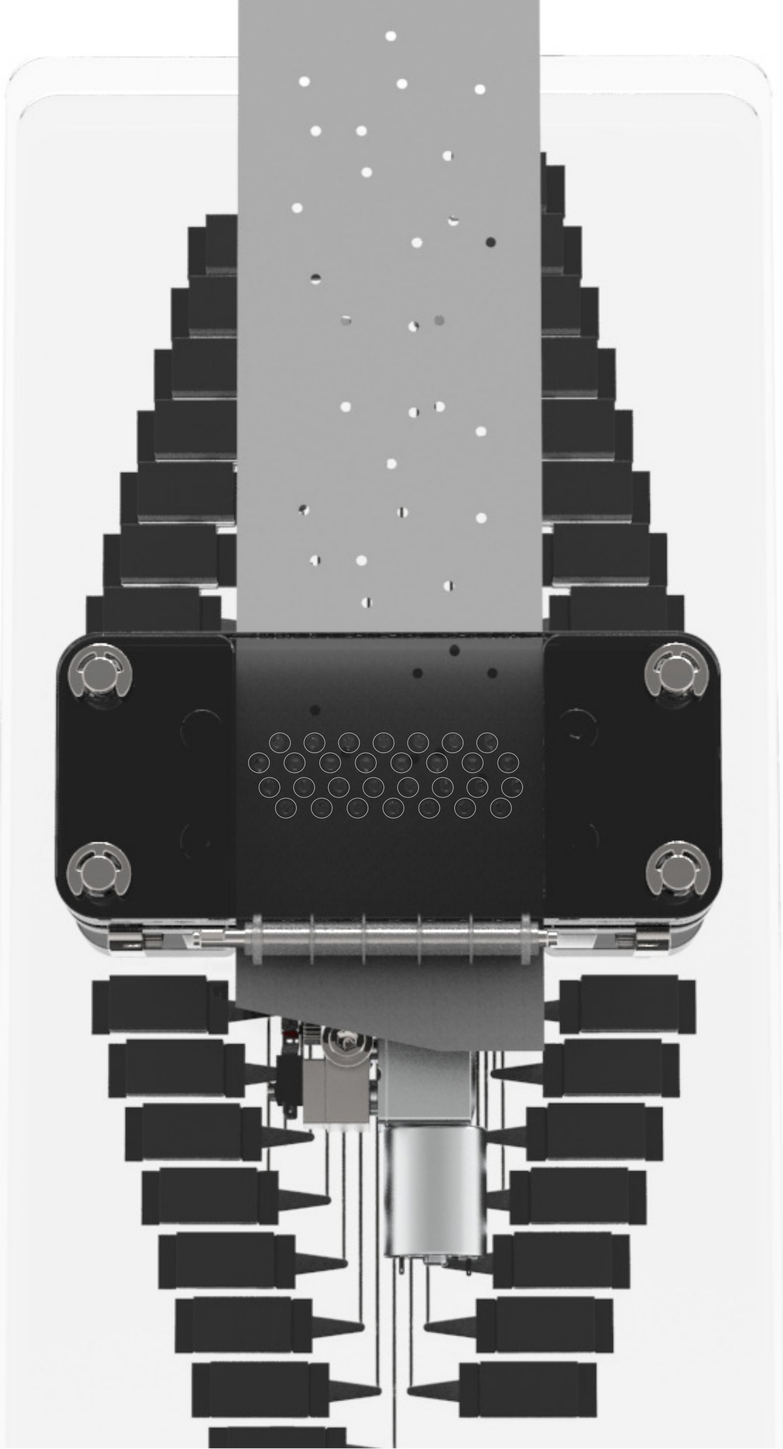
The resulting music is optimized for 30 scale music notes and punched on to the paper sheet

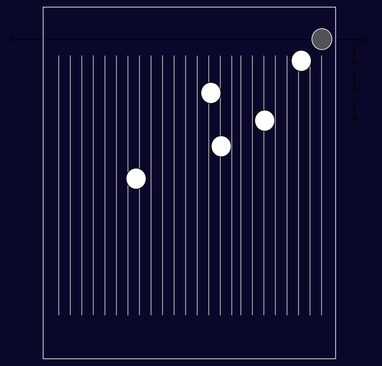
SERVER (Python-Flask)

MACHINE PLAYS MUSIC AS IT IS COMPOSED

The music is uploaded to the web cloud, and the punching machine plays the music as it is being composed

PUNCHING MACHINE (Arduino)

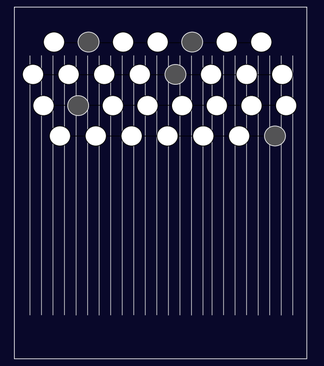




LINEAR PUNCHING

To punch one hole, the machine need to go through 30 notes

Too much time consuming job to punch polyphonic notes



ACCUMULATIVE PUNCHING

Holes are arranged in 4 batches of holes, and one batch can cover 7 to 8 holes

Dramatically reduces punching time in the price of hight power

Can we produce music sheets within in few minutes?

We had to redesign the punching modules that allow multiple hole punching at the same time.

As a result, 30 notes were arranged in 4 lines (7-8-8-7) and designed to punch multiple holes for each line as the punching progresses. 30 servo motors that open/close the hole were individually controlled with the streamed machine commands from the web server.

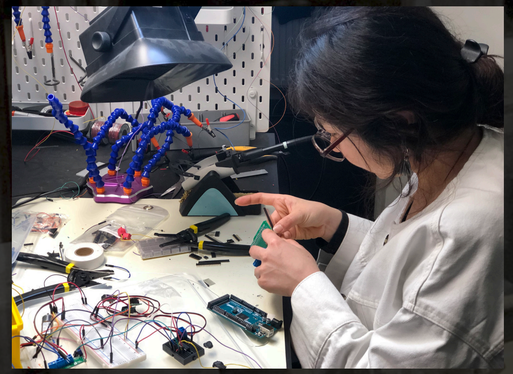
TWO MONTHS OF MARATHON SPRINTS

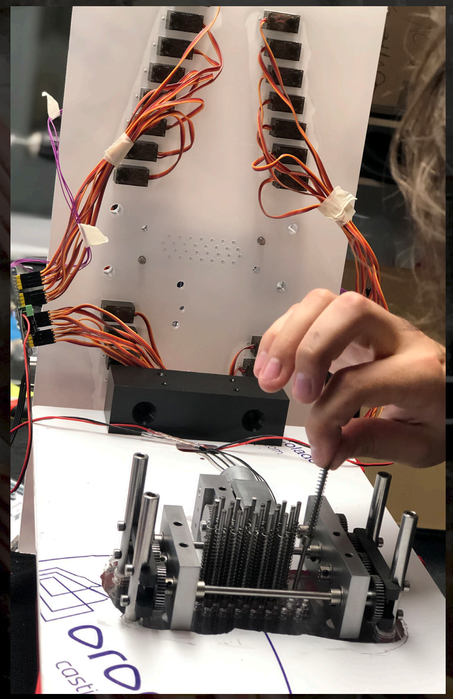
It took two months in total for 2.5 people working full-time to develop the whole experience after the project kick off.

Closing to the system integration, I spent time on constituting online music repository where participants can revisit and hear their personal melody with the given ID.

Find more information from following link

PERSONAL BLOG INDEED JOURNAL





2016

RATCHAIR

Furniture move itself with vibration

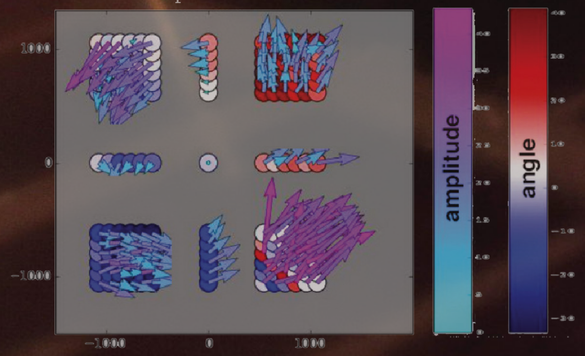
Ratchair is a strategy for displacing big objects by attaching relatively small vibration sources. After learning how several random bursts of vibration affect its pose, an optimization algorithm discovers the optimal sequence of vibration patterns required to (slowly but surely move the object to a specified position.

Tetiana Parshakova, Minjoo Cho, Alvaro Casinelli, Daniel Saakes

SIGGRAPH 2016, DC EXPO 2016

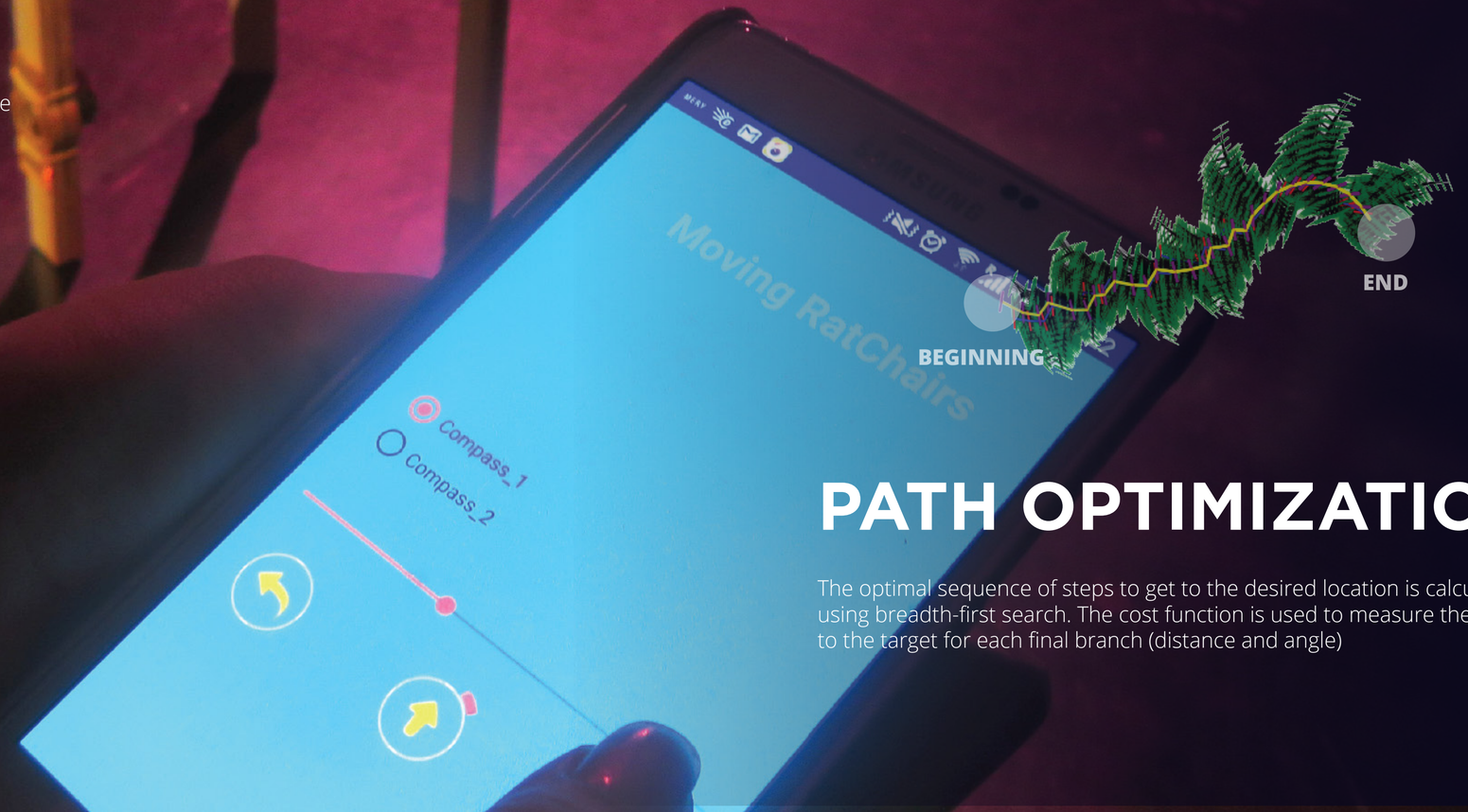
We designed sources of vibration that can be easily attached to furniture and objects. Embedding vibration modules as part of mass-produced objects may provide a low-cost way to make almost anything mobile. The principle is agnostic with respect to the shape of the object, number, type, or relative position of the actuators

Matrix of possible transformations



LEARNING PHASE

When the actuators are set, the system builds a matrix of possible transformations (rotations & translations) by sampling the space of possible vibration patterns and recording the resulting motion.



PATH OPTIMIZATION

The optimal sequence of steps to get to the desired location is calculated using breadth-first search. The cost function is used to measure the proximity to the target for each final branch (distance and angle)

2017

CALM AUTOMATON

A DIY Toolkit for Ambient Displays

Calm Automaton is a user-customizable automaton toolkit that functions as an ambient display for peripheral information. It allows users to be calmly notified of information changes with shape shifts of the automaton.

Minjoo Cho, Daniel Saakes
CHI Interactive, 2017

CALM + AUTOMATA

Slow movements

> Designing for calm technology mean to provide non-invasive tools or cues for action that encalm while stimulation the scenes

Weiser, Mark & John Seely Brown. "The coming Age of Calm Technology" Xerox PARC : Oct 5 1996

SHAPE CHANGING DISPLAY WITH GENTLE NOTIFICATION

Instead of noisy alarms disturbing your concentration, Calm Automaton lets you be aware of the sequence of information with slow and gentle shape changes over time

USER CUSTOMIZABLE DISPLAY

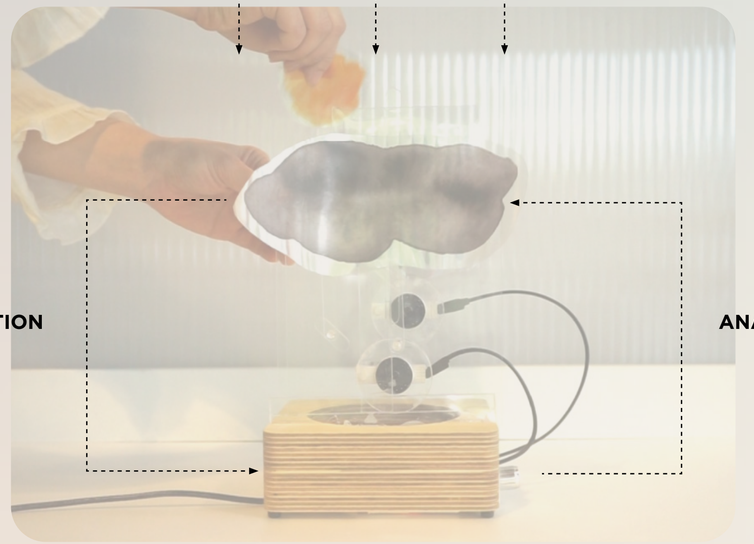
Make your own calm alarm by simply attaching printout images or objects from your surroundings.

Read XML from webpages

Personal Information

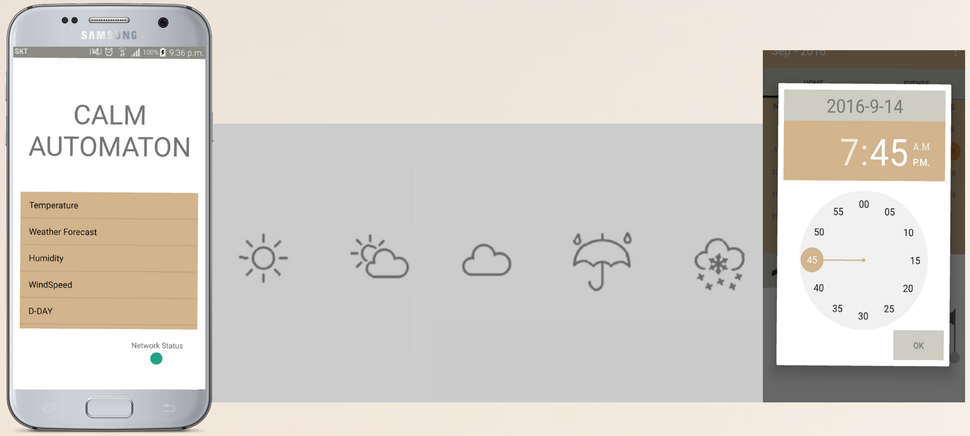
Finance

Weather



SERVO POSITION

ANALOG FEEDBACK



Tangible Programming

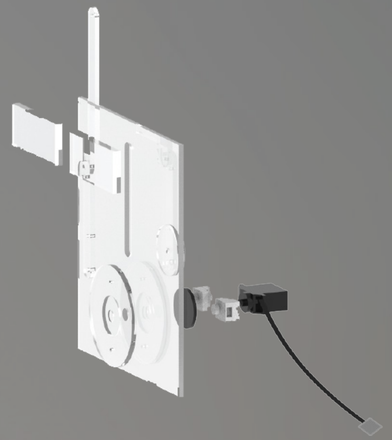
Tangibly programming of the motion with web information

Mobile Application

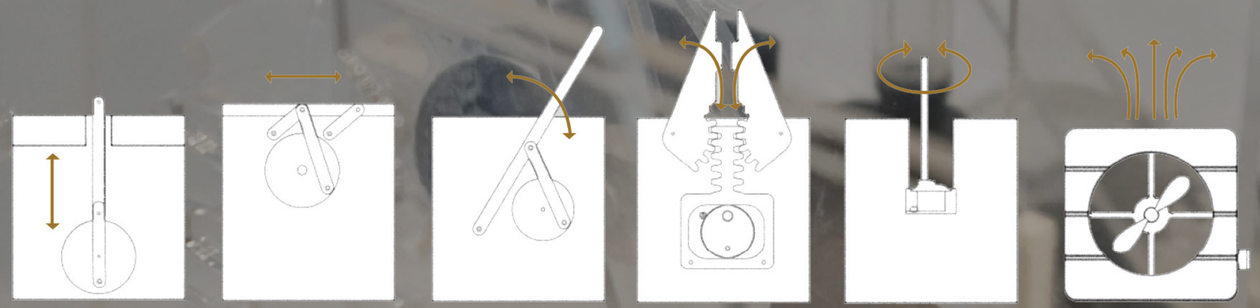
Select the type of information you want to be notified.

TOP MODULE

There are five different acrylic modules and one fan module defining identical mechanical movement . By layering two-dimensional plates a user can implement three-dimensional movements.



Each transparent acrylic plate defines a single motion, actuated by one analog feedback servo motor attached to the back.



VERTICAL MOVEMENT

HORIZONTAL MOVEMENT

RISING MOVEMENT

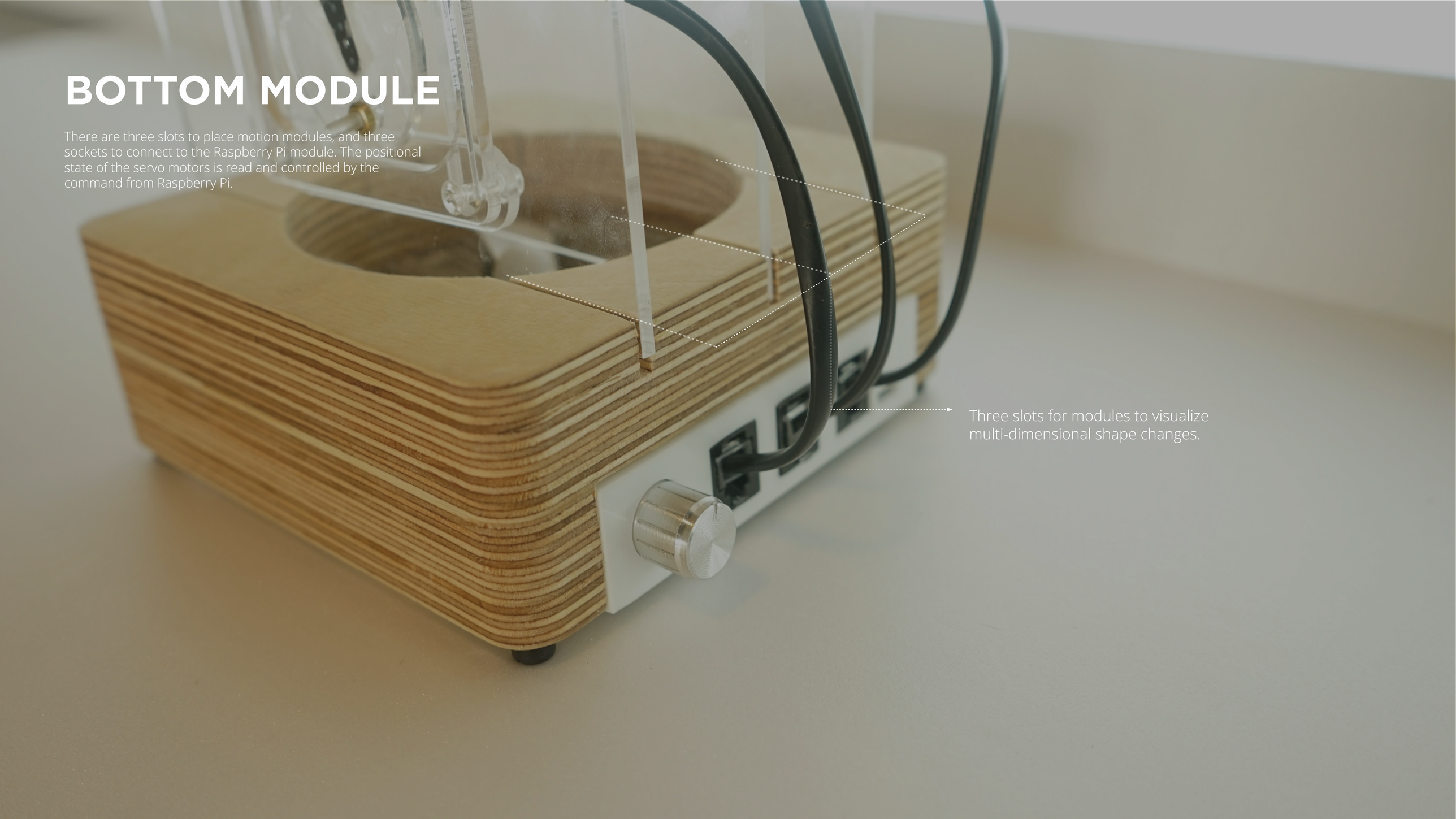
OPEN/CLOSE MOVEMENT

ROTATIONAL MOVEMENT

BLOW MOVEMENT

BOTTOM MODULE

There are three slots to place motion modules, and three sockets to connect to the Raspberry Pi module. The positional state of the servo motors is read and controlled by the command from Raspberry Pi.



2018

SMART TROLLEY

How can we track the food inventory in the air cabin with out RFID tags?

ROLE
Form exploration , SW/HW development, System Integration

DEVELOPMENT SCOPE
IoT proof of concept prototyping

TEAM
PM 2, Creative Technologist 1

CLIENT
An airline corporate

Inventory Status

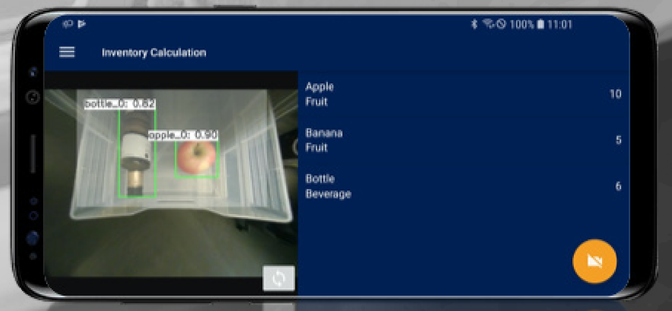
Trolley ID : 001

Water bottle 30 (-1)

Chocolate 45 Beer

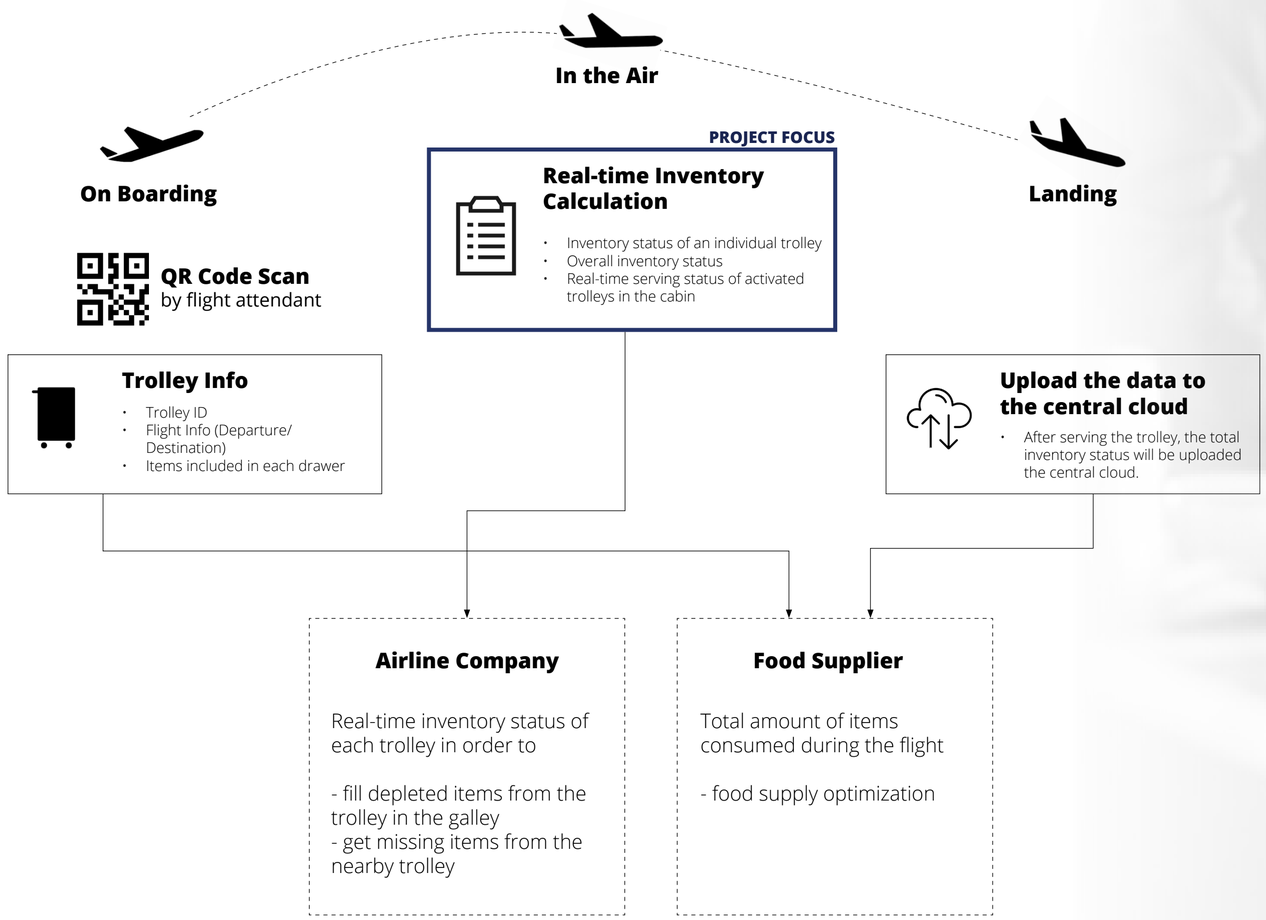
cans 20

⋮

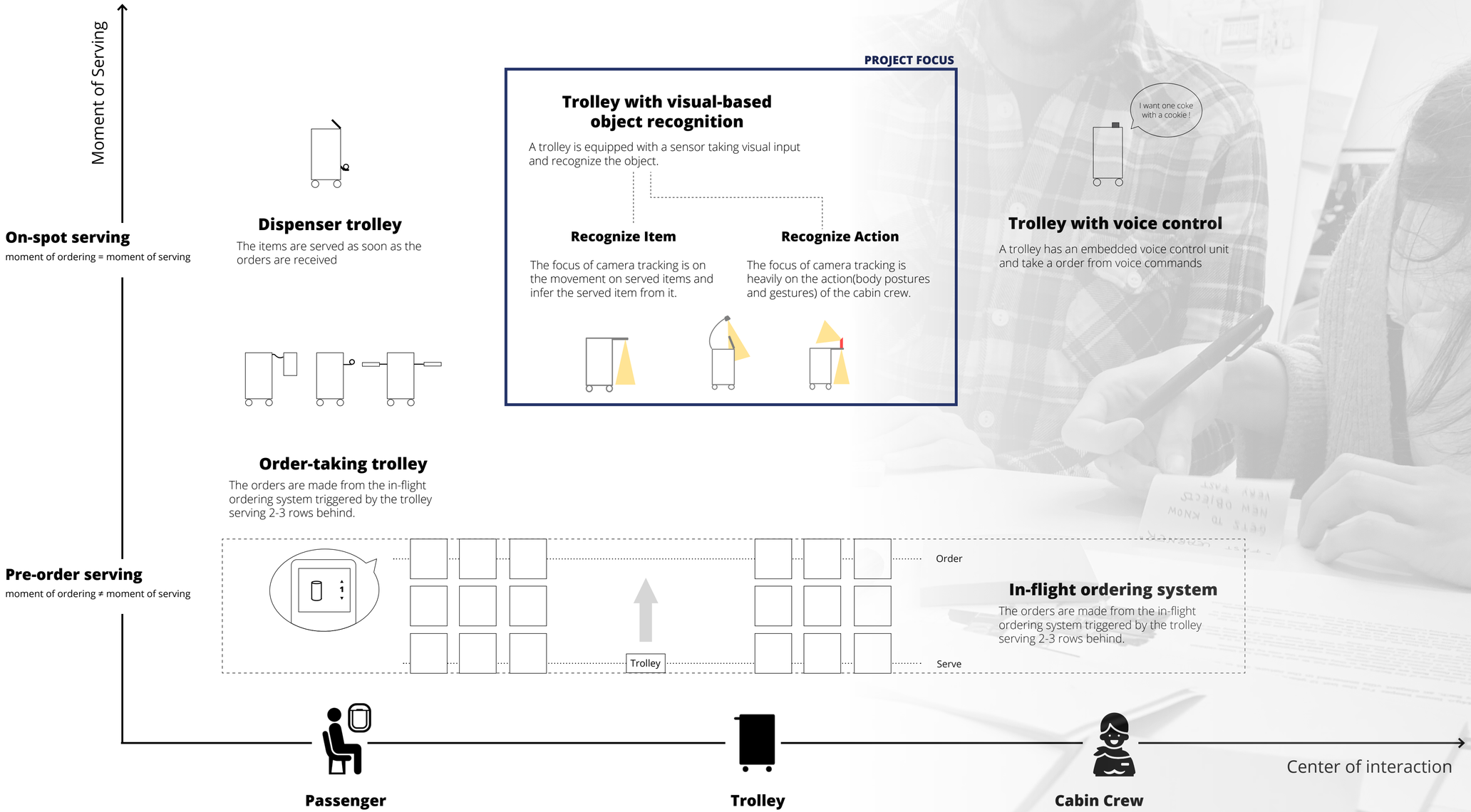


IN FLIGHT INVENTORY TRACKING

Our client, one of the most renowned airline corporates, wanted to implement a minimal invasive smart trolley solution that tracks the items served in air cabins **without RFID tags.**

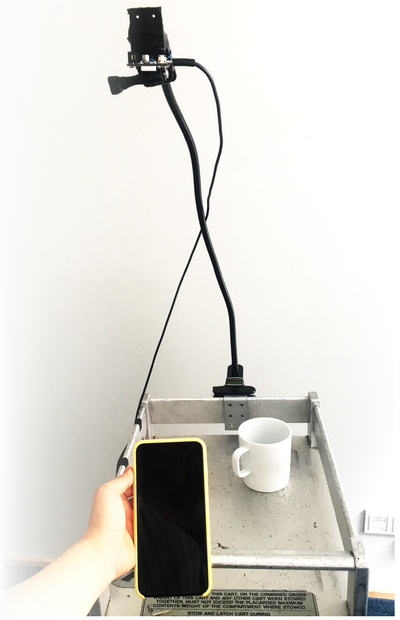


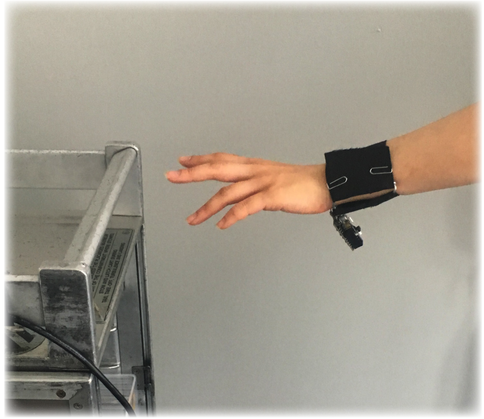
Several technical approaches are compared under proposed service framework after the ideation workshop

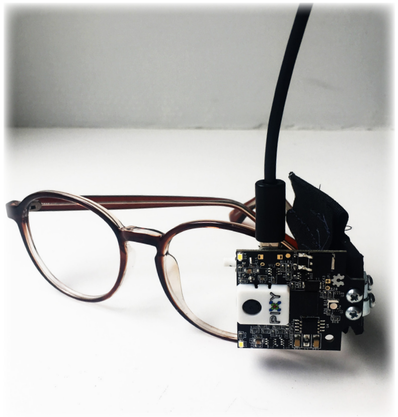


ITERATIVE PROTOTYPING PROCESS

After the client agreed upon the visual-based technical approach, I explored through different camera with regard to it's locations. I quickly iterated through ideas by iterative prototyping processes, and validated the feasibility by comparing the use case by role-playing the actual use case in the air cabin.







PRETOTYPE APPROACH

Training custom machine learning model for object recognition required to much investment and efforts. Instead, we decided to validate concept with “pre”totype, a system that only works within pre-trained object recognition model

CAMERA BASED APPROACH

Item level tracking with camera-based object recognition

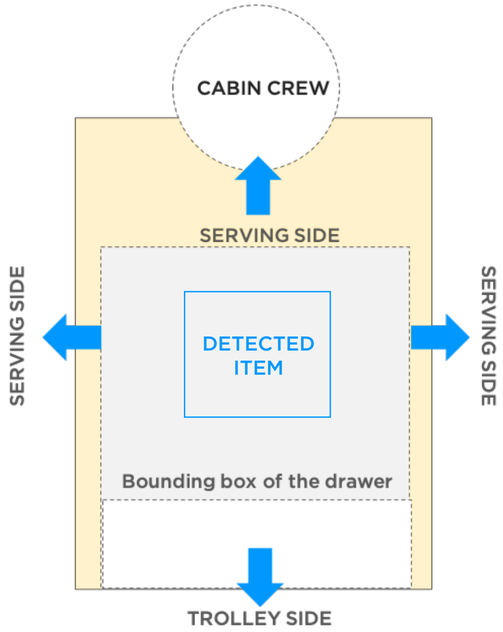
Utilize one mobile device on the top drawer to detect the movement of items

DETECTABLE ITEMS (8 ITEMS)

Stückgut (Nuts / Chocolate bars)
Cans (Coke / Sprite)
Bottles (1 bottle of wine / 1 bottle of champagne)
Duty-free items (2 different perfumes)

RULES

Only focus on the items only inside the drawers (we don’t consider items placed on the table area)

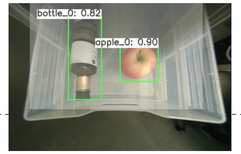


FRAME-BASED VIDEO ANALYSIS

We analyze the captured scene by frame and analyze item’s trajectory **with regard to the trolley** to calculate inventory status in real-time

SYSTEM OVERVIEW

A fish-eye camera attached under the transparent working table tracks recognized items and deduct/add the amount of inventory by analyzing the appearing/disappearing direction of the tracked item.

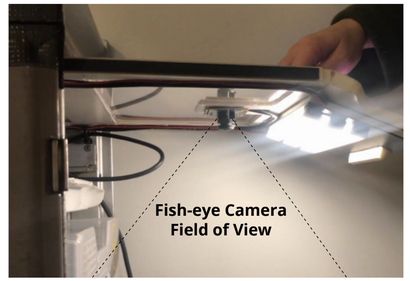


Fish-eye Camera Video Stream

PYTHON-FLASK WEBSERVER

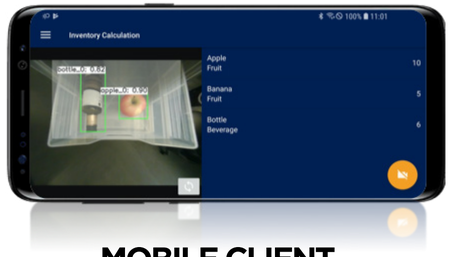
- Read Webcam frame data
- Multiple object tracking
- Tracking / Counting Algorithm
- Send message to the client

Object Detection: Yolo v2 pre-trained with coco-dataset



TRANSPARENT WORKING TABLE

- Transparent working table to see-through items on the drawer
- LED light on when mobile is placed on the charging station
- Fish-eye Camera to track items in the drawers



MOBILE CLIENT (ANDROID)

- Scan QR code to read initial inventory data
- Add/deduct inventory as message from the server is received
- Read real-time camera view from the server

2020 ~

DIGITAL STEAM

Can we make a steamer smart so that users can receive feedback on the cleaning quality ?

ROLE
Form exploration , SW/HW development, System Integration

DEVELOPMENT SCOPE
IoT pretotype (with AWS integration)

TEAM
PM 1, Creative Technologist , Mechanical Engineer 1

CLIENT
A home appliance company

How can we notify users of the cleaning quality of a steam device?

Our client, a home appliance company wanted to make their steam mop models a bit more smarter so that **it notifies users if they are steaming the floor in a right temperature and the speed.**

Cleaning score

35

Floor type : white wood
Speed too low

Cleaning score

95

Floor type : carpet
Ready to proceed

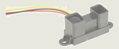
There are so many different technical decision to make, but we will never know what is the best solution unless we test with users..

Why not integrate every sensors into one steamer as a testbed and select right ones afterwards?

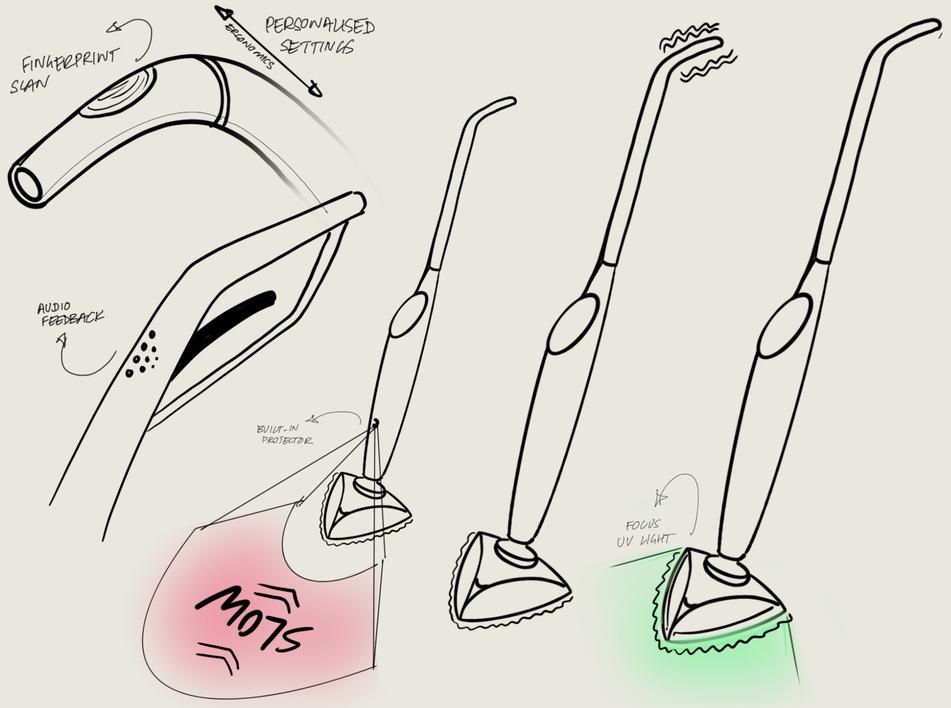
FLOOR TYPE DETECTION

DEVICE MOVEMENT

FLOOR TOUCH DETECTION

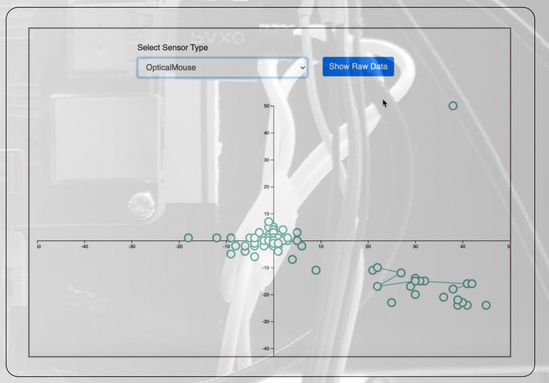


USER FEEDBACK



PROTOTYPE DATAFLOWS

The sensor data collected from the device is stored in AWS Dynamo DB through MQTT protocol, and number of actuators are attached for the potential user feedback.



AWS IoT Core ↔ **AWS Dynamo DB**

PYTHON-FLASK WEBSERVER

STORE IN DATABASE

DATA STREAMING (WEB SOCKET)

MQTT CLIENT MESSAGING

{
"message" : {individual message depending on sensors},
"sensor_type" : (Sensor name),
"row" : (time_stamp)
}

HARDWARE PROTOTYPE

INPUT

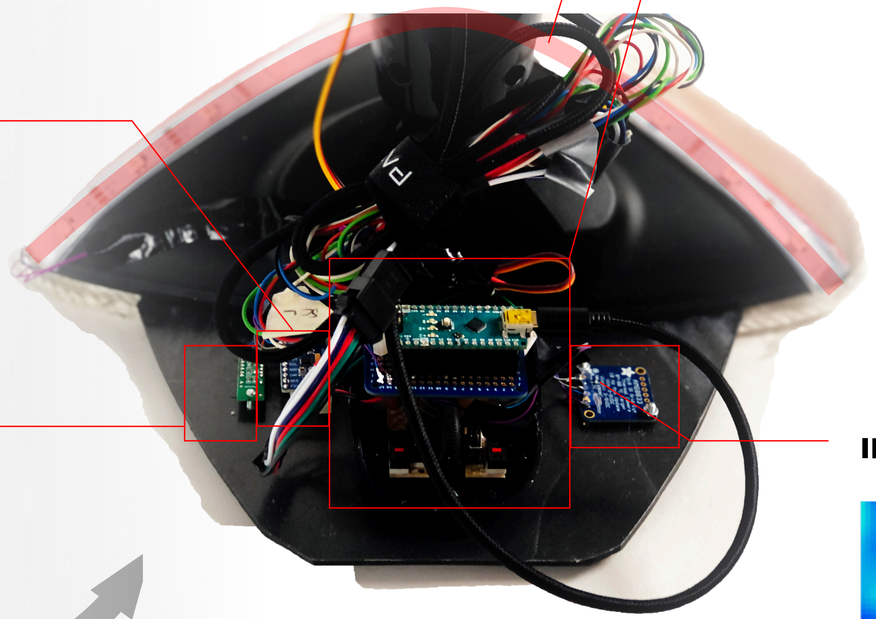
- Pulsed Radar Sensor
- Raspberry Pi Camera
- Optical Mouse Ensor
- IMU (MPU 9250)
- IR Transmitter and Receiver
- Doppler Radar Sensor
- IR Camera Sensor

OUTPUT

- Piezo Buzzer
- Audio Output / Mini Speaker
- Vibration Motor
- Neo Pixel (WB 2012b)
- Laser Diodes
- Servo valves (steam modulation)

BOTTOM MODULE FOR BETTER INTELLIGENCE

The core function of the bottom module is to get the sensor data to estimate the speed of the movement and floor type, and LED strips are attached to visualize the steamer states.



Neo Pixel

Indication of steamer states
by directional visualization with full color range

Optical Mouse Sensor

Arduino Nano transmits the data read from the optical mouse sensor to Raspberry Pi via Seial port to estimate the movement of the device

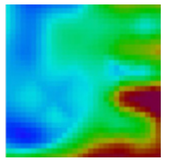
MPU Sensor

Estimate the orientation of the steamer head

IR Proximity Sensor

IR sensor detects if the steamer touches the floor

IR Grid Sensor

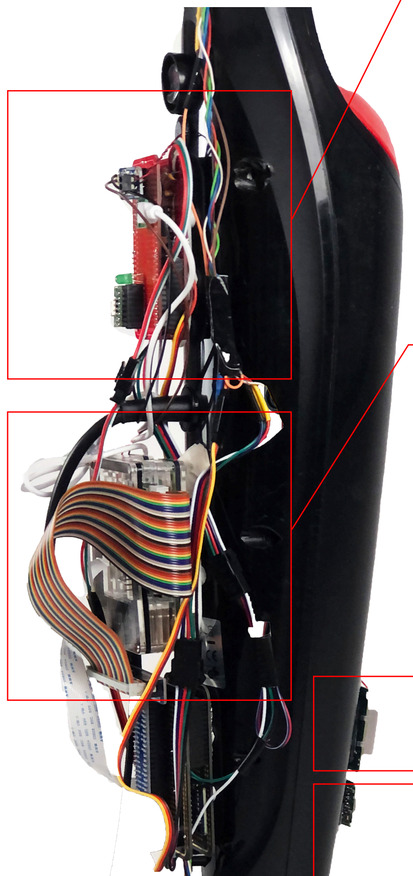


Measures the temperature of the floor in order to estimate the heat capacity of the floor.

A CENTRAL PROCESSOR AND USER FEEDBACKS

The middle module is the heaviest unit having Raspberry Pi for the central processing and two circuits that interfaces the sensors and actuators. Top module has haptic actuator placed on the handle, and audio outputs (speaker / piezo buzzer) that will be used to indicate alert message to the user

Middle part



Soldered circuits (RED/BLACK)

Sensors and actuators requiring high current are placed

- Neopixel
- Audio module
- Microwave sensor

Sensors operating with lower current, and logic boards are placed here

Raspberry Pi

Central processing unit of the system.

Microwave Sensor

Estimates the relative speed of the obstacle ahead

Camera

Camera can be later used to detect floor type (object recognition)

Top part

Haptic actuator

Give haptic feedbacks to the user

Piezo buzzer

Audio feedback for alert

Haptic Driver

Provides around 200 customized haptic patters

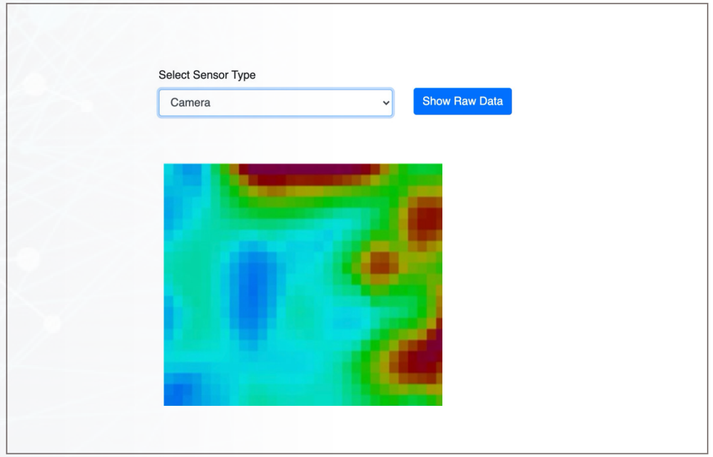
PYTHON SERVER FOR DATA VISUALIZATION

I quickly built a prototype web server that visualizes the data stored in AWS Dynamo DB or video data streamed from the steamer device

Server-side platform : Python-Flask
Data Visualization : D3.js

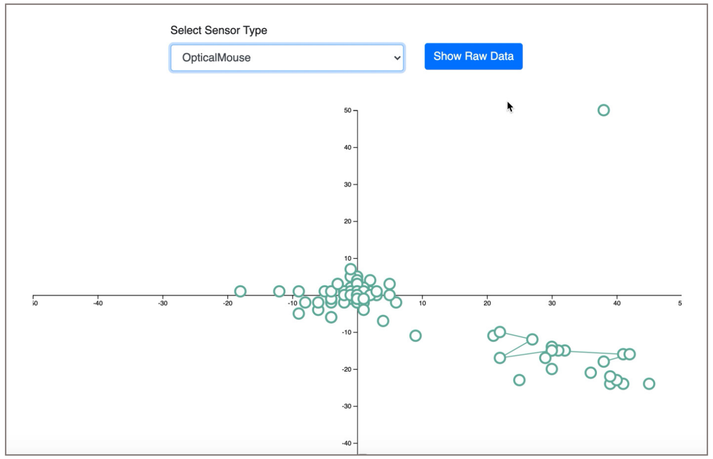
AWS Dynamo DB

Web Socket



REALTIME CAMERA STREAMING

A screenshot of server receiving IR Grid sensor data streamed from the device with web socket protocol



DATA VISUALIZATION FROM DATABASE

A screenshot of visualized optical mouse sensor data showing the moving trajectory read from AWS Dynamo DB

2017

AI FOR FOOD INNOVATION

How to estimate weight of the ingredient without any external sensors?

ROLE
Form exploration , SW/HW development, System Integration

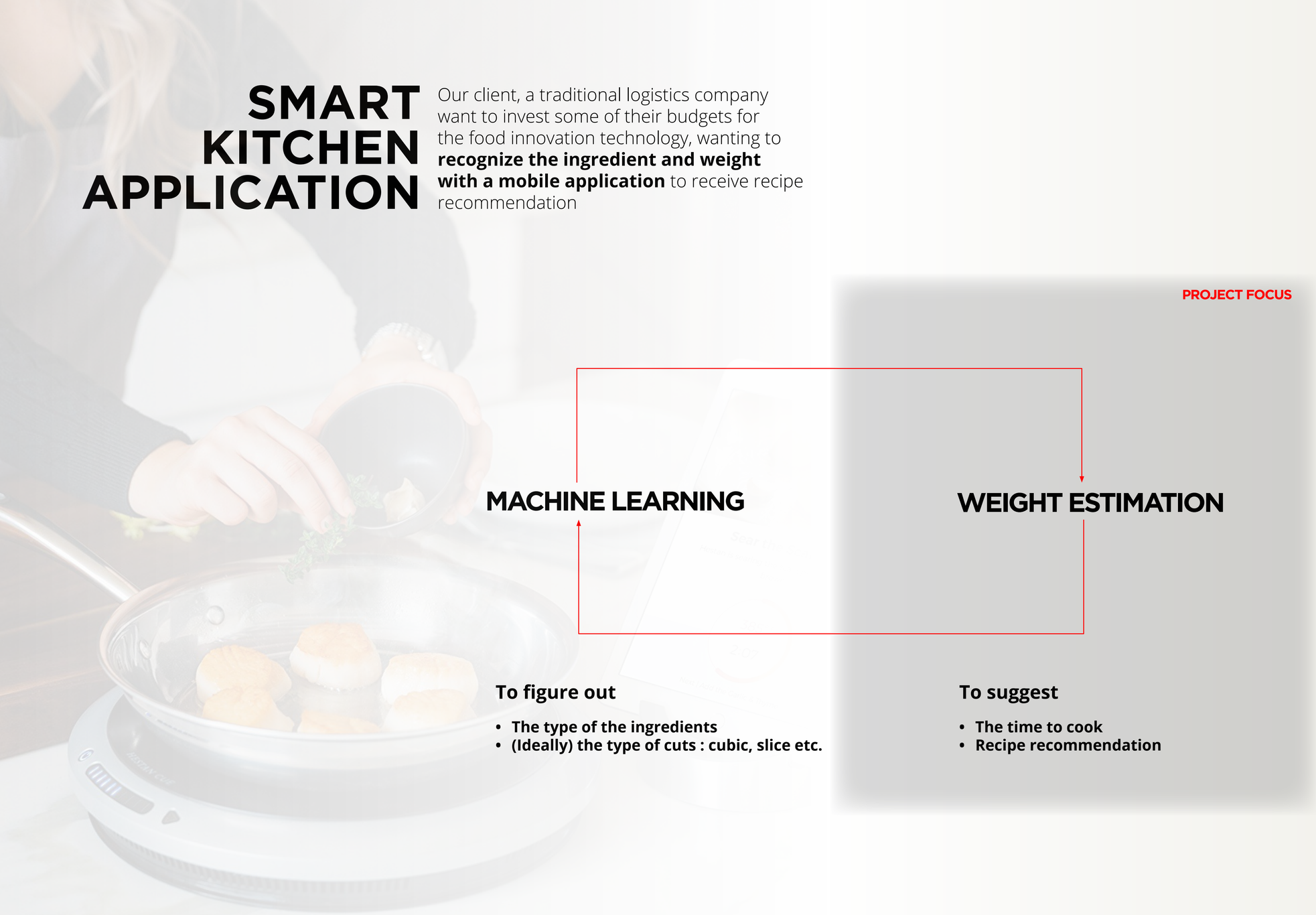
DEVELOPMENT SCOPE
AR Prototype

TEAM
PM 1, Creative Technologist 1

CLIENT
Nondisclosable

SMART KITCHEN APPLICATION

Our client, a traditional logistics company want to invest some of their budgets for the food innovation technology, wanting to **recognize the ingredient and weight with a mobile application** to receive recipe recommendation



PROJECT FOCUS

MACHINE LEARNING

To figure out

- **The type of the ingredients**
- **(Ideally) the type of cuts : cubic, slice etc.**

WEIGHT ESTIMATION

To suggest

- **The time to cook**
- **Recipe recommendation**

NOTE

The scope of this project was set so that we will explore the possibility of the weight estimation (without the weight sensors) before investing resource on machine learning training.

Why not estimating the food weight by multiplying ingredient volume with food density?

Weight Estimation

Weight = Volume x Density

APPROACH

+ Estimate the weight of the object **without the weight sensor**
+ Calculate the weight through the food density

VOLUME CALCULATION

+ 3D Reconstruction
+ AR based on-screen Interaction

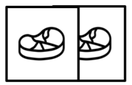
Food name and description	**Density** (g/cm^3)	**Volume** (cm^3)	**Weight**(g)
Bread, dry mix, prepared	0.845	150	126.75
Natto	0.74	150	111
Noodles, Chinese chow mein	0.19	150	28.5
Rice, white, raw	0.782	150	117.3
Soybeans, green, raw	1.082	150	162.3
Tofu, raw, regular	1.048	150	157.2
Tomato sauce	1.036	150	155.5
Orange juice, raw	1.048	150	157.2
Egg, white, raw, fresh	1.027	150	154.05
Apple juice, unsweetened	1.048	150	157.2

TECHNICAL RESEARCH

Available technical approaches to estimate the food volume were investigated and compared in several criteria including the processing time, precision and development efforts.

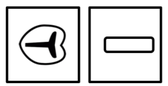
SINGLE PHOTO

Take single photo to estimate the volume



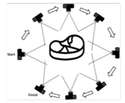
TWO PHOTOS w/ RANDOM ANGLES

Take two photos in two random angles to estimate the volume



TWO PHOTOS w/ TWO PERSPECTIVES

Take two photos in two different perspectives



MULTIPLE PHOTOS

Take array of photos to get the full scan of the object

CHOSEN

AUGMENTED REALITY

On-Screen manipulation calculate the volume

3D RECONSTRUCTION

- Requires heavy mathematical computation (Image Processing / Depth Estimation)
- Takes a lot of time to process (10 ~ 45 min)
- Requires printed markers or object with known dimension (finger, coins etc.)

AR MEASUREMENT

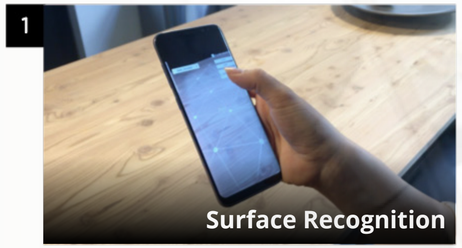
	PROCESSING TIME (taking photos + processing)	PRECISION	DEVELOPMENT STAGE	LIMITATIONS
	LESS ● ○ ○ ○ ○ MORE	BAD ● ○ ○ ○ ○ GOOD		
SINGLE PHOTO	3.5 sec	~ 11 % Error	Research Stage (Need collaboration with Computer Vision Lab)	- In the very early research stage Low precision rate
TWO PHOTOS w/ PERSPECTVES	5.5 sec		Research Stage (Need collaboration with Computer Vision Lab)	- Need to provide **a printed image** for image processing - Too many processing steps
TWO PHOTOS w/ PERSPECTVES			Research Stage (Need collaboration with Computer Vision Lab)	- Need to have **a reference object(finger, coin etc.)** for image processing. - Difficult to take pictures in perfect angles - Difficult to estimate irregular shapes
MULTIPLE PHOTOS	10 ~ 45 min		Several Apps exist on the market	- Need to take too many photos - Too much Processing time
AUGMENTED REALITY	Instant		Commercial Stage (Lots of open source for implementation - AR Toolkit)	- Difficult to estimate irregular shapes (can update template later on)

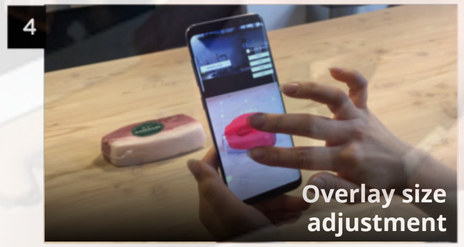
CHOSEN

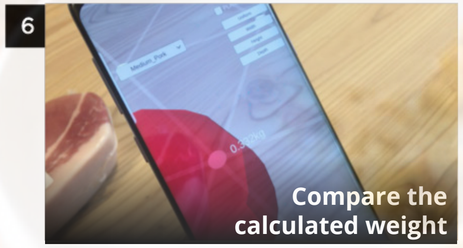
WEIGHT ESTIMATION APP

Food weight estimation algorithm were **quickly implemented in two weeks** of time, and tested. After a user hold a camera still until the app recognizes the ground plane, user can drop the 3D overlay based on the detected object. **The size-adjustable overlay** then calculates an estimated weight instantly as soon as the user overlays the 3D template on top of the meat.

PORK MEAT	ESTIMATED WEIGHT
0.354kg	0.332kg







Development environment : Unity 3D with Google ARCore and complied in Android Phone (Galaxy S8)