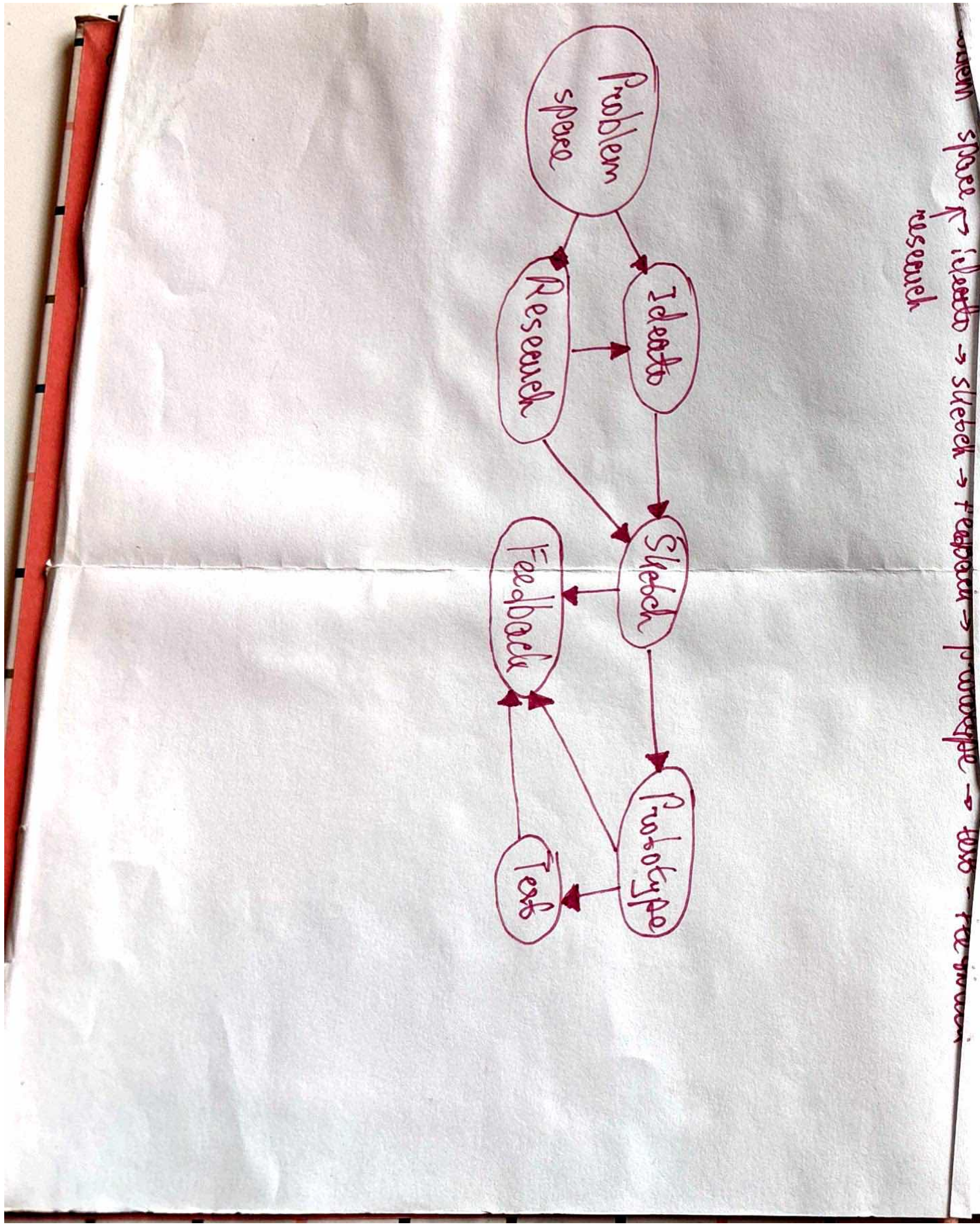
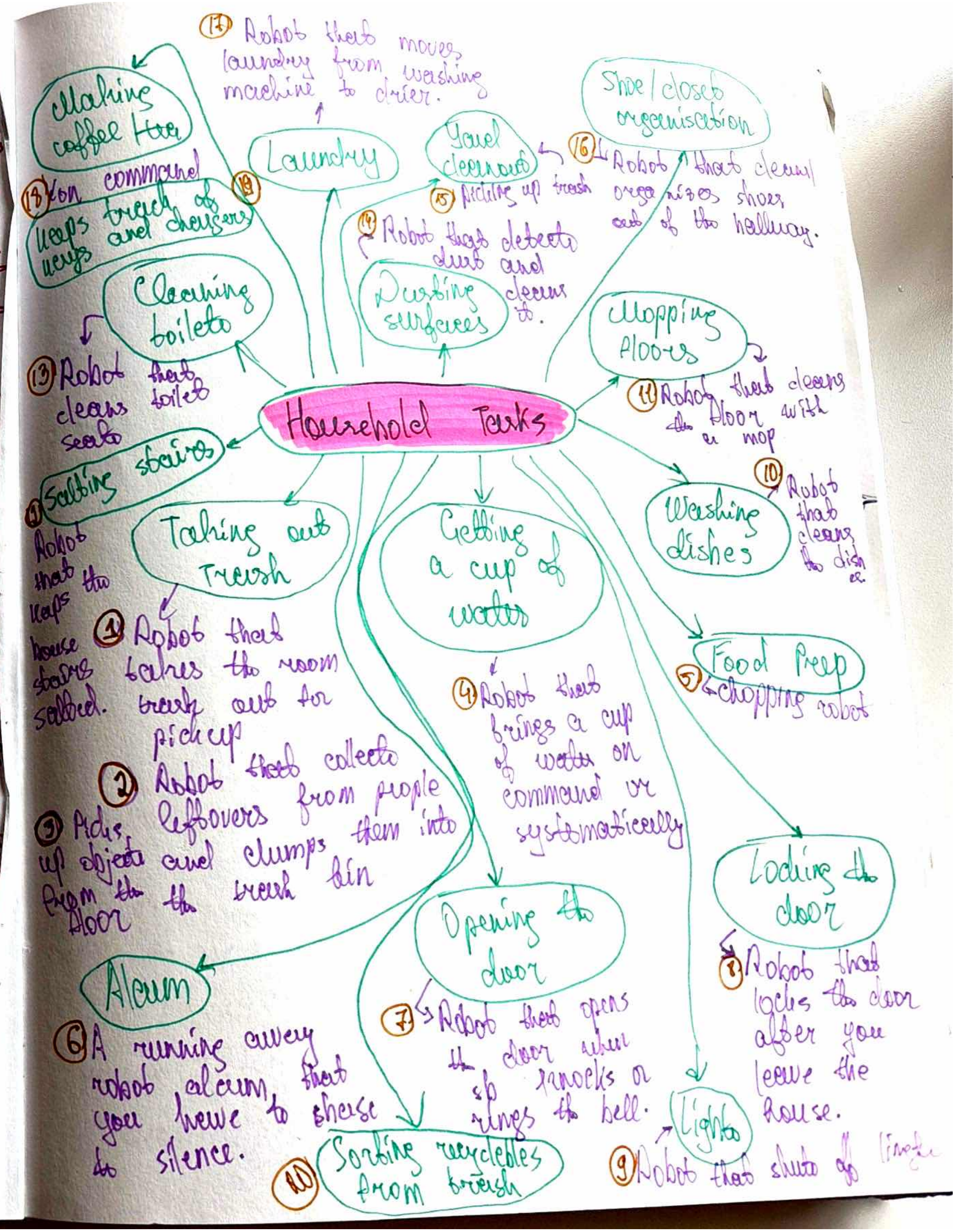


Problem space
Ideate
Research
Sketch
Feedback
Prototype
Test
problem space → ideate → sketch → feedback → prototype → test → feedback
research



Household Tasks
Making coffee/tea
(18) on command keeps track of keys and charger
(19)
Laundry
(17) Robot that moves laundry from washing machine to drier.
Yard cleanout
(15) picking up trash
Shoe/closet organisation
(16) Robot that cleans/organizes shoes out of the hallway.
Cleaning toilets
(13) Robot that cleans toilet seats
Dusting surfaces
(14) Robot that detects dust and cleans it.
Mopping floors
(11) Robot that cleans the floor with a mop
Salting stairs
(12) Robot that keeps the house stairs salted.
Taking out trash
(1) Robot that takes the room trash out for pickup
(2) Robot that collects leftovers from people and dumps them into the trash bin
(3) Picks up objects from the floor
Getting a cup of water
(4) Robot that brings a cup of water on command or systematically
Washing dishes
(10) Robot that cleans the dishes.
Food Prep
(5) chopping robot
Alarm
(6) A running away robot alarm that you have to chase to silence.
Opening the door
(7) Robot that opens the door when sb knocks or rings the bell.
Locking the door
(8) Robot that locks the door after you leave the house.
Lights
(9) Robot that shuts off lights
Sorting recyclables from trash
(20)

More Brainstorming

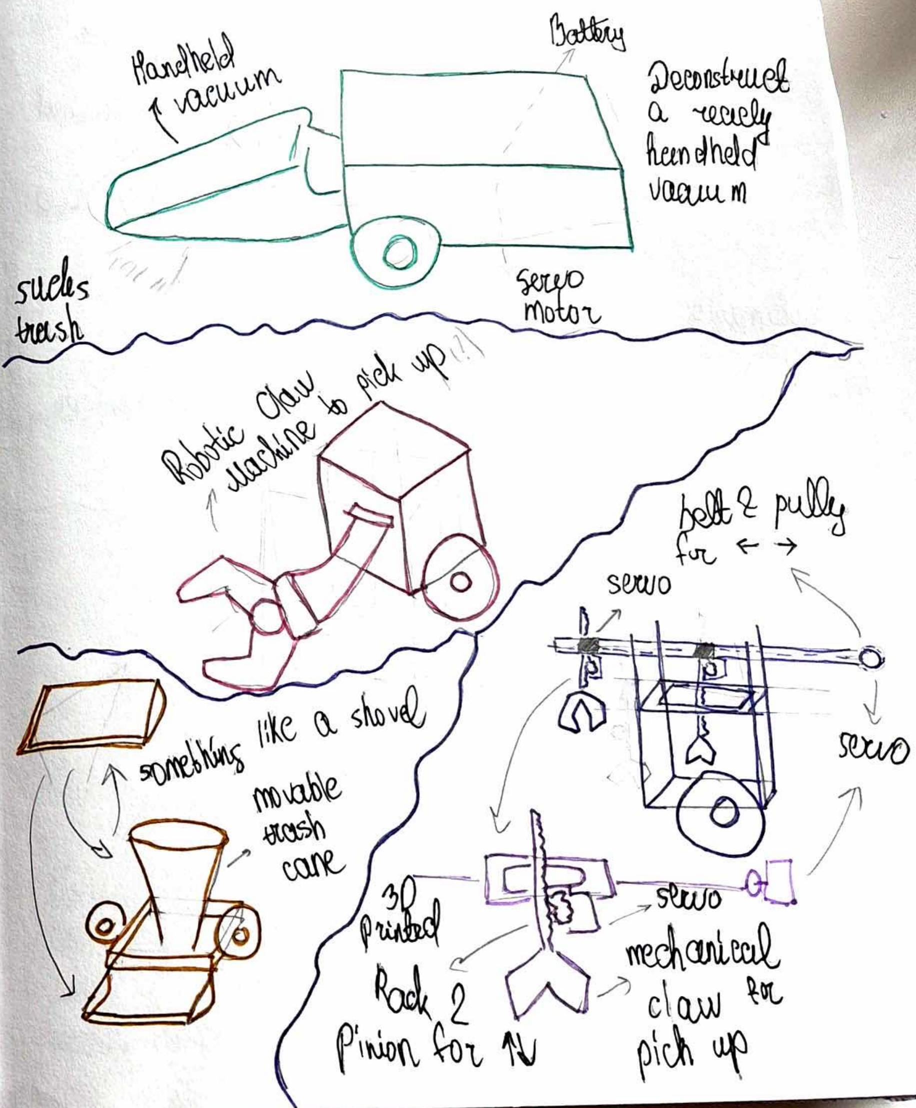
KITCHEN
- Loading/unloading dishes
- Mopping the floor
- Washing the dishes
- Cleaning the grease off of the oven
- Taking out the trash
- Cleaning the fridge
- Meal prepping
- Notifying of expired food in the fridge

BEDROOM
- Turning off the lights after sleeping
- Night lamp robot
- Charging the devices for the night
- Waking up in the morning
- Bring water/snacks/coffee to the bed
- Picking up items from the floor
- Sorting slippers/shoes
- Sorting laundry
- Vacuuming the floor

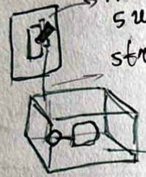
COMMON ROOM
- Cleaning the surfaces
- Opening the door
- Taking out the trash
- Turning off lights and running water
- Locking the door
- Serving food and drinks
- Putting laundry into the washing machine/drier.

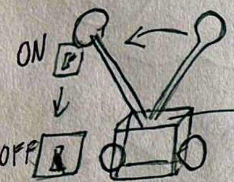
BATHROOM
- Cleaning up the shower after the bath
- Flushing the toilet
- Mopping the floor
- Replacing the toilet paper rolls
- Deep cleaning the toilet seat
- Replacing the towels
- Replacing the shampoos
- Holding the shower suppliences while showering.

TRASH PICKUP



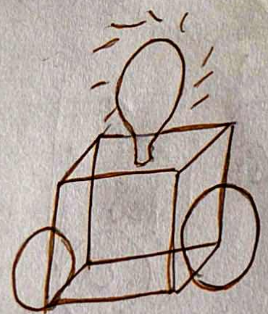
Automatic lights switcher





Timer?
motion sensor

Lights up the way to the bathroom at night



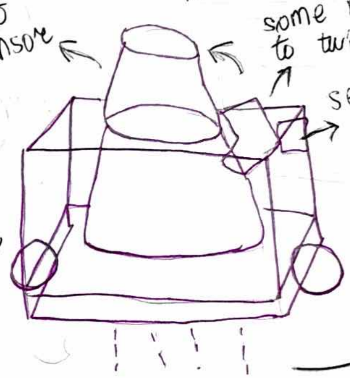
→ Photoresistor to know when the lights off

→ Motion sensor

→ Lamp

Automatic Salt Dispenser

Insight from the cardboard prototype → * The salt dispensor actually works by pressing, not twisting, so it's simpler mechanism



This could also work on the table food potentially

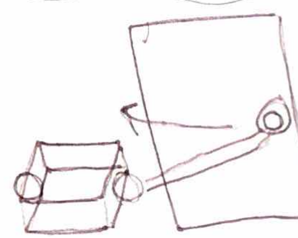
→ salt for snow

How to automate getting the sink ~~water~~ to the cup?

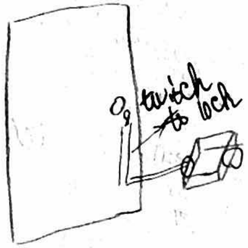
Cup of water delivery on command

* Or food and beverage delivery robot for parties

- Turning the door knob was actually really hard
- Lots of power to open the heavy door



Open the door



washing machine

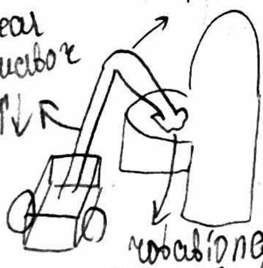
Dryer

moves clothes from washing machine to dryer

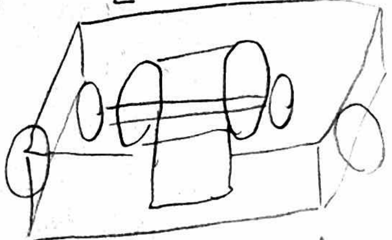
- Linear actuator for the press
- Robot's voice command
- Movement on the table

press usage

Toilet cleaning Robot

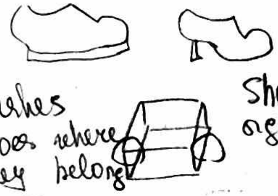


Because my housemates always complain about my usage



Toilet Roll Holder

Rationer robot

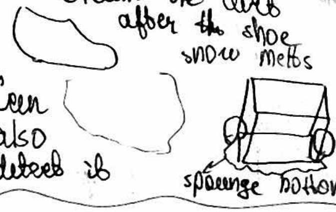


Pushes shoes where they belong

Shoe organizer

Cleans the dirt after the shoe snow melts

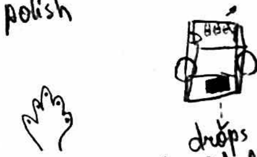
Can also detect it



Alarm clock that runs away

(+) Should be fairly easy to implement with a speaker, motion sensor (it hears), and random movement

Automatic Hand cream/nail polish supplier

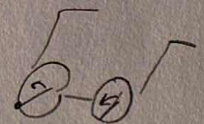


- Very inaccurate
- Needs to clean the pips
- 1D motion

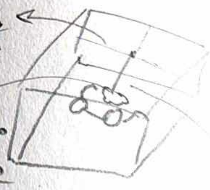
Food Bug/Fly killer

- Requires very specific precision
- Flies' movements can't be detected with motion sensors.

Automatic cleaning Glasses #1

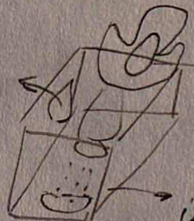


Automatic Cleaning Glasses # 2

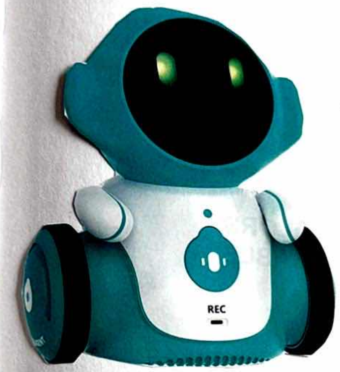


- Requires great presicion and 3…

Weather Indicator



OBSERVATIONS



Voice Control Commands:

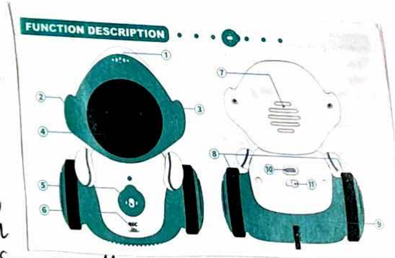
→ Contrary to other students' observations, my robot's microphones were working great and were very reliable.

→ I tried all the commands on the manual.

→ The robot was able to move on different materials as well, such as on the floor, carpet, and on the bed.

Touch Sensors:

→ The touch sensor on the head worked as described.



→ The touch sensors on the ears didn't work, the robot didn't respond in any way, while it was supposed to turn to either left or right depending on the ear.

Recording and playback ☆

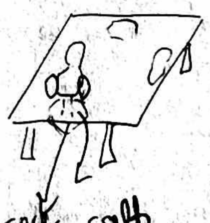
→ I was most interested in the recording part of the robot since it's such a subtle function but can tell / spy on a lot at the house.

→ It worked as described although it took couple of attempts of pressing the button.

RECORDING

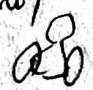
Records household chores within the housemate and displays them on the display.

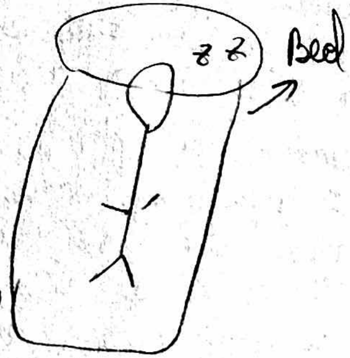
Records the conversation at the table secretely.



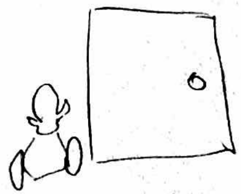
spits salt on the plate

→ Sings songs / plays podcasts / / plays audio books for you to fall asleep.





→ Records the sleep cycle (snoring, sleep talking, etc) and plays back in the morning.



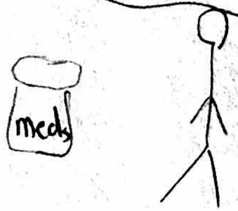
→ Records who comes and leaves and when
- Would need an added camera since it doesn't have one now.

Brings water + reminds to drink water

→ Records panic attacks
Plays self-soothing techniques.
Useful to show doctors & therapists or for personal use.

Keys Phone Gloves ? Anything you don't use but think you will

→ Records you saying out loud where you put those things.
→ Repeats back when asked.



→ Records you taking meds
→ keeps track of the number / timing.
→ Reports back

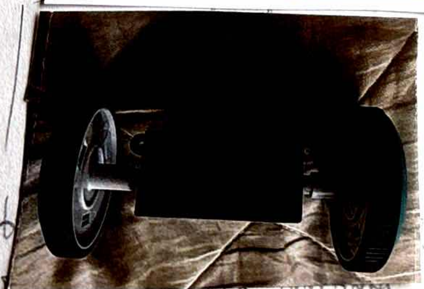
Hardware Parts

① The speaker
2 green wires connected
to the yellow microcontroll

② Battery
Red and black
wires connected to the
green microcontroller

③ Green microcontroller JR-M005B4
seems to be connected to power and to the
yellow microcontroller. → Memory push botton swi

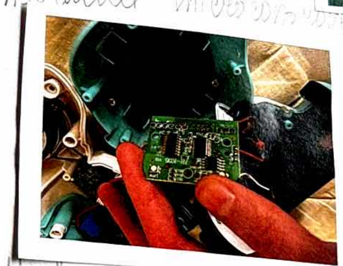
④ 3 Touch censors
Each connected by one wire
(red, white, black) to the yellow
microcontroller.



⑤ 2 DC motors
Both in a black case
connected to the wheels,
each has a 104 capacitor,
each connected to the microcont ... es:
power & ground. Was looking fo ... since
the movement is biodirectional, but couldn't se

⑥ The screen
The screen on the head
was not electrical and
was not connected to
anything. The perception of ey
changing colors was due to
microcontroller.

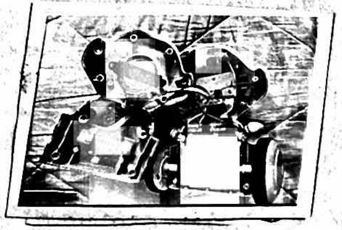
⑦ Deconstructed microcontroller

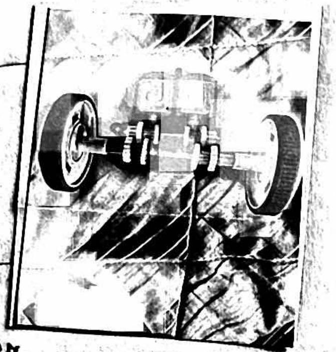


⑧ The black case next to the wheels
I unscrewed the case out
which came out attached
with the wheels. My
assumption is that there are
2 motors, a button, and
the microphone with the
recording device.

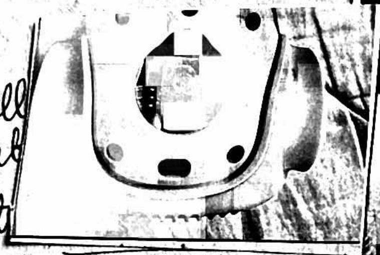
I need to open the case ... mponents
individually since right n ... pins
sticking out of the case and I'm not sure what they
belong to or how to work/connect them.

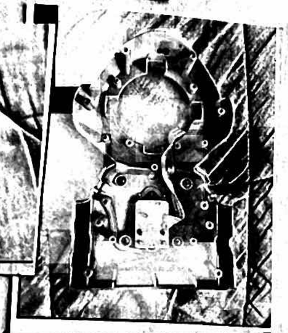
⑨ Unscrewed black case with motors





⑩ The Microphone - Recorder





After unscrewing the front white shell of the robot that contained the butt[on] for sleep and also record, I discovered the "JR-406MIC" device, connected through 3 pins.

Google Search About "JR-406MIC" device:
Connects to 5V, GND, and to either digital pin or analog pin depending on the purpose. I want to understand and potentially write down the speech => analog pin.

Options of Libraries to work with Speech

Option 1: External Speech Recognition Module
Goal: Converting Sound to Text
→ The Elechouse V3 Voice Recognition Module is an Arduino-compatible board that can recognize pre-trained words and phrases
→ Used with VoiceRecognition3 library
⊕ Works directly with Arduino, no need for external processing
⊖ Requires a hardware that I don't have!!!
⊖ Limited to pre-trained commands

Option 2: AI-Based Speech-to-text API
Goal: Real time speech recognition
→ Google Speech-to-Text API
→ IBM Watson Speech-to-Text
→ Vosk API
⊖? This requires sending microphone data to ESP32 with WiFi (microcontroller that I'm using)

My ESP32 connected to eduroam but not the house wifi, which, when I searched online, could have been because of the settings mismatch. Could not do anything about it since I don't have an access.

↓ Tried option #2

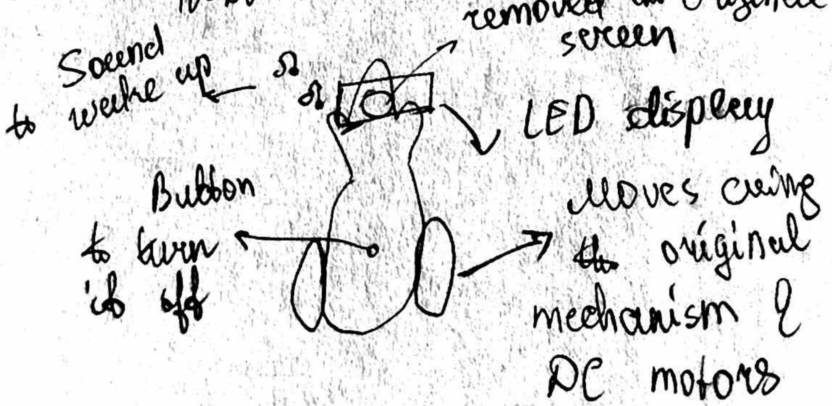
Turns out I needed a microcontroller that supports the I2C protocol, which neither the original JR-406MIC, nor my own "big sound" microphone from ELEGOO kit were supporting. I was surprised since the robot was using speech recognition before I took it apart. The internet search showed that it was a pre-trained data.

(9) Previous idea: Receives voice information and transcripes that information on the display

After realizing that my microphone is not equipped with real time voice recognition

New idea: Make an annoying alarm that you have to chase to turn off.

- Moves around using the DC motors.
- Senses the distance using an infrared sensor (my sensor lol)
- Has a button to be turned off.
- Uses active buzzer for the alarm.
- Uses LED display to show a TO-DO list.



Hardware Assembly

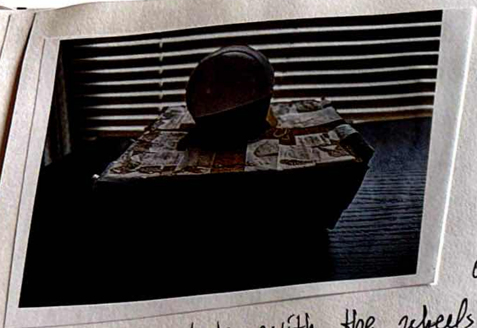
(1) Unscrewed and screwed back the motor case as I was interested how the mechanism worked inside. However, I left two gears outside and when I tried opening up the case again, the screws were broken. Will try to attach my own DC/servo motor to the mechanism instead.

(2) Put up the LED display.

(3) Wired a working button

(4) The speaker: Tried to connect the original speaker to my ESP32 however found out that ESP32 doesn't provide enough power for this speaker to work w/out an amplifier. Will try to use a passive buzzer instead.

(5) Tried to connect my servo motor and work the wheels ~~but~~ broke my laptop. Probably wrong wiring and more current was required from my USB port than it could have supplied with.



One of the 3 card board prototypes

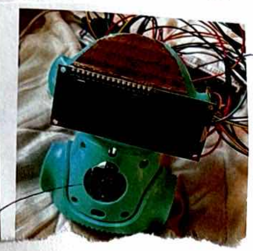
All my initial prototypes had the cube shape since I was planning on using the bottom part of the robot with the wheels and the motors, however the later prototypes kept the whole body of the robot as the head was not detachable. I also used 3D-printed wheels from one of my previous projects to immitate the robot wheels. This specific prototype was supposed to light up the way to the washroom at night.

The other two prototypes at the critique session were:

~> Salt dispensery automation

~> Vaccum cleaner robot where I dissassembled my handheld vacuum cleaner.

Reflections



Used the cardboard cutouts to immitate LCD display case. Would have 3D printed the case for more accurate representation.

My button.

The wire management could have definitely been better. I filmed the video from the front as I didn't know how to fit the 16 pin LCD connections within the robot case.

- Used Arduino ESP32
- My passive buzzer for the alarm replaced the original non-interactive display with my LCD display
- Used a button

What I learned:

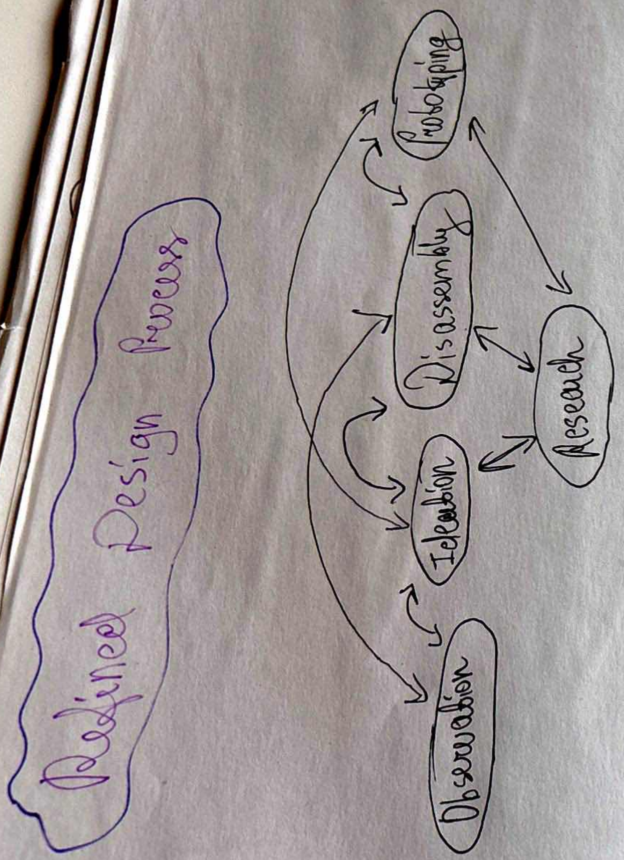
① Speech Microphones have to have / support I2C communication for real time transcription. That's why my first idea failed.

② Check that the voltage is correct before running the code with the motor. That's what killed my laptop.

③ I learned / researched the hardware parts of the robot.

④ Some wifi networks might not be compatible with Arduino 32. That's also why my original idea failed.

⑤ Not to break the wires while dissembling the robot.



DP 1 - GRADING SHEET

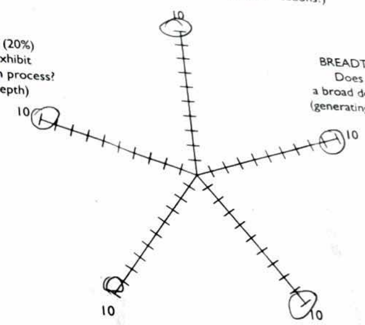
INFO 4410 / INFO 6420/ CS 4754

LiLi /100

COMPLETENESS OF PROCESS (20%)
Does your logbook exhibit
a complete design process?
(concept, development, implementation, and evaluations?)

DEPTH OF PROCESS (20%)
Does your logbook exhibit
a deep design exploration process?
(exploring ideas in depth)

BREADTH OF PROCESS (20%)
Does your logbook exhibit
a broad design exploration process?
(generating and exploring many ideas)



DESIGN EVALUATION (20%)
Does your logbook document your
evaluation criteria and design
decision making process?
(evaluating ideas)

VISUALIZATION OF PROCESS (20%)
Does your logbook exhibit use of design
visualization and design sketching
techniques to generate, evaluate,
and develop your designs?
(generating and developing ideas visually)

What worked well in your idealog?

- LOTS OF DETAIL
- AWESOME REFLECTIONS
- EVIDENCE OF RESEARCH AND LEARNING
- CLEAR DESIGN RATIONALE

What didn't work so well in your idealog?

- TRY TO USE SKETCHING FOR IN-DEPTH EXPLORATIONS (E.G. MECHANISM
  IN ADDITION TO ILLUSTRATIONS

AUTOMATIC DOORS

Sensors
- Lights
- Tolling doors
- for distance
- to open up
- Cold handles
- Extreme temperatures

Buttons

Elevator buttons:
- floor buttons
- open the door
- close the door

Apart. building security:
- intrance code
- Accessibility button

Security
- Apt. building
- Key card access

Visual cues
- what indicates "automatic"?
- where are the buttons?

when the disabled person doesn't manage to pass through

Hotels
- What makes people feel special?
- what makes people feel welcome?

Elevators
- Why are there keep the door open or close buttons?
- How do people decide when to use those buttons?
- How much time could be saved if elevators knew how many people to wait for?

What makes these employees irreplaceable?

Bars
- Bouncers

They check sobriety and deny entry if needed
- Alc level detection sensor?
- ID scanner door?
- Why can't bouncers be replaced by automatic doors?

when sh closes the elevator door on you

Emotions
- Frustration: doors that don't stay open long enough.
- Suspence

- Social norms?
- Door-less elevators!

Social expectations

Authority

Incidents
- Apologizing doors
- Socially aware doors waiting for the door

Guest Lecture: Hannah Pelikan

"Interaction is orderly"

"Once you look really closely there is nothing you can't explain why it's happening."

→ Look for "weird" interactions/reactions and try to answer the "Why now?" question.

Co-creation & sequence org.

Before → now → after

Third person proof procedure:
"Looking at the response to make sense of what action a behavior is constituting."

For the elevators there's usually uncertainty around expectations:
- ~ Who presses the buttons?
- ~ Do you ask another person? Do you try to reach them by yourself?
- ~ When do you wait for the other person?
- ~ Why do the buttons "open" & "close" exist if it's automatic?

Participation: Focus on how categories are mutually constructed and oriented to by the participation.

How people self prescribe to roles

What ~~they~~ us expect from the door automation?

Accountability: What/who is considered a member? Actions available vs not available to certain members

USEFUL REFERENCES:

Adjacency pairs → actions that come in pairs
- ~ Greetings
- ~ Q&A
- ~ Request-fulfilment

Keep the transcription very descriptive, what you see, what you hear! No analytical categories at the beginning.

Feeling a slot → creating a slot to fill in

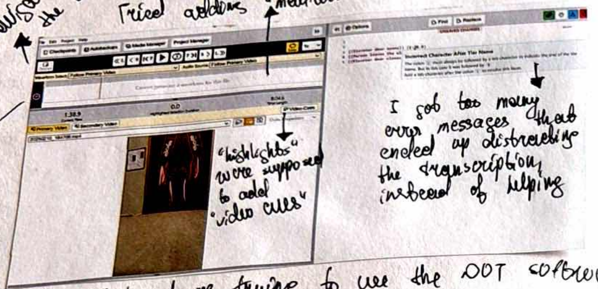
ELAN → Annotation software

You can count seconds of door opening, waiting, steps taken

Using DOT

navigates the video

Tried adding "markers" to highlight the video but didn't work



"highlights" were supposed to add "video cues"

I got too many error messages that ended up distracting the transcription instead of helping

Error msg

A screenshot of me trying to use the DOT software

① Started getting some error messages right away trying to transcribe the video. I think this particular one meant that I used a Tab where I wasn't supposed to. There is only one Tab allowed per line, otherwise it breaks the code. And symbols such as "()" also break the code. I was just trying to add timestamps.

② Synchronizing the transcriptions with the video was harder than I expected and then the instructions/shortcuts showed. I think anything with the sign is supposed to help synchronize the notes with the video, but the button didn't work.

6:09
enters the elevator

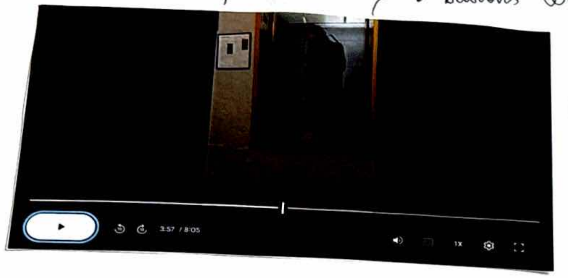
6:10
turns and looks at the left side of the elevator
"Why?"
Hypothesis: In his mental model the buttons are on the left side of the elevator.

6:10
Turns to the right side of the elevator

6:11
Approaches to the right side of the elevator.

Where people are looking for them

Where the buttons are

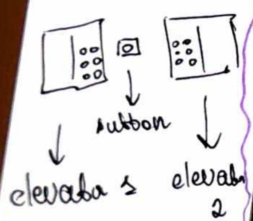


3:57
Enters & looks at the left side of the elevator

There is also a 2nd elevator and the elevator button on this side

3:58
Looks straight up, changes his body orientation.

Mental model?



3:58
Looks and approaches to the right side of the elevator

Elevator Video Transcription

(elevator door opens) 1.39
(the person leaves)
(elevator door open for 3 seconds)
(elevator door closes for 4 seconds) 1.43
(another person runs towards the door) 1.44
(the person immediately leaves) 1.45

(elevator door opens) 2.37
(person 3 leaves the elevator) 2.39
(person 4 leaves the elevator) 2.40
(elevator door starts closing for) 2.43
(elevator door closed completely) 2.46

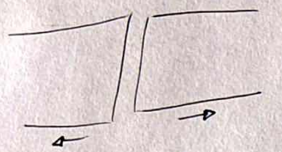
(person 5 presses the elevator button) 3.52
(elevator door opens) 3.54
(person 5 enters the elevator) 3.56
(person 5 turns and looks to the left of the elevator) 3.57
(person 5 turns and looks to the right of the elevator) 3.58
(person 5 presses a button [assuming it's close the doors]) 4.01
(person 5 turns around to the wall) 4.03
(elevator door starts closing) 4.04
(person 5 moves and puts down instrument) 4.05

(elevator door opens) 5.09
(person 6 starts stepping out) 5.10
(elevator door starts closing) 5.15
(elevator door fully closed) 5.18

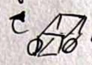
(person 7 approaches the elevator button) 5.37
(person 7 presses the elevator button) 5.38
(person 7 is moving around and tapping their hand)
(elevator door starts opening) 6.05
(person 8 starts stepping out) 6.06
(person 7 starts entering the elevator) 6.08
(person 7 looks at the left side of the elevator) 6.09
(person 7 looks at the right of the elevator) 6.10
(person 7 approaches the right side of the elevator [buttons]) 6.11
(person 7 presses the close button on the elevator) 6.14
(person 7 presses the close button again) 6.19
(elevator door starts closing) 6.19
(elevator door is completely closed) 6.22

Interaction Ideas

HOTEL



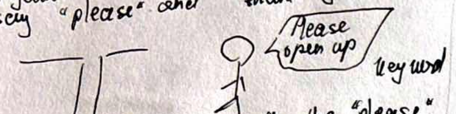
Takes guests' luggage and greets them as a door man



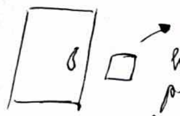
No more looking for buttons

Voice activated elevator

Against the annoying people who don't say "please" and "thank you"

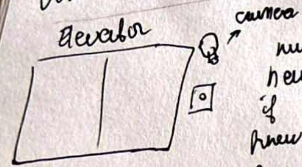


Voice activated door with the "please"



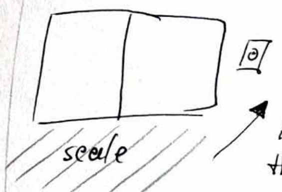
The automatic opening button heats up so that people don't have to freeze touching it.

Elevator



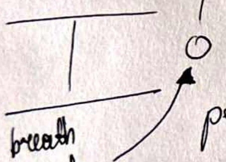
Imagine how much time would have been saved if the elevator knew how many people to wait for by looking around so it doesn't stay open for no reason.

Elevator



The scale estimate how many people are in front of the elevator

BAR



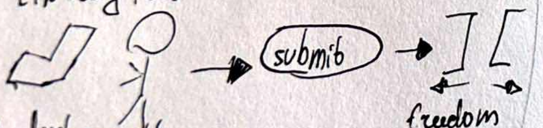
Breathalyzer for people entering the bar => no intoxicated people allowed

Just breath out

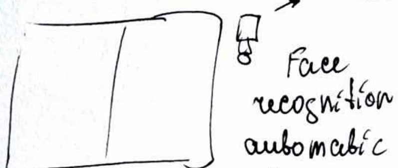
BAR

Automatic ID scanner for bars

Library/classroom



student working on an assignment



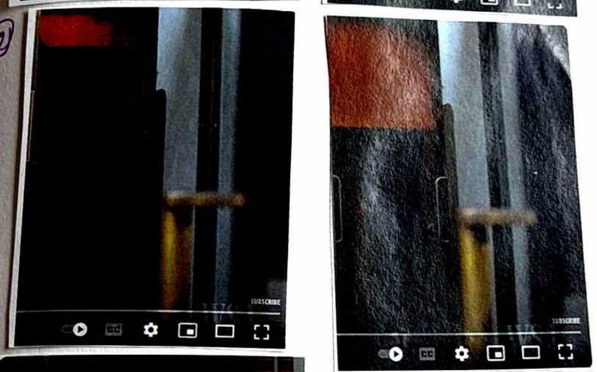
Face recognition automatic doors

Doorless Elevators

Why have we introduced doors to elevators if they existed without them for so long?

1

2



3

Doors are first and foremost safety measures.

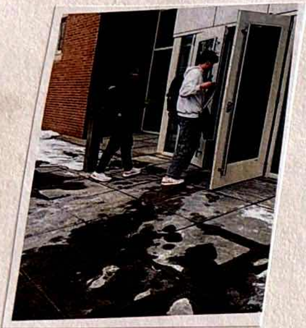
1) The woman looks terrified. Reaches up to hold the handle. Looks calmer when both of her hands are on the handles.

2) The person almost heats their head on the moving elevator.

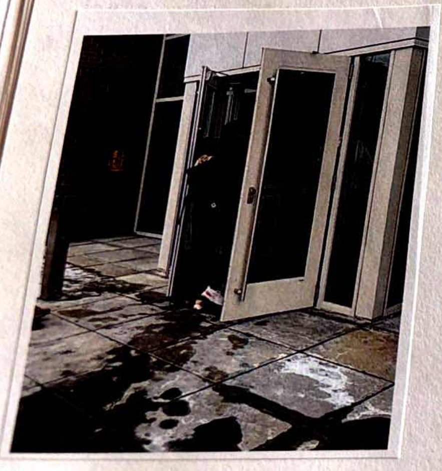
3) The person jumps out of the elevator halfway through. Safety hazard. The person doesn't use the handles to balance themselves.

Accessibility Button Observations

Two people approach the building together at the same time. One person reaches to open the door while the other person presses the accessibility button.



The ~~tw~~ doors start opening assymmetrically. One from the pull of the first person. The other one from the press of the accessibility button.



The doors close on the second person.

Key Level Access Observations

Lisa approches to a locked door that requires a key level access. The door is locked because it has a red light on.

Lisa taps her ID to pass through the door. The door changes to green indicating that the door has been unlocked.

Lisa tries to enter but the door, in fact, hasn't been unlocked. It was an incorrect feedback by the system.

Feedback on the critique session

① Watch out for Anthropomorphism. no talking doors, no human-like characteristics. Research shows that anthropomorphism in robots back-fires since people start having unrealistic expectations from machines.

② Don't try to improve intention detection, improve the interaction, such as in 3rd person proof procedure. What if the automatic door was a human, how would that interaction look like?

③ Change the automatic doors in very subtle ways, without changing the concept ~~too~~ much.

④ What if the door could signal that it's about to open or that it's about to close by a gesture before fully "committing" to it?

⑤ Consider what actions are available to users throughout the interaction.

⑥ Some groups considered children as the users of the Ithaca Science center (diverse set of users). Some groups explored the visibility of the doors and how that can become an issue. Doors never shutting or doors as thermo balancers.

Designing Gestural Interfaces

ARMS FOLDED

→ Both arms are folded across the chest.

→ Possible use: stopping an action

? stopping a falsely opening automatic door

STOP

→ A flat hand is held upward and forward, with the palm facing away from the body.

! This sign might be very offensive in some parts of the world, such as Greece.

→ Possible use: cancelling, quitting

SLAP

→ A flat hand is moved left/right in a sweeping motion.

→ Possible use: open up the door (elevator, automatic)

Move Body To Activate

WHAT: The physical movement of the body or a part of the body triggers an action. Many current automatic doors have motion sensors.

USE: Use when the action you are enabling requires that the person be moving, not just be in the area.

HOW: This pattern requires the ability to sense movement, frequently, directional movement. This can be accomplished with cameras, infrared beams, or via accelerometers embedded in wearable devices.

An interesting/unique way to open the door.

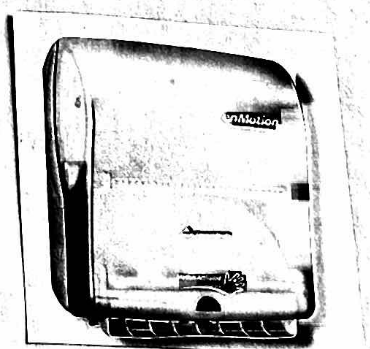
Wave To Activate

WHAT: Waving a hand (often in front of an indicated sensor) triggers an action.

USE: Use wave to activate for a simple gesture that is not typically done by accident. As such, this pattern is good for use in public spaces.

WHY: Wave to Activate is a simple, common gesture. It's also used by people trying to manually trigger Move Body to Activate or Proximity to Activate.

HOW: A number of sensors can be employed to detect a wave, including a camera and, most frequently infrared beam. A wave can also be captured by a very small range on a motion detector or heat sensor.



Hand dryers are using wave to activate

~~the~~ the "arms folded" gesture to stop the doors from opening

The "stop" gesture to activate door opening

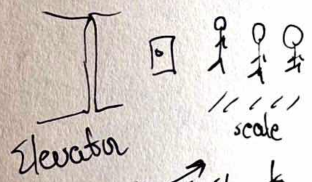
STEP TO Activate

WHAT: A user steps (either deliberately or unknowingly) onto a designated spot that triggers an action

USE: Use step to Activate when other proximity detectors (sound, infrared cameras, etc) would be impractical, or for actions that would naturally be delivered by the feet (stepping, dancing, etc)

WHY: This pattern is useful for alternative controls when the hands are occupied or for controls in low places where it would be difficult to reach with the hands.

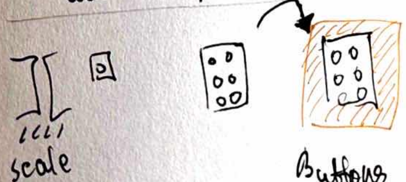
HOW: Step to Activate typically requires a pressure sensor placed inside or beneath a flat object.



Gives priority to the floor where there are more people waiting

Door automatically opens when there's an extraordinary heavy object on the scale

Dance floor games are using step to activate with pressure sensors.



Buttons light up when sb step into the elevator

2nd Critique Session

Strings to manually control the elevator position.

Tracks for the elevator to slide up and down.

The door also slides side-ways to immitate the elevator door opening and closing.

Tracks for the elevator door to be able to stand / slide.

Elevator prototype

Interaction ideas:

- Use pressure sensor to activate the lights and buttons when a person enters. Solves the problem of people getting disoriented.
- Use pressure sensor to get how many people are waiting on each floor to give the majority a priority so that more people can benefit.

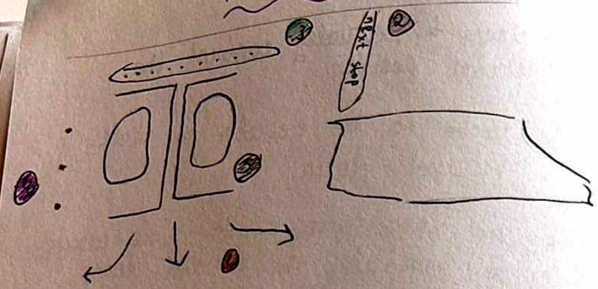
! The wait time for some people will significantly increase.

Feedback:

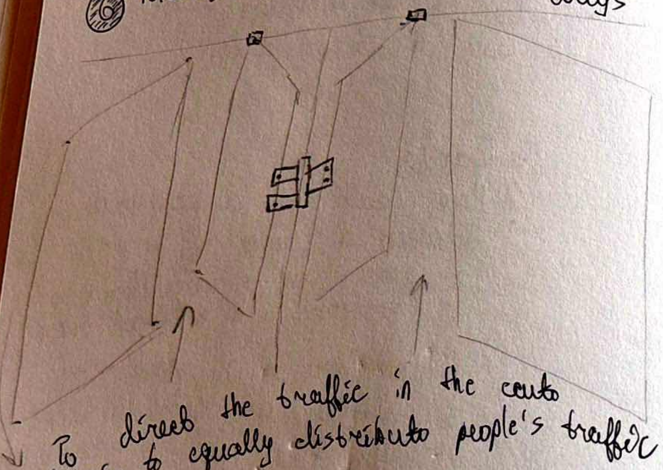
? How would you differentiate between a group of people, a person on a wheelchair or someone with a food truck?

! While there is no real way to differentiate between those groups from just a pressure sensor, the priority should probably go to the people who can't take the stairs otherwise.

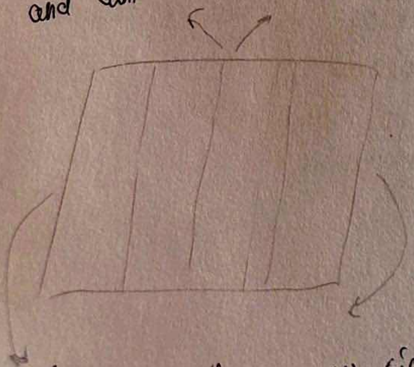
NYC Subway Automatic Doors



⑥ Folding doors to open up several pass thru ways



To direct the traffic in the centr and aim to equally distribute people's traffic



Aims to replace the arrow signs on the ground and use space to restrict people's movements.

① Signs on the floor that show people which direction they can go to. Research shows that signs don't really work

② A display on the top showing the next stop. Very inconvenient to see depending on where the person stands/seats.

③ A display on top of the doors showing the next couple of stops. Usually doesn't show middle stops. Isn't visible from outside.

④ Lights flush to indicate which side doors are opening.

⑤ Sliding doors to let people in/out.

⑥ Instead of sliding doors, what if we made folding doors that would direct people's directions and pivot the[ir]

The setting in question

Another example/inspiration from a subway door setting taken from Instagram. Shows how a simple are added to the passways in subways could solve something that the company sees as an issue. The important takeaway is the simplicity of their solution.

I 3D printed a hinge for a small prototype of a folding door. I forgot to remove the supports so all the holes are filled with supports, that I couldn't (didn't know how to remove, even after trying to drill through it.

First Prototype → Redesigning
to relocate people

Closed doors

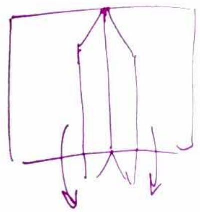
(+) The cardboard material was steady enough to hold the frame.

(−) The cardboard wasn't foldable or flexible at all. Not ideal for prototyping folding doors.

Fold 1

Fold 2

? Probably the left and right folding doors are not necessary. If the centre door folds inward with the 2 walls it would make 2 entrances.



Developed Prototype

(+) The doors are more foldable & flexible so we can imagine the mechanism better.

(+) There are stick figures to visualise the real life situation and how the solution would work out.

(−) Still using tape & staples to hold the doors open.

(−) Isn't steady, doesn't hold itself up. Had to put tape around the frame so it stays.

Final prototype

Subway doors closed with a random crowd in front.

Subway folding doors start to open up: 1st fold

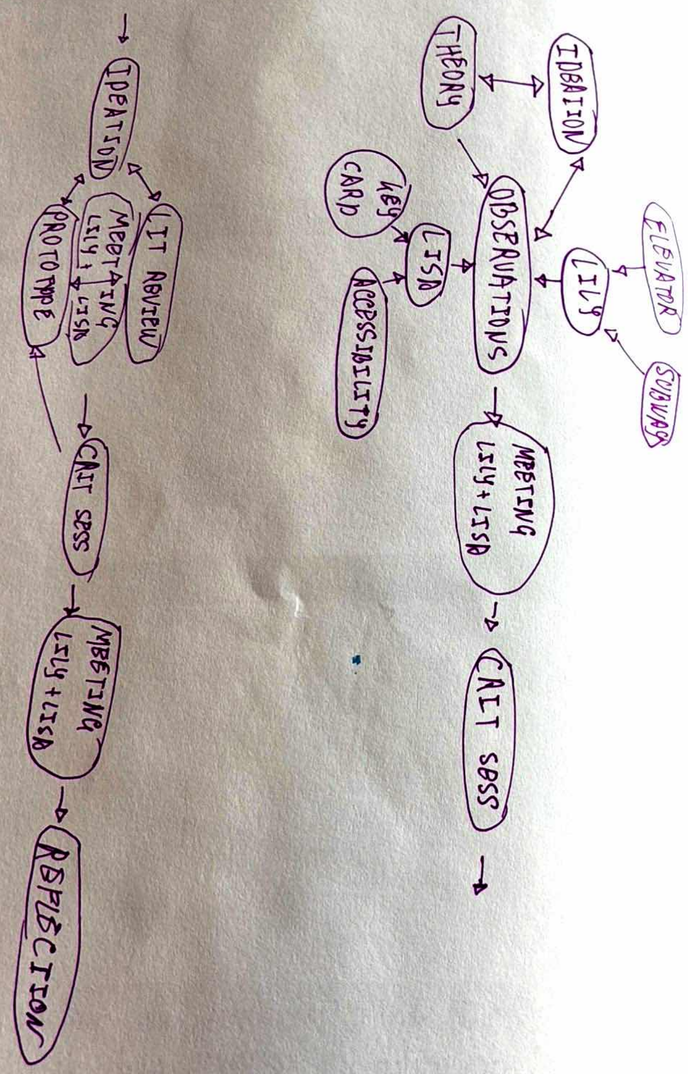
Changed the material after the 1st stick figure because cardboard wasn't flex

Subway doors completely open, the crowd starts tak a shape of 2 r organised lines.

? With the 2 entrances, one can be designated for entrance and the other one for exit.

(Please skip the reflections and then come back)

REFLECTIONS: Design Process



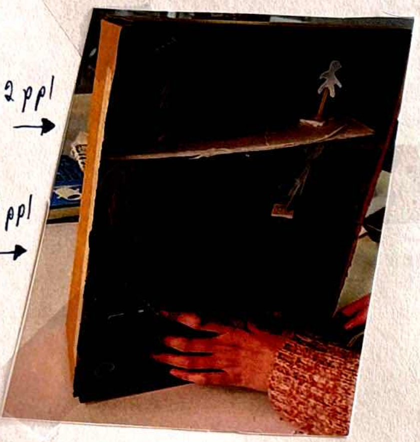
REFLECTIONS

- Experienced that the first ideations are usually useless/trivial + no need to add modalities to tech in order to improve it ⇒ my first 10 ideas ended up useless since I was trying to add sound and/or new sensors.
- Learned about anthropomorphism and 3rd person procedure. Never before I had thought about thinking about "correcting" the tech, rather than trying to improve its predictions.
- Learned how to analyze videos to capture human-machine interactions. Had so much fun doing so.
- In order to understand the role of the automatic doors went back and looked at the videos with doorless elevators to understand the main purpose.
- Was reminded to turn off the supports when 3D printing components with holes in them.
- Experimented with different materials for prototyping.
- Realized that to improve a tech we should use a better fitting interaction to a specific problem area and utilize people's psychology, rather than create a whole new interaction.
- Learned how to categorize activation mechanisms, such as "move to activate," "wave to activate", and "step to activate." Read a book about it to better choose an activation mechanism.

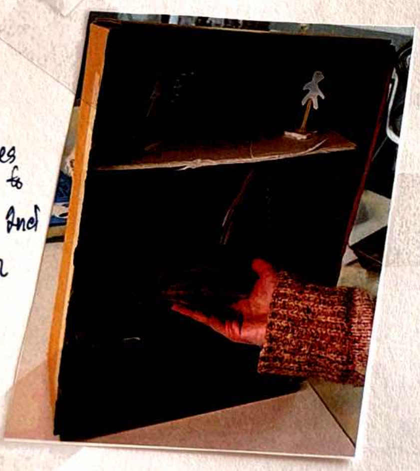
Additional Interactions Considered

2 ppl →

3 ppl →



Goes up to the 2nd floor



Skips over the people on the last floor.

Elevator that gives priority based on weight measured by the scale implemented on each floor.

Physical Constraints Implemented

Crowd control Barriers

This prototype illustrates the subway arrows on the floor ↖↑↗ using physical constraints.

Had to use clay for the curves.

It mimics/is inspired by the airport security/passport control lines that don't show lines but constraint people's movement.

The ideal interaction would be people following the lines but the reality is (pictured) that this interaction would be a safety hazard.

→ The person is pressed to the crowd control barrier by the stomach.

Safety hazard especially during the rush hour when people are pushing each other to the trains.

STATLER HOTEL OBSERVATIONS

The lobby

The back office has a lot of prominent privacy issues since the space is limited. However, privacy is also very much needed since the staff are taking calls for reservations all the time, most of the time simultaneously. The privacy is created through the artificial "walls." This seems more like an architecture issue than a robotics issue.

This seems more of a software issue than a hardware/robot/human-computer interaction solution issue.

The main issue pinpointed for the lobby is the bell boy/key card management, because:

- Hotel guests need to call or even come down to the lobby to reserve a parking.
- Finding the keys is a messy and manual process.

- The hotel is still using two booking systems that don't sink with each other.
- The payments often don't go through.
- There is not enough parking for all the guests.

The kitchen

Polishing is very important for luxurious kitchens since they don't want to serve cups/silverware with stains. I noticed that before polishing they put the cups on a steam of a water then they manually hold cup towards the brushes of the polisher. After doing some research I found out that they don't use the polisher as intended as in other kitchens the cups polish on their own.

Manually holding the cup at diff angles/positions to polish it.

The steaming hot water.

Could be that the placing of this shelf doesn't afford the cups to spin on their own.

Fan to dry the polished cups.

The storage comes up as the most troubling issue for the kitchen. Every day there are tons of fresh products entering the storage which have to be put at the ~~front of the~~ back of the shelves, so that the older products get used first: first-in-first-out (FIFO) method. And those products are heavy and have to constantly be moving around. ① The storage of cups also is an issue as the hotel serves different cups at its 2 restaurants and the bar. ② The boxes are not labeled and are put in the storage room randomly with all the very similar-looking cups.

②

①

③

The takeaway is that while the kitchen and the chef himself are
very open to new tech in the kitchen (they were very happy with the
new ovens), those tech come with their own risks. Such as, these
new ovens are like black boxes for the kitchen staff so if/when
something happens they have to stop the kitchen operation (which is
a disaster for the hotel) and completely rely on other people to
assist them. This happened once with the new ovens. While the
older ones have been around for 10s of years and are like "hummers"
that wouldn't break.

The new very expensive ovens.

old vs new

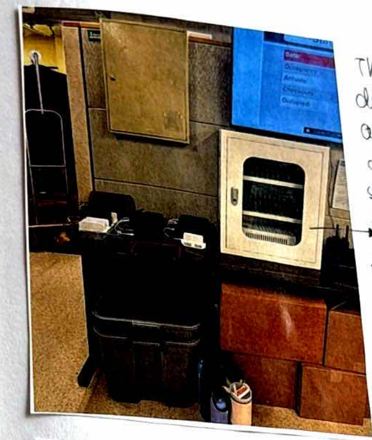
The old "oven" that's still being used.

In addition to that, chefs still love to be able to manually control the state of their meats which is more possible in the old way of cooking.

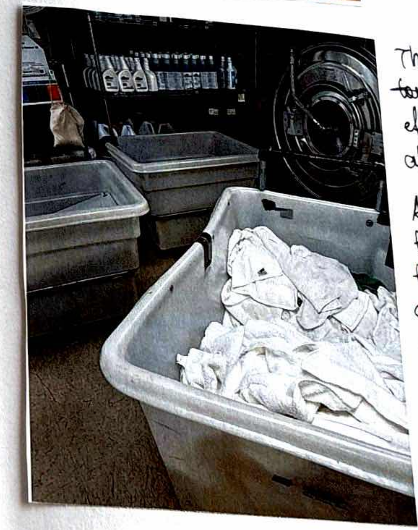
There's a lot of paper around the tables of the kitchen. This ones particularly are to keep track of the prep meals and what products have been ordered/received. They used to use the monitor before but now it only to play music. Mainly because the paper "cheat-sheets" & recipes are easier to move and carry around.

A lot of time and effort is being used to wash the dishes. This machine requires a 2-people operation - one to load the machine and the other one to unload it. And if the person who loads ~~th~~ dishes were to also unload them, they would have to wash their hands every time which would further slow down the process.

The Housekeeping



The housekeeping keeps tablets and distributes them to the staff to assign rooms to the staff members, check their progress and also display some information about the guests.
They got a new charging machine that's not in use yet.



The major issue mentioned during the ~~tour~~ was how much time and effort it takes to fold the towels after washing.
After doing some research we came to the realization that folding towels, aka soft materials, is yet a very challenging and an unsolved issue in robotics and will be almost impossible to tackle in a scope of a semester.

One of the major issues for housekeeping is pushing the laundry cart from room-to-room to distribute clean linen, towels, and supplies like shampoo, slippers, etc. It's hard because the cart is pretty heavy and they need to push it themselves the whole day. A lot of workers then report back & shoulder pain.
As part of the process they change the linen, clean the bedroom, and clean the bathroom, with the bathroom being the most tedious and tiring part. They also have to restock their supplies themselves. The carts are too big to enter the rooms so they push outside and block the hallway.

Each room takes 30 min max | has a 30 min available cleaning window between when the prev. guest checks out and the new guest checks-in. So any intervention has to be fast enough to keep up with the speed. Usually motor-relying home robots are slow for this part.

Housekeeping: mop the shower
+ collect the hair from the shower

Notes on the walls
- cheat sheets for recipes
- what to order for storage

Ticketing system
- do they put notes
- they divide the tickets by the restaurants

Car system
- communicates with Crandl transportation
- Couple of software systems that don't synchronize
- if you wanna reserve you gotta come down a call
- different databases
- non-scannable bar-code key (not a QR code)
- billing issues
- policy issues

privacy issues in the back office
- staff using partitions to create private cubicles

Ideas / Observations

Housekeeping
- room service robot automated
- active using becomes easier
- How do you make things less heavy.
- electric bycicle example
assistive augmentation
- speed issue, keep up with the speed

Touch screen w/info
- No one was using the info screen

Dishwasher
- 2 ppl job

Towels
- its super hard to fold towels because the material is super soft

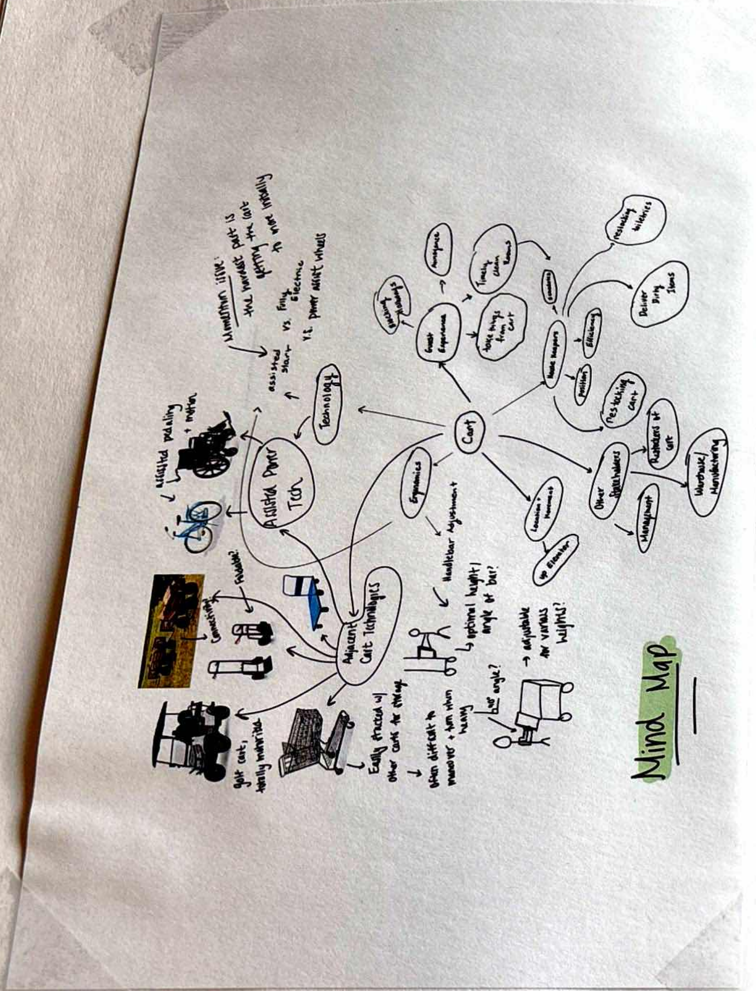
pattern matching ipad

Storage
- order food bake the food
- 1st in 1st out
- sliding shelves
- almost collapsable
- vending machine like

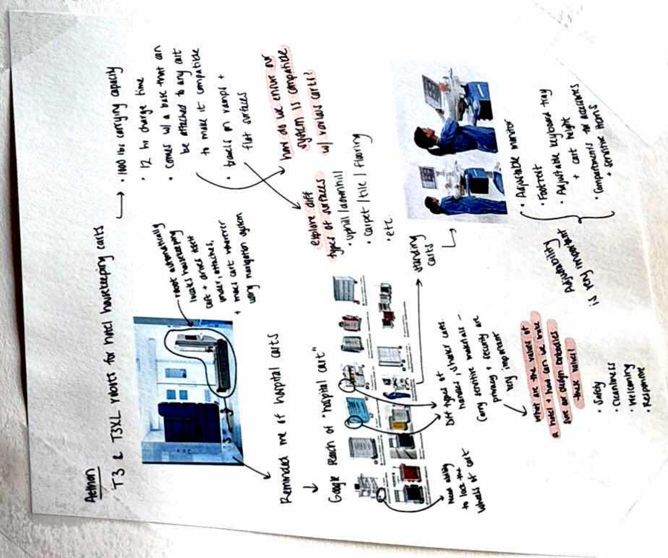
smth like a lazy suscan
- cup storage
- hand written labels

oxygenated wine
- polishing cups
- change angle
- make it a automati
- lots of rotati

Mindmap A mindmap exploring the problem area



EXPLORATION OF EXISTING CARTS

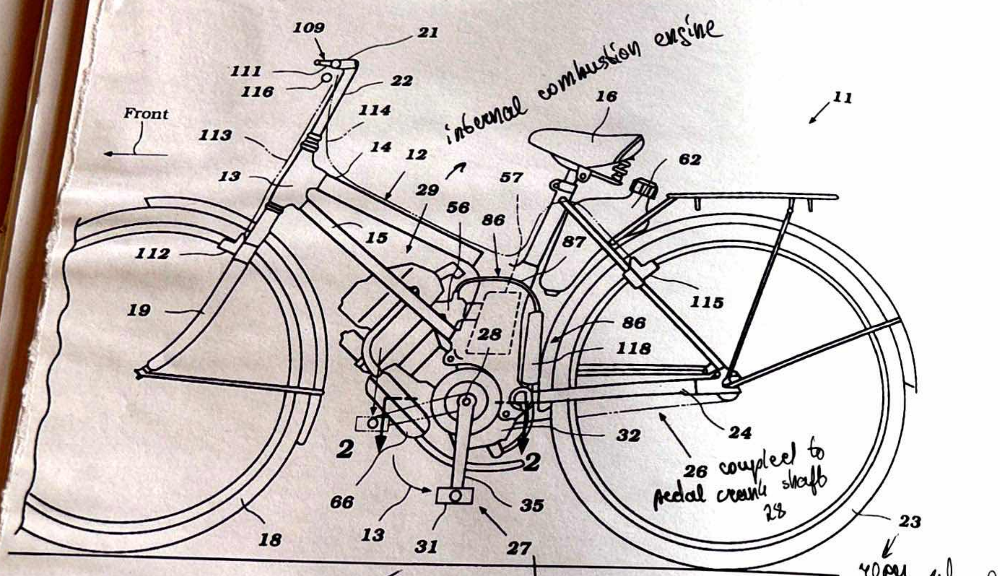


Research into what exists

[57] **ABSTRACT**

A gasoline engine power assisted pedal operated vehicle. The amount of assist provided by the engine is varied in response to variations in the manual force applied by the operator to the pedal mechanism. However, in order to provide smoother power assist, rapid changes in manual power application and, specifically, rapid reductions are dampened in the engine response. In addition, the system includes a disabling device for disabling the connection between the engine and the vehicle propulsion system if the vehicle brakes are actuated.

The e-bikes are very similar to what we're envisioning to help with the housekeeping carts. They are assisted by a motor in addition to mechanical pedalling



pedal **Figure 1** manually operated pedal device

controls the motor 29

2017 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)
Sheraton Arabella Park Hotel, Munich, Germany, July 3-7, 2017

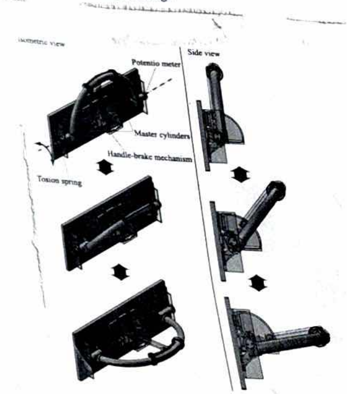
1 DC motor, 2 brakes, differential gear, potentiometer, rotary encoders.

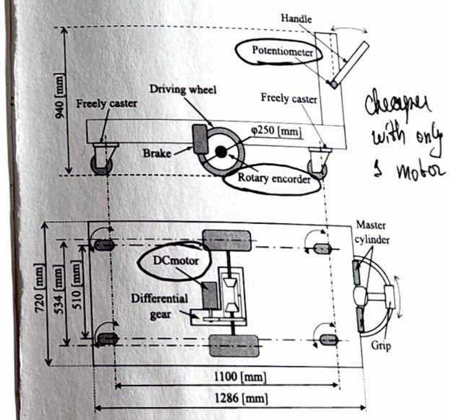
Design and Control of a Heavy-load, Low-cost Power-assisted Cart using Brakes and a Differential Gear System

Yuta Wakabayashi[1], Akira Seino[1], Jun Kinugawa[1] and Kazuhiro Kosuge[1]

Given the importance of improving the maneuverability of power-assisted carts, several researchers are working actively on the topic. For example, Fujiwara et al. proposed a power-assisted cart powered by four motors [5][6]. This power-assisted cart is equipped with universal wheels on each motor, which allow the cart to move in any direction. Thus, the user can operate the cart along three DoF: straight, sideways, and rotational direction in the plane. Furthermore, the cart uses a force sensor as an interface, and the operating force applied by the operator on the cart is reflected directly in the cart's movement. Many other projects use force sensors as the interface to determine the user's desired cart motion [7][8][9][10][11]. By contrast, from the viewpoint of reducing cost, research on power-assisted carts that use inexpensive sensors such as potentiometers as the interface for operation has been conducted. Kashiwazaki et al. proposed a power-assisted cart powered by two independent wheels, allowing motion along two DoF (straight, turning). The cart interface consists of a joystick and a mechanism called assist bar [12]. The user operates the assist-bar, which subsequently pushes and tilts a joystick equipped with two potentiometers. By reading the pose of the joystick, the system determines

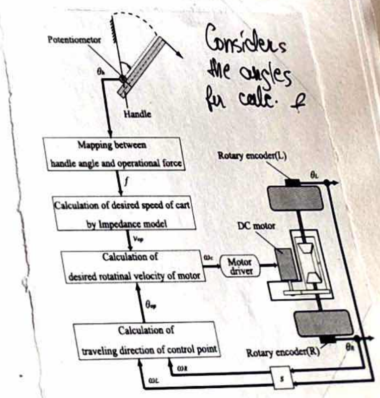
The old way 4 motors on each wheel + force sensors





Cheaper with only 1 motor

Fig. 1. Top: Structure of power-assisted cart (Side view). Bottom: Structure of power-assisted cart (Bottom view).



Considers the angles for calc. f

Fig. 3. System diagram of cart

Control of an omni-directional power assisted cart (Maeda et al)

lateral direction, it is difficult to balance the traveling operation in the lateral direction and the cart turning operation, and therefore, to travel smoothly. Thus, by making a correction to the equation for cart rotating speed to decrease the moment generated by the right/left directions' operating force, the right/left directions' operating force and operating moment are balanced, and operability in the lateral direction is considerably enhanced.

The second method is a control method to prevent shifting of the cart to the right/left.

In such a case, as the operator pull-operates by one hand, it is difficult for the operator to apply moment on the operating handle. Particularly in cornering, the cart easily shifts to the right/left directions. Thus, the right/left directions traveling amount is detected from the rotating ratio of the respective drive wheels, and position control is applied to eliminate the motion to both sides. This facilitates the cornering operation without shifting in the right/left directions.

This paper describes the control method to enhance operability and safety of an omni-directional power assisted cart employing universal wheels.

2. Overview of the Omni-directional Power Assisted Cart

2.1 System configuration

A schematic view of the omni-directional steering power assisted cart is given in Fig. 1. The control system comprises, as shown in Fig. 2, a force detecting unit, a CPU and a driving unit. First, the force-detecting unit detects the operating force. Based on the detected values, the CPU calculates the traveling speed in the longitudinal and right/left directions and the turning speed of the cart, and furthermore, it calculates the rotation speed of each driving wheel to achieve the traveling speed. Based on the calculated values, each driving wheel generates driving power, respectively.

The force-detecting unit measures the displacement of multiple flat springs with three eddy current gap sensors. The conceptual diagram is shown in Fig. 3 (a).

The operation part (handle) is connected to the body of the cart on both the left and right sides through the handle base and flat springs. The handle base is restrained by the flat springs so that it allows both sides of the handle to travel independently in a forward and lateral direction relatively to the body of the meal delivery cart. Two gap sensors detect the forward displacement d_r and d_l of the right and left flat spring, respectively. Another gap sensor detects ... han- ... f_{hx} ... $f_{h\psi}$ ... ned ... of ... or ... ed ... he ... ne ... d ...)

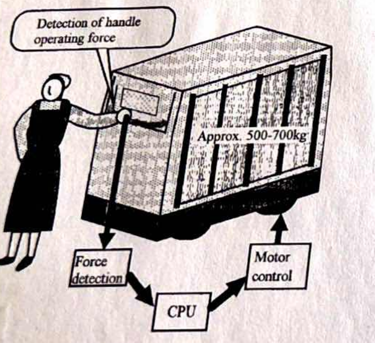
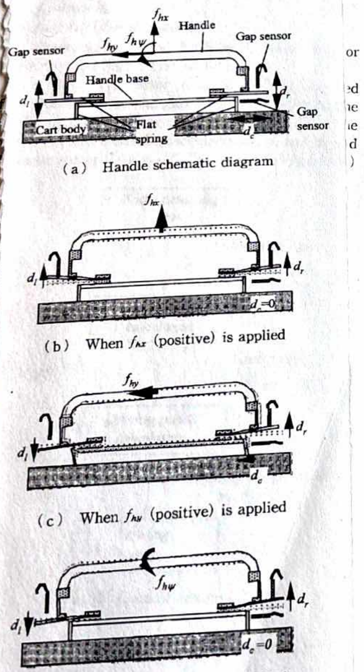


Fig. 1 Overview

Gap sensors indicate which spring has been used on the handle.



(a) Handle schematic diagram

(b) When f_{hx} (positive) is applied

(c) When f_{hy} (positive) is applied

(d) When $f_{h\psi}$ (positive) is applied

Fig. 3 Force detecting unit

A bit outdated since it's from 2003 but the force detection feel & structure is similar to what we're looking for with our prototyped stapler feedback feel.

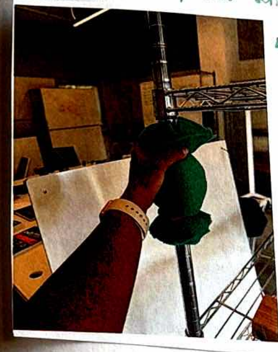
1st st prototype benchmarking

First hands on prototype to understand the feel of the cart:

① "Cart" with white boards. ⊕ Heavy enough to assume a staffer housekeeping cart. ⊖ Doesn't have the feel of "shelves" on the sides.

② Cart with shelves. ⊕ Has shelves to play around with. We adjusted the height. ⊖ Is too light weight.

simulated a feedback mechanism for a power sensor

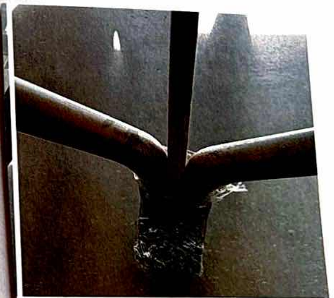


Also the current staffer handle is horizontal ☺

Really liked the "snipping" feedback

Diff mechanisms side by side

Tried to simulate the wheels but there are couple of issues with omni-directional movement



Takeaways: Sensors need to have a feedback mechanism to comm with the user. Making the handle adjustable is a bad idea b of the electronic wires. Need to understand what wheels turn.

Guest Lecture : Ilan Mandel

Ready made prototype
Mebot: emulate back-challening, balanced turn-taking
Phripheral robot object → fits into the context, not a participant
Borrow design language / affordances, expectations
Elegnt: Pixar's lamp made real by Apple (lots of gestures)
Highly contextual! Look into worldwide Google Trends!

Hoverboards:
→ Have powerful motors → brushless DC motors
→ Are cheap
→ Because they were a $\boxed{\text{fad}}$ → opportunities
Whole hog:
→ Control systems, Bluetooth controller
→ sensing systems
→ Rigid co-linear frame
→ BLDC motors & controllers
→ Lithium - Ion batteries
From chairbots: Don't directly stick the moving parts to the static part because parts can be different sizes → flexibility

Opportunities
→ Free upcato cycles → Massage robots → CD players
→ Speakers → children's toys → Hard drives
→ Things that break
→ Windshield wipers, car repair, affordable, accessible motors
→ Razors & blades business model : cheaper to buy a new one than fix it
→ Printers, TVs, Voice assistants, gaming consoles
→ They expect to get profits on add-ons, consumerables, subs
Github repo for hoverboard use:
A Tune the spring relative to the weight because lots of hoverboards use the LED brakes.

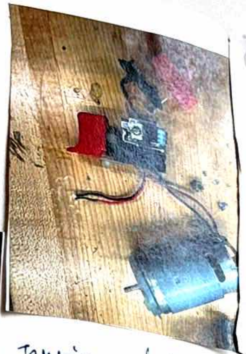
Benchmarking presentations
- Vacuum is required in the cart A
- They can't push the cart & take the vacuum at the same time
- Dirty sheets bag
- House person vs housekeeping people (collab)
- A lot of not planned activities
- Wished they could bring some supplies in
- Carts are outside also because not to bother guests
- Charging the cart (?) A
- Doorstop with them in the cart A
- Building momentum (back up first)
- Shopping cart pusher automation
- Manually navigating the carts (shopping) for collecting carts turning the carts → keeping the chain short requires manually
- Also the robot doesn't turn in itself, all the carts just follow the cart in front and there's a person in front riding
- Powering techniques: AC brushless motors outperform DC motors
- Rosie robotic service cart vs Tech roboCart
- Nymelai robotic group → hotel delivery robot
- Foldimate laundry folding robot
- \$2000 for a single stroller cart → crazy!!!
- A whole day supple in the cart A As many things as they can → to avoid restocking during the day

Feedback for us:
→ Self-parking carts (?)
→ Hotel specific carts → critical function
→ Gestures (?)
→ Hand over between manual control vs automatic

Shopping for our first low-fi prototype

Broke the shell of the drill to get the mechanism.

- Powerful DC motor
- Torque converter
- Multi-directional turn (no need to implement a fields)
- Pressure sensor



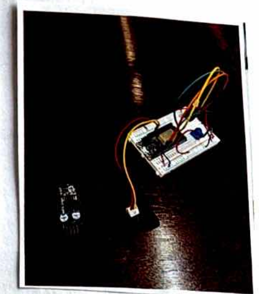
Tennis rackets and water guns for handle prototyping. At least for now

Critique session feedback:
- The housekeeping carts don't leave the floor (no elevator), it's a different person restocking the cart

Interactions suggested:
- self-parking cart
- changing from power-assist to autonomous & back
- Not bumping into other people and walls
- Check which wheels are fixed and/or if all the wheels are omni-directional
- Consider a self-restocking cart

Constraints:
Noise, navigation, speed, etiquette, space (1/3 of hallway rn),
etiquette: passing people by, communication
There's another person with a separate cart (houseman) who comes around and collects everyone's dirty laundry bags

Critical function prototype



Function: Avoid bumping into stabler walls and/or people on the hallways. Self park when indicated.

Implementation: Infrared sensor to notice the desired distance and notify. LED to turn red when about to hit anything.

Next steps: Advance the system so that the sensor is connected to the motor/brakes and adds resistance slowly parking the cart, instead of just notifying.

Takeaway: Use the avoidance sensor instead of infrared sensor + potentiometer because it's more compact. VCC ⇒ +5V, GND ⇒ GND, OUT ⇒ [pin]

Q: How to hack the motor and connect it to other hardware?

1

2

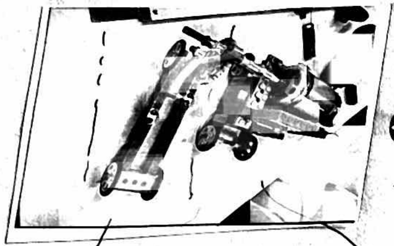
3

Tried the ready robot wheels to make a cart market. Even saw the extra parts to fit in the motor.

Abandoned the robot and started assembling a LEGO cart.

(2) Tried to find a fitting lego part for the motor so that it will both fit with the motor and the gears of the wheels. Failed. Can 3D print later if needed.

(3) The motor's original gear didn't fit with the robot's gears to spin them.



Main Take-aways/Reflections:

① The motor power torque has to be equally divided between all the wheels otherwise the cart becomes hard to move/turn.

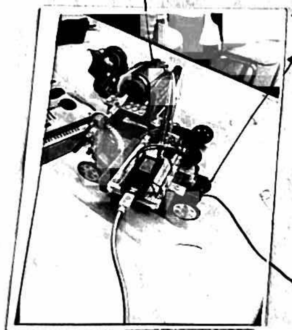
② The weights on the cart has to be equally distributed otherwise the cart starts flying and gets off balance.

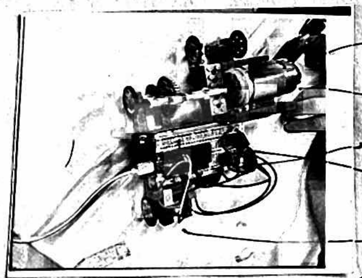
The part corresponding to the housekeeping cart.

The part carrying the hardware for the "cart" to move. In the final cart all the equipment will be content on the same cart. (Also, need to think about the wire/hardware management)

Motor is only connected to the back & wheels at the moment

these wheels would fly





Battery

Motor potentiometer

LED

The infra red sensor.

Main takeaways:

① We probably need an avoidance sensor for each 4 corners, since those are the first to hit anything.

② We can't just program the cart to stop and shatter the housekeeping staff member. It has to ease into motion/parking.

③ A question remaining: How would a staff member handle the parking to the cart (controlled vs autonomous)

Robust Cart Lecture: Leila Takayama

Handle bar → physical affordance for people to control

Form factors: mechanical & ergonomic considerations
vertical vs horizontal
diverse body sizes, grip hand sizes
left-handed vs right-handed

Obstacle avoidance: pictures helped the obstacle avoidance

Materials in case the cart collides to people

Scared of: safety mechanism, brake that checks that there are fingers around the handle, and not a leather

Carbers & Scrappy

Baby strollers → space for feet because people need to walk with it. How deep and how high the cutout.

When the robot gets big it needs to indicate navigation. ☆

LEDs, bar small keys, haptic keys → the way you drive, tilt a little

When you grab Carber it would hump before moving, before moving

Turn signals? Laser pointer? ☆ Tactile feedback ☆

What perceptual signal is available → safety critical

How time sensitive?

Carber: Autonomously → obstacle avoidance on,
Manual → obstacle avoidance off. ☆

Make a movement/direction indication before committing to it.

Which way to cross when people are passing by? ☆

Clear path auto → communicate with the bystanders which way they're planning to go.

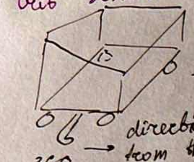
Radar vs cameras → cameras are cheaper, collision impact ☆

AMR robots

For Carber → once the person touches it (uses it) it stops whatever it's doing. Continues doing what's doing once the person leaves.

Different authority to diff. workers in the hierarchy.

Crib Session



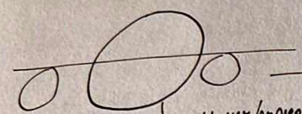
Cart

Motors are just to push the cart forward

direction comes from the person switching the handle

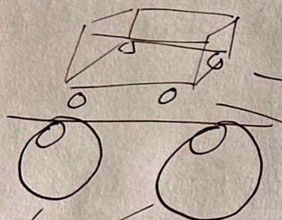
360

Diff ways to attach the cart to the hoverboard



our cart

Hoverboard wheel so it moves



The cart on the hoverboard

Don't even need the wheels if we put the cart on the hoverboard

Hoverboard wheels

Spring Break: University Club Hotel, D.C. Observations

① Sensor activated: green light

② Trash bin opens

③ Trash bin fully open

④ Trash bin starts closing: red light

⑤ Trash bin fully closed

Spotting robots / machines in a new hotel

☆ Interesting to see how they decided to use the robotic trash bins in public spaces but not in private rooms.

☆ It was mostly intuitive but the sensor only notices when the trash is right on top of it not when it's on / beyond the can itself. So people have to move it around a bit.

Traditional non sensor enhanced trash bin

Housekeeping Cart @ University Club Hotel

Housekeeping room for supply refill = Stabler's Housekeeping room on each floor

Housekeeping cart

Guest room

The housekeeping cart looks more compact and smaller than Stabler's cart and doesn't block the whole hallway.

I specifically looked for the handles and the vacuum cleaner on the cart. They carry the vacuum cleaner on the cart as in Stabler. There are no handles, so they push the cart (?)

Vacuum cleaner

The dirty laundry basket

speed, position → meeting a guest, go towards the wall

speed (slow → fast) → leaving the housekeeper

politeness / courtesy for meeting a guest

say hi and give guests some space to go around

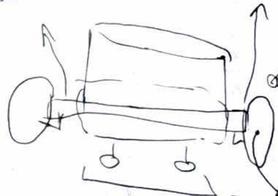
Disassemble the hoverboard

ODrive connect → from GitHub repo

1.5V only

10A 12V power supply

wheels have attached motors on them



attached wheels

hoverboard

attached wheels

Motors are built into the wheels. The GitHub has a control panel to control

Connect the wheels?

Rigid wheels

laser cut a thick piece of wood

Build our base

Most imp → single axle connecting two (all) wheels together base

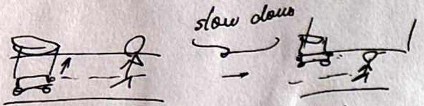
Can run the wheels independently to turn. Also depends on the design.

Sensors might not react fast enough.

Joystick control or even keyboard for wizard of Oz.

Or even put a limit on the speed.

~~Robust Coast lecture~~ Blender for animating in 3D?

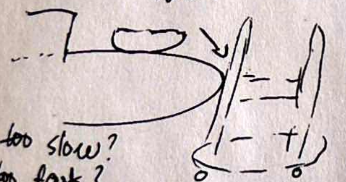


In the trajectory how do you signal "I see you" to the by stander.

What would the robot have to recognize from the other person to know what that person expects?

Interaction affordances
Critical aspects
HRI aspect
Core assumption that makes or breaks the design

How would it stack?



actuators vs pulley

too slow?
too fast?

Assumption: The conveyor belt is fast enough to slide the tray to the cart. → That's the critical

→ Small vs big dishes
→ Receiving vs depositing and

To solve the re-washing dirty dishes issue.

→ Maybe the cart can distribute the clean dishes to the stock room.
→ Putting the dishes into tray vs conveyer belt.
→ A lot of robots just shift the human labour instead of reducing it.

Disassembling the Hoverboard

① Touch sensors to control the speed and direction of the hoverboard.
Seems to be a binary input but it's not because the sensors read (500, 1300).
Infrared sensor blocking? Light blocking?
There's no metal in it.

② Exact same sensor board configuration on both sides, connected to a single controller.

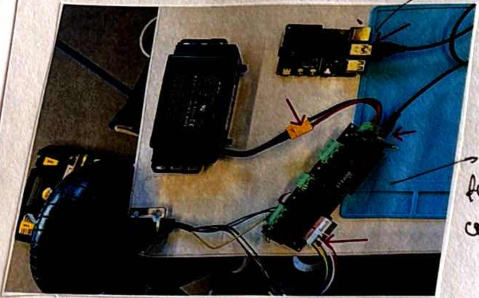
Sensor

Connection of the hoverboard to the battery (50V)

Battery

Motor wires

Sensor pins → 4 of those 2 for each wheel



Rasberry Pi Controller

ODrive for motor control

The instructions from the GitHub: completely replace the original board with the Rasberry Pi & ODrive.

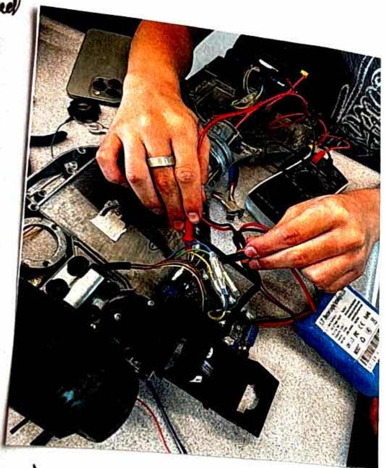
⇓

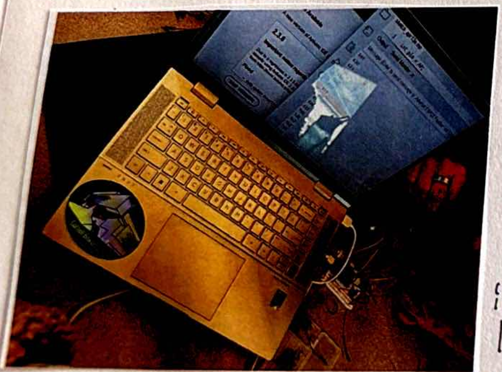
✓ Rasberry Pi — This one powers on

? Different model for the ODrive ordered

How many motors can one ODrive power?

Either after adding a tape to the speaker (that goes off when the hoverboard is unbalanced) or adding the jumper wires to extend the sensor/motor distance the board got sparkes and we lost the current in the board. There's still some electricity in the board especially in the sensors but the motors no longer turn on. Most probably the motors are alright, it's just the board that's broken.





The touch sensors removed, connected to Arduino Feather to test the sensors → ✓ working. All sensors show the same reading in the range of 500 (stable) to 1300 (fully stretched).

How does the motor know which direction to move if the numbers are the same?

Getty's Group CEO Guest Lecture

What makes hotels special?

→ It's about the feel.

→ Office buildings don't care about the feel.

→ Automation to supplement guest experience → should make it more comfortable than less.

→ Example: guests in the same elevator as a robot. Is it unnerving? How to interact?

→ Automation shouldn't make people uncomfortable.

Nvidia's robot:

→ Creating personalities for robots → How do you balance then the seamless integration with a robot personality?

→ Robots that don't have a personality are confusing for people.

→ What personality and how to express those? Skeleton Crew the movie

Robots in hotels now

→ Delivery robots → weight differences

→ Next gen: personal butler

→ Bell cars are stupid.

→ Automatic wheel chairs → kind of like an elevator guide to clear the path. The one in LAX has a display of the traveler info. Awkward experience.

Driverless cars

Order → Agree for driverless → car comes at your spot → car has your name →

→ You use your phone to unlock the door → very good driver

Most important aspects for these robots:

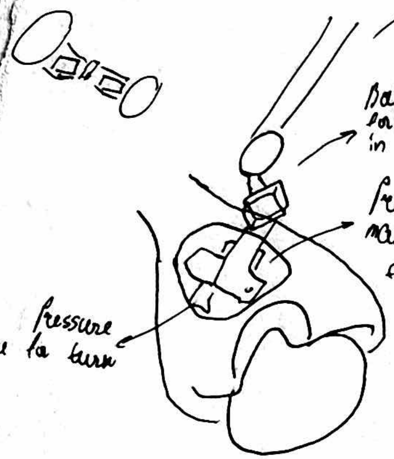
Safe & Secure | Communication | Trading | Personality

The biggest limiting factor for the housekeeping is the weight.
The cart should be a vending machine. Mobile vending machine.
Use your card to access it.
↳ If you wanted something (soap, towels, etc) you could use your card in an appealing way.
↳ Series of robotic parts that all know how to work together.
↳ If there's a clean laundry cart, there should be a vacuuming robot, clean laundry robot, etc.
↳ The last thing the housekeeping person does is to spray.
↳ Security → report to the operator (time when entered, how long, time when left)
↳ If someone wanted to communicate with the housekeeper the cart could become the translator.
↳ Bilboard → sell sponsorships for housekeeping cleaning company. Now there's an advertising space.
When does the robot/machine add vs reduce from the hotel atmosphere?
→ Interesting looking vending machines exist.
→ Farmer's fridge → Art dispensing vending machine
→ Champagne bottle dispensing vending machines
Housekeeping carts aren't able to collapse to a smaller profile right now. Like the wheelchairs do. ☆

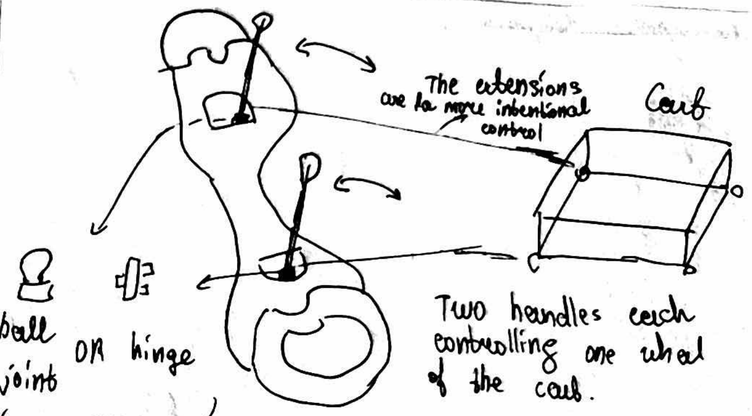
Robot Expressions

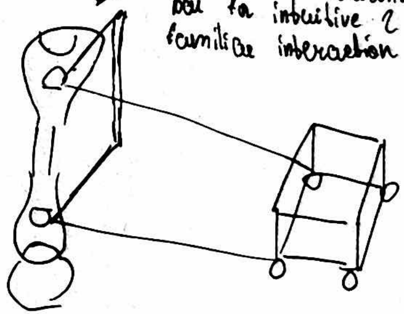
→ Cozmo, Alexa's enhanced robot, Astro, Waldo's new Disney-backed the robot
→ Why do all these companionship robots look the same/similar?
- Gets inspiration from sci-fi movies, builds from prev. robots/tools
→ What makes the robot social is its ecology, the interactions with them
→ Reasons for expressive: trustworthy, likeable, handle errors, uncertainty
→ Ajung Moon → robot ethics → gaze research
- Projected hand-over trajectory location
- shared trajectory location } Coordination function: The robot looks at where it's extending the hand. ☆
→ Sorting game HERB → Can robot's gaze and handover delay make people comply with robot's counterintuitive suggestions?
Handover delays get people to comply. ⟸
→ Prof Hoffman's Lab → pleasant tone → warmer robots
→ angry tone → scared robots
→ Back Channeling support
- In a "collapsing building" find the given objects following the robots.
- Non-verbal: nodding to indicate the robot was listening
- Outcomes: backchanneling reduced stress, reduced cognitive load, BUT made people perceive robots as dumber.
→ Animation Principles
① stretch & robotic arm to show weight ② wiggle ③ Anticipation → to indicate movement, intention
→ Computational Approach
Video coding, machine learning, training
Assumption: What works for humans should work for robots too.

How to Connect Our Hoverboard to a Handle ?



A single little pressure would activate the motors.





Takeaway:
The hoverboard wheels are bigger than the cart wheels => can't put the hoverboard directly underneath.

The 1st Moving Prototype

Cutting wooden materials @Maker's Space

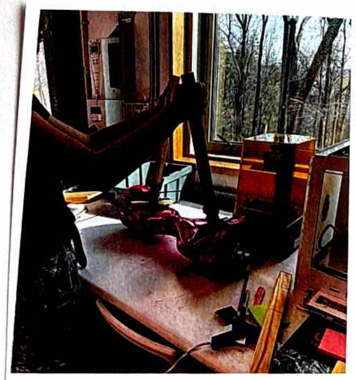
Cut from a yoga mat

Temp. structure to attach the hoverboard to the shelf-cart

Used the nails for a pressure center

Didn't drill anything on the hoverboard, just only zip-ties.

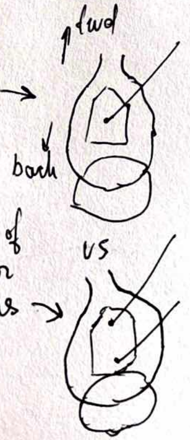
This is the point that would allow for the stick movement backward/forward ⇒ hoverboard direction. The lab doesn't have hinges or ball joints, so we used this weird bolting part.



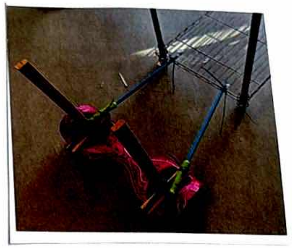
Takeaway:
A single point of ~~sensor~~ pressure per motor $\boxed{\text{can}}$ control the direction. As long as that pressure point can move & change angles.

central point of pressure →

Two points of pressure for both sensors →



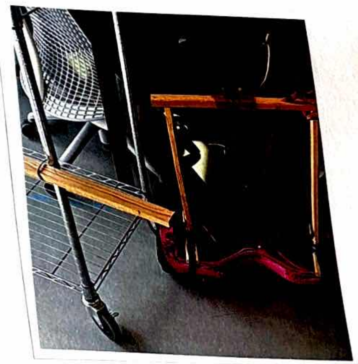
Different Handle, Cart, Hoverboard Configurations



Two separate vertical "handles" each moving forward/backward separately to allow turning. Connects to the board from the bottom.

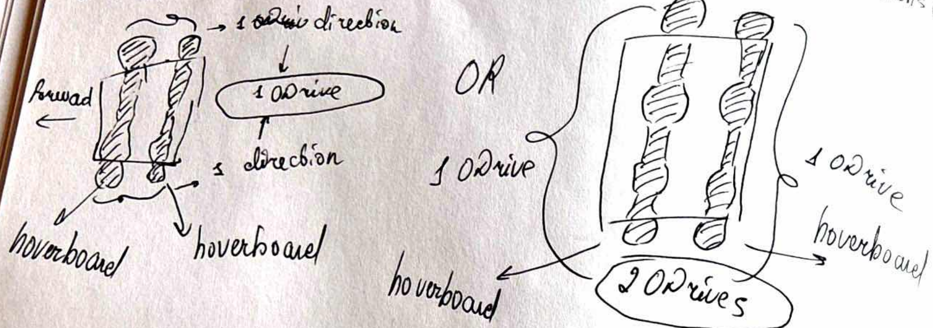
Extended vertical handles for a more ergonomic cart. This is the preferred height for the final cart/handle → extend the sensors on the hoverboard.

Connects to the cart from the middle. Very unstable and unclear handle.



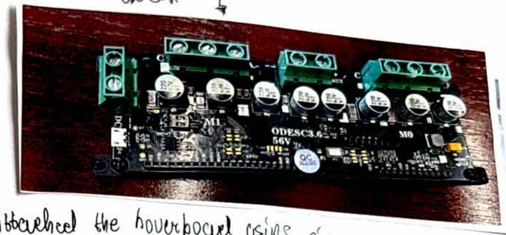
Since normal cart handles are usually horizontal it would be great to integrate sensors into a horizontal handle.

1 ODrive, 1 Rasberry Pi ¼ second delay
Control 2 motors together
They detached the wheels (?)
Control the speed and the direction
1 ODrive can only control 2 motors, or if 4 motors 2 of 4 have to move to the same direction, can't move different directions (turn)

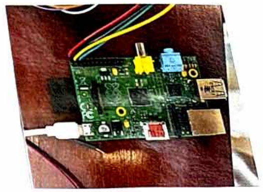


Wizard-of-Oz the handle motion instead of directly connecting it to the hoverboard.
Read the subtle pressure movements in the handle through a reading in the Arduino.
Hide the laptop with the sensor reading somewhere in the cart
Screenshare the sensor readings to the remote Wizard to predict and control the cart/hoverboard movements.
Reading the sensors OR we need a very readable visual cue so that the Wizard can read it → something like a light maybe

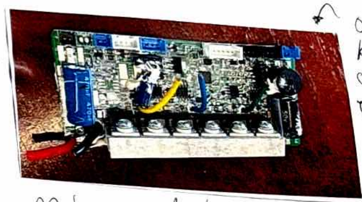
ODrive = ODesk →



Rasberry Pi V3 →
No wifi, need V4 or V5

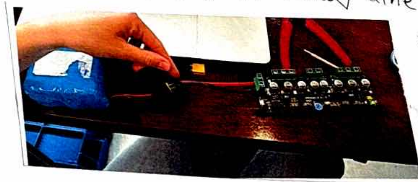


Attached the hoverboard using zippers, change to screws

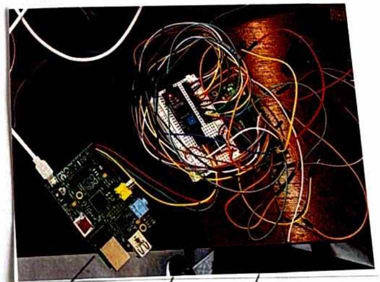


original board completely removed

ODrive connects to the battery line



Need the IP Address of RPI ?



Directly connecting display to RPi: doesn't work!

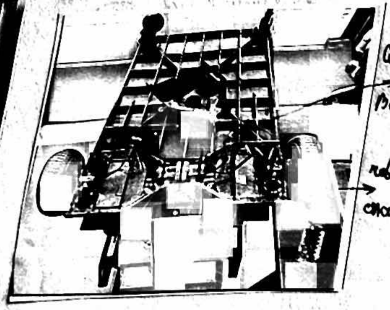
Wiring for the LED display, didn't find a mini TFT

LED display

50 W resistor

Constructed the cart

Changed wheels



Connects to Battery

rotary encoder

Connecting the RPi to Windows and running a Python code

Take-aways for ODrive & Rasberry Pi:

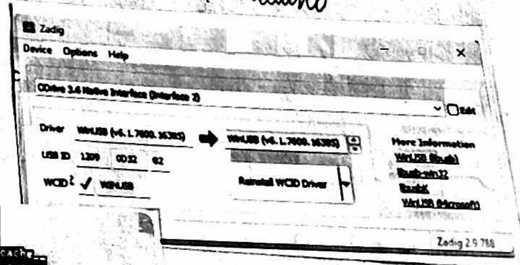
- Rasberry Pi's USB power port only supplies power - it doesn't automatically let us access the Pi through our computers like a normal USB device.
- Because of that we have two ways we can interact with the Pi:
  1) Use a monitor + HDMI cable + USB keyboard to control it directly.
  2) Pre-configure the wi-fi settings before booting it, so it connects to a network automatically, and then SSH into it remotely.
- RPi v3 doesn't have wi-fi → it needs a USB wi-fi or ethernet cable.
- RPi v3 might not be sufficient to handle the hoverboard config, need at least RPi v4 (what they're using in the GitHub) or RPi v5 (the newest one).
- Rasbery Pi is almost like a computer that has its script-writers and everything.
- Need an SD card to boot the code.
- Need to download the software for RP and log in.

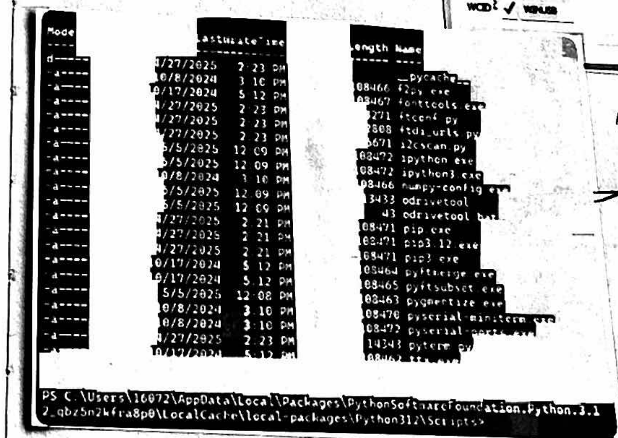
Raspberry Pi VS Arduino

Feature	Rasberry Pi	Arduino
OS	Full Linux	None
Language	Python, C++	Arduino, C++
Communicat.	USB, UART, SPI, I2C	UART, SPI, I2C
Real-time	No	Yes
Power	High	Low
Use case	Complex software, easy USB control, networking	Real-time control, low-power system

Trying to connect my Windows to ODrive + Arduino

Downloaded the ODrive drivers





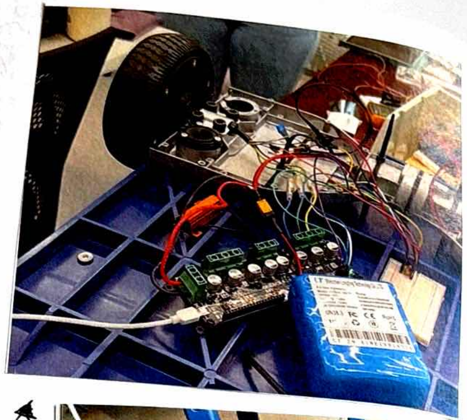
Windows recognizes the ODrive but

→ odrv0 = odrive.find_any()

never found the port connected to the ODrive.

Final Prototype

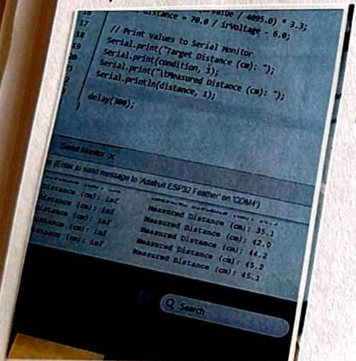
ODrive + Raspberry Pi + battery (36V) + rotary encoder + motor → moving wheel attached to the cart



The cart with hoverboard motors

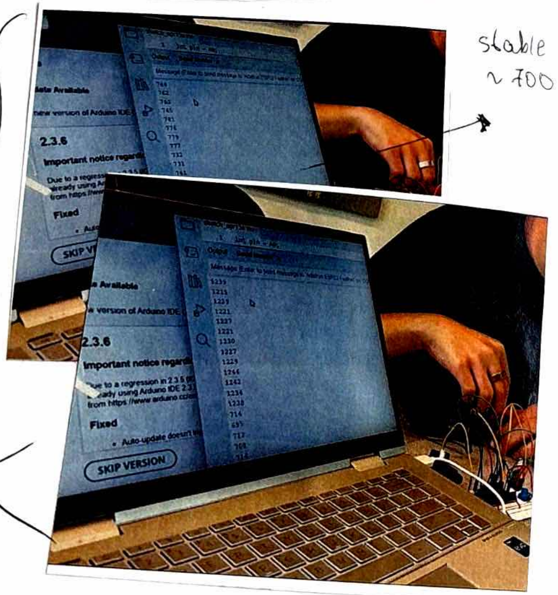
potentiometer

IR sensor



Lidar implementation

Pressure sensor readings



stable ~700

moved ~1200

Feedback

RobustAI

↳ Be careful with obstacle detection - can annoy the housekeepers but stakeholders tend to like the feature

Getty's Group

↳ Add some sort of collapsible design when the cart is auto-parking, so it takes up even less space in the hallway

↳ Vending machine style interface for guests looking for items

Hospitality Union

↳ Make sure the attachment is not too heavy, since a broken robotic hospitality cart is even worse than a regular one

Frank Bu

↳ Concentrate on a smaller design space (eg handing over control of the cart to the robot)

Reflections

- → Learned how to ideate and explore the problem space from observations (such as in studio)
- → There are cheap alternatives that can be used for quick prototyping, such as hoverboards and other out-of-trend tech.
- → The differences between Raspberry Pi and Arduino as well as the differences between diff. versions of Raspberry Pis: v5 doesn't have wi-fi, v3a also doesn't have wi-fi, v3b can work with ethernet cable, v4 and v5 are the easiest to implement and use.
- → Learned how to deconstruct hoverboards.
- → Worked with an ODrive for the first time.
- → The most tricky part was ideating the interaction between the machine and the person for it to be efficient, safe, but also natural, and intuitive.
- → For the future: order the hardware very early on!
- → Next steps: get both of the wheels working,
  start user testing,
  refine the cart based on the feedback.