Science fair logbook

Name: Sophia Hyunju Lee
Grade: 9
School: Stem Innovation Academy (Junior high)

Project: SmartPestSense

what?

Innovation project

A pest monitoring device that detects their activities.
↳ best for homes

Timetable :

	Task / Milestone	Target Date	Page
✓	Find my project topic that interests me.	October 25, 2025	3
✓	Finish my background research using my topics and project idea. ~~↳(create a simple design)~~	November 20, 2025	4 - 10
✓	Create testable question/purpose using my background research.	November 21, 2025	11
✓	Write a hypothesis for my project's experiment results and testings.	November 22, 2025	12
✓	Write down materials needed for my project	November 23, 2025	13
✓	Finish design for my device ↳ blueprint	December 20, 2025	

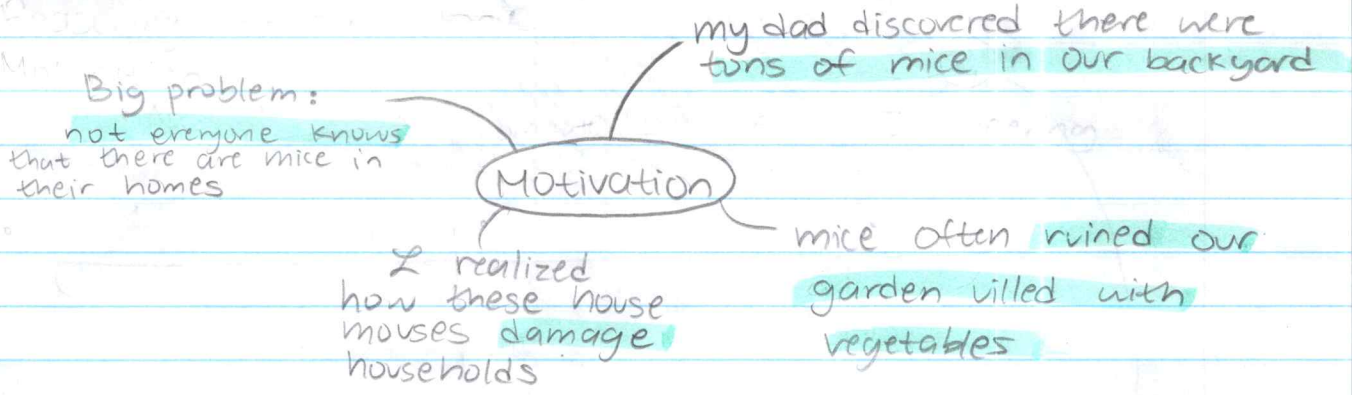
√ Print out design	December 21, 2025
√ (Try 1) Coding	~~January~~ 5, 2026
√ Trial and Error	January 15, 2026
√ ~~More testing~~	~~Jan 20, 2026~~
√ Webpage coding	Jan 30, 2026
√ Webpage testing	Jan 31, 2026
√ Final device testing	Feb 15, 2026

- How do they work?
- What do they like or dislike?
- What harm do they do?
- What's the best structure that can attract them?

October 25, 2025

Topics:

1. Animal science
2. Computer science
3. Engineering



Animal Science	Computer Science	Engineering
• focuses on animal behavior • studies of biology + management of animals under human control	• uses coding as a crucial tool to help solve problems	• can use math and science to design innovative structures and systems

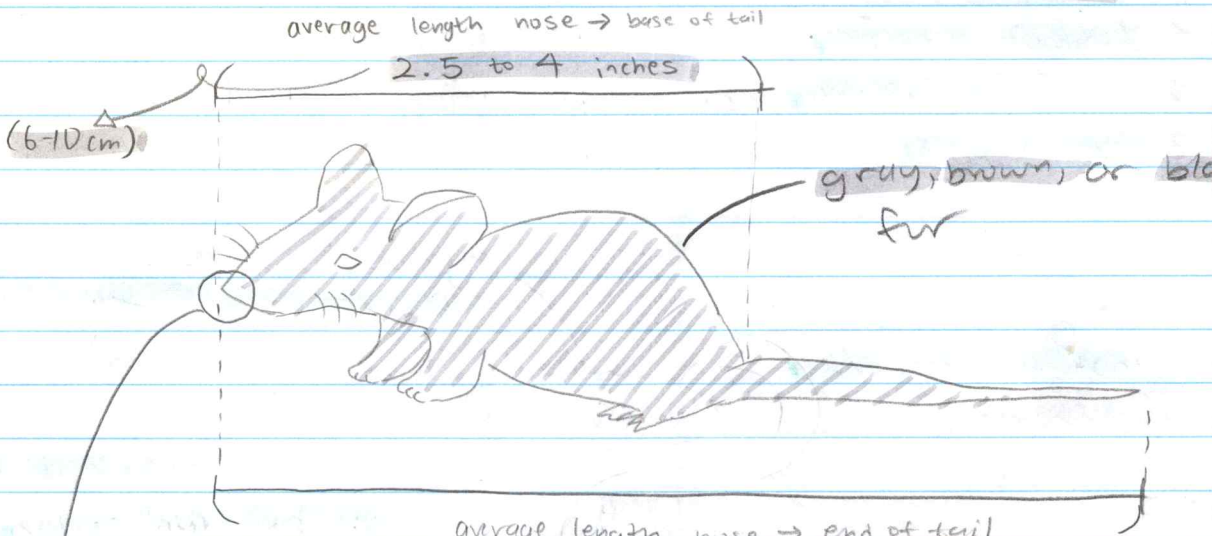
Summary:

All three topics support my intentions and the function of my project I'll be doing.

November 8, 2025 : mouse research

↑ basic information

most common rodent in households → House Mouse (Mus musculus)



Olfaction System — sensory system for smell

highly developed in mice
- crucial for their survival

detects pheromones (chemical signals from other mice)
- this system is crucial for
  - mating behavior / chosing mates
  - aggression
  - mother-pup recognition
  - social hierarchy
  - finding food
  - avoid danger

Special organ:

Vomeronasal organ (VNO)
- detects pheromones
- helps communicate with other mice

Habitat

└ house mice mostly live near humans:

- houses
- farms
- warehouses
- etc

} prefer warm places with easy access to food

Diet

they eat:

- grains & seeds
- fruits
- vegetable
- bread
- etc

They are omnivores

+ they can see blues and greens

+ they prefer darker colors as bright colors can set them off

└ house mouses help spread seeds + a part of the food chain

Classification

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Rodentia
Family: Muridae
Genus: Mus
Species: Mus musculus

- ★ warm place
- ★ enclosed space
- ★ dark colors
  - └ black, grey, brown, blue, green
- ★ blend into the environment
- ★ measurements: (approx) ← for my project
  - height = 60mm
  - length = 80mm
  - width = 9mm

A house mouse is a vertebrate, warm-blooded animal.

November 9, 2025: likes + dislikes

Likes	Dislikes
-warm, dark places	- bright colors/light
-quiet areas	- loud noises
- grains + seeds	- strong smell (peppermint, ammonia, vinegar)
- sweet foods	- cold temperatures
- soft materials	- open spaces
- night time (nocturnal) ★	- sudden movements

Is the problem of house mice trespassing and damaging homes very severe? A universal problem?

How many people are unaware that mice are in their homes?

How should I struct ?

-round and soft appe

- use dark coloured t

- apply sweet food/scents to the insides

- innovative structure that allows the motors and devices to be hidden

- soft cushioning in the inside

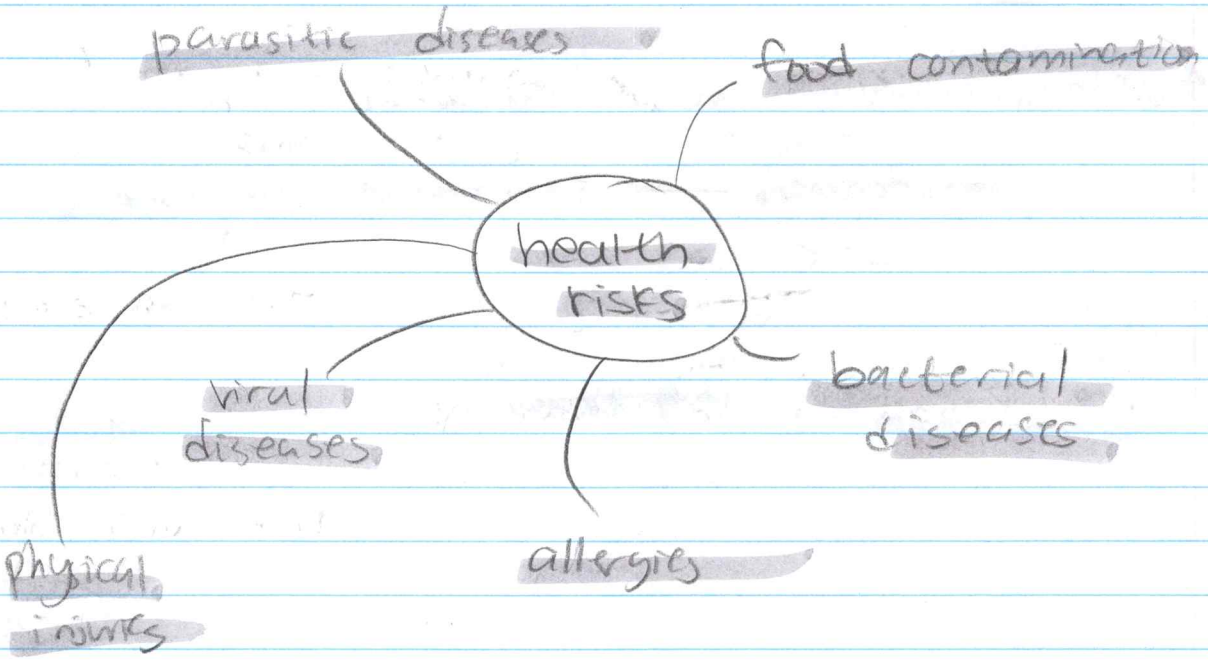
November 15, 2025 : human impact statistics

Global impact

★ Wide populations are impacted

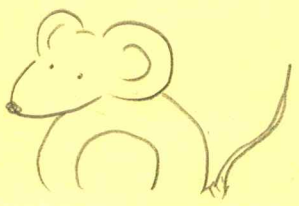
- the danger → structural damage
  - mice chew on building materials
    - damage to homes, weakening the house and potential danger of falling apart
- property loss
  - severe damage to furniture and house structure
    - could potentially lead to home losses
- fire hazard
  - could chew on electrical wiring

- 1993 Australian mouse plague
  - severe mouse infestation
    - devastation to crops + livestock
    - damages estimated at A $64 million or more
    - forced people from their homes
  - approx 20,000 mice trapped in a single day (farmers)



Why detecting earlier can help / be beneficial

- prevent:
  - health issues
  - economic cost
  - structural damage
  - food loss
  - infestation



I'm sure that many people don't know that there are mice in their homes.

↳ letting them be will worsen the house condition and hygiene

November 19, 2025 : behavior ~~end of research~~

Activity patterns

- nocturnal ☆
  - activ at night → this means it is harder for people to detect mice in their backyard or homes
  - high adaptability

☆ Biological Diversity

House mice = social animals

Structure

- 1 dominant male
- several females
  - young mice

Mice communication:

- high-pitched sounds
- body movements
- scent markings

Good Areas:

- wall spaces
- storage box
- enclosed spaces

Survival behaviors:

Thigmotaxis - move along walls instead of open spaces

Quick movements - run, climb, squeeze

Freeze / Hiding - when sense danger, quickly hide or stay still

Time of research : 1 hour ☑

November 20, 2025

Why monitor? Why not trap?
- don't want to harm living organisms
  - may be invasive but unethical for my level

Types of computer mice monitors

1. Mechanical Ball Mouse

time: 1970s ~ 1990s

Rubber/metal ball rolled as a mouse moved.
- internal rollers detect

2. Opto-mechanical mouse

time: 1980s - 1990s

Ball + optical sensors to detect mice.

3. Optical mouse

time: 1990s - 2000s

LED light + optical sensors
- detects movment by rapid pictures

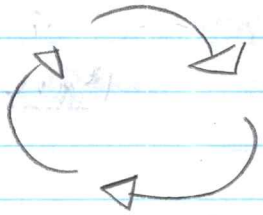
4. Laser Mouse — Used laser instead of LED.

time: 2000s

November 20, 2025

What could be the most efficient method?

We need:



- high precision
- works on any surface
- no moving button parts
- little to no maintenance

↓

by not to use too much filament

↳ minimize the amount of waste that could be produced for the environment

Sensors + Devices:

- input device → detects hand movement + click
- webcam → detects images/motion/faces
- microphone → detects sund/voice
- motion sensors / infrared sensors → detect movement near computer using motion

proximity sensor → distance of subject to the sensor/camera

~~X~~ can use WIFI for data signals + storage sensors + hard drive for errors

November 21, 2025

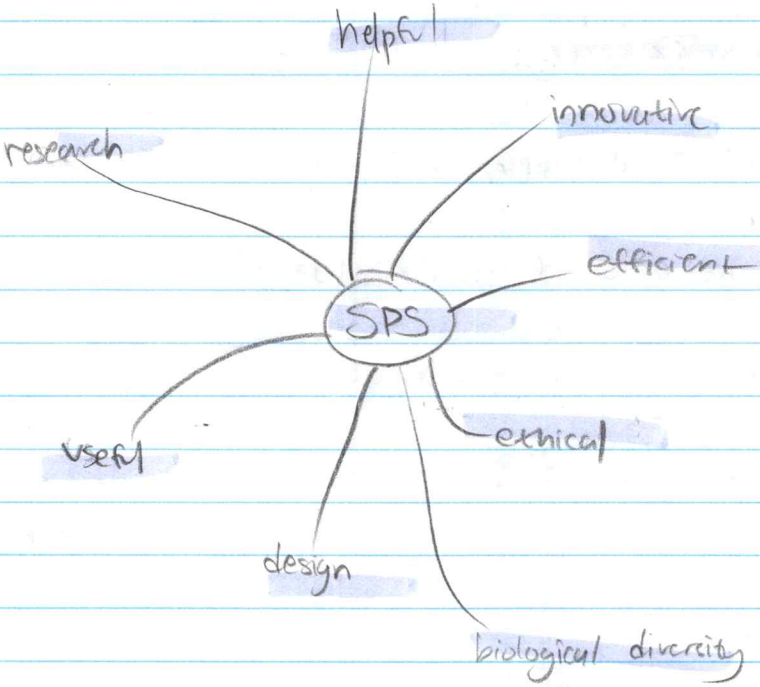
Testable question:

Which type of house/design structure would be most suitable for pests/mice?

Purpose:

The purpose of this project is to determine which specific components in designing could attract mice in order to gather as much data.

Summary:



November 22, 2025: Hypothesis

Hypothesis

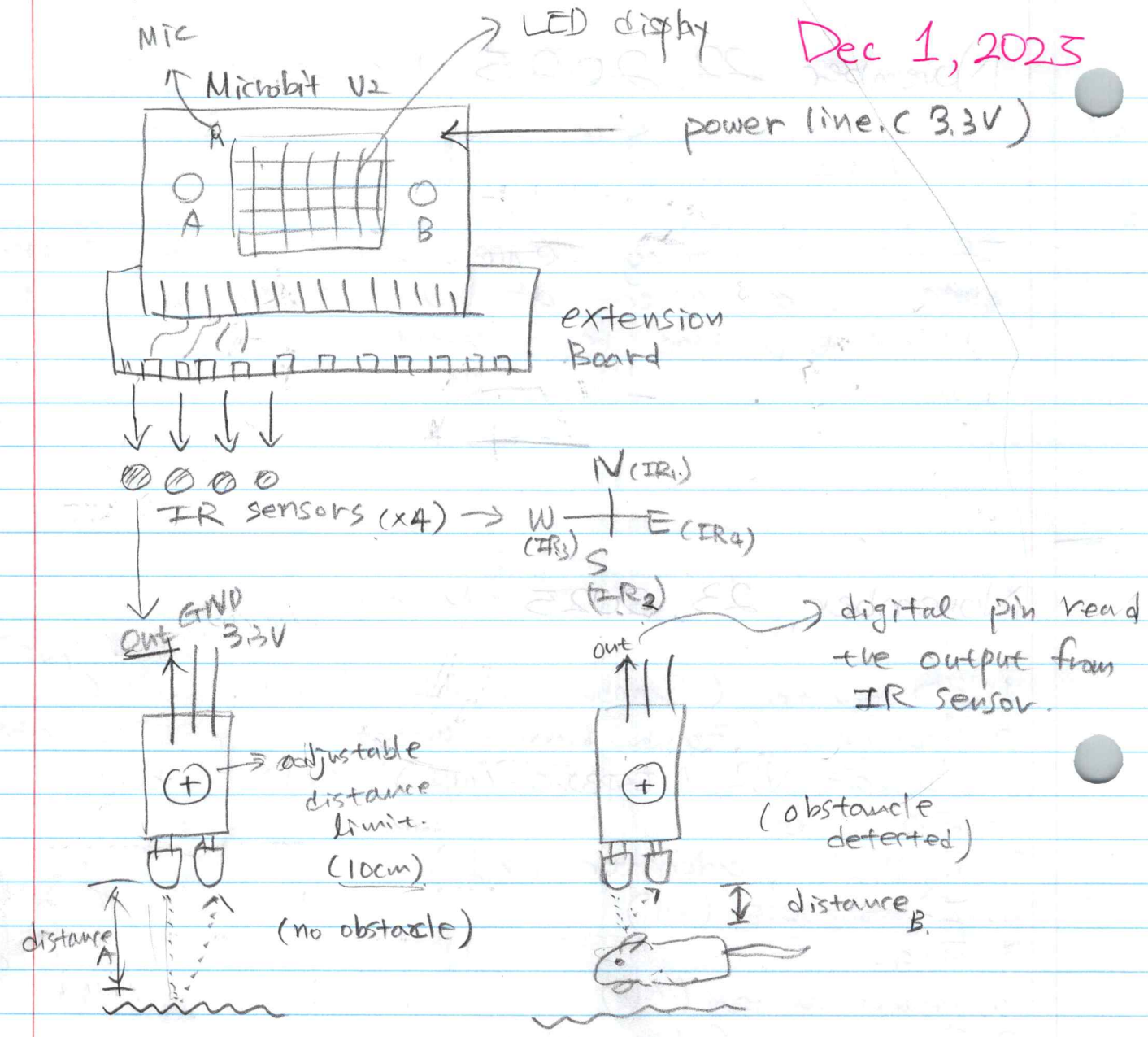
If the monitoring device uses motion sensors, then it will detect at least 50% of pest movement in the test area.

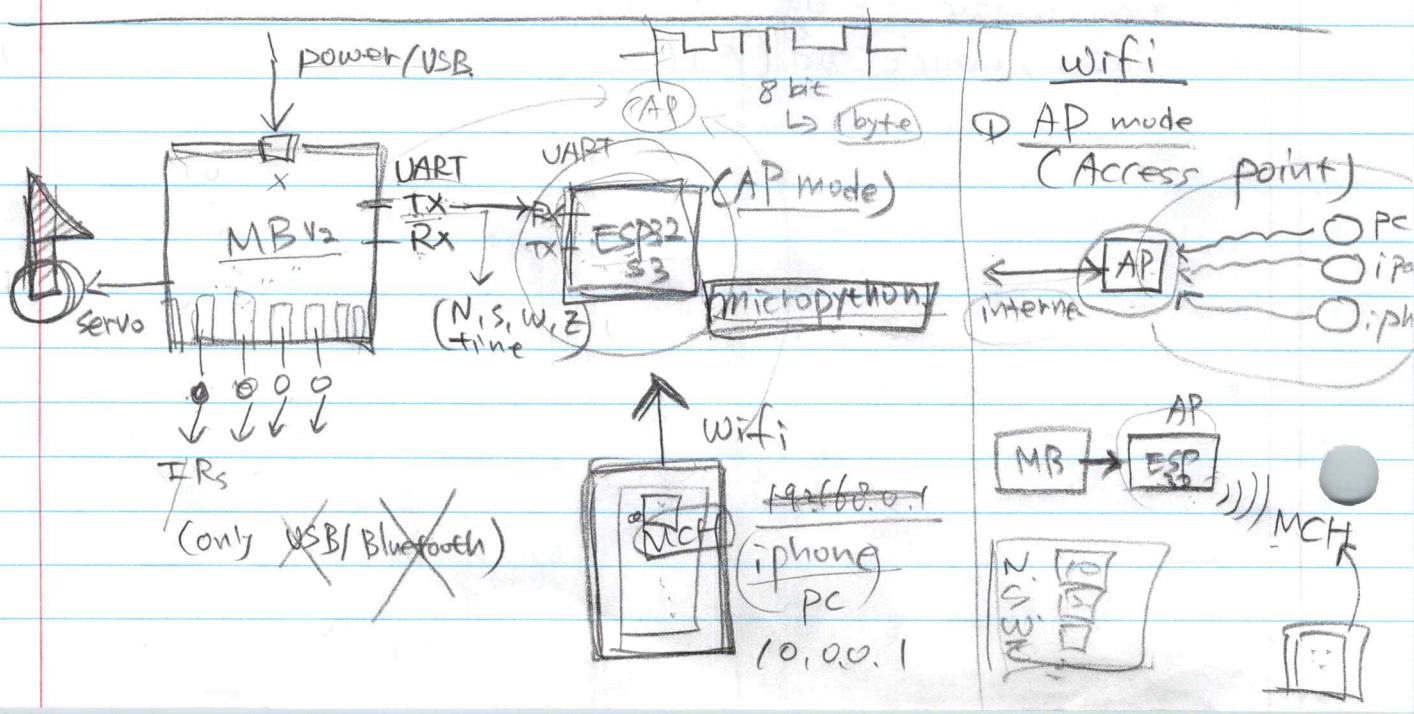
November 23, 2025: Materials

1. 3D printer (Bambu Lab A1) (x1)
2. Filaments (Bambu Lab filament: PLA, PETG, ABS) (x5)
3. Microbit V2 / ESP32-S3 (wifi) (x1)
4. ~~LED~~
5. Extension adapter (x1)
6. IR sensors (x4)
7. ~~Rin~~
8. Peanut butter (x1)
9. Servo motor (flag, x1)
10. Wires / connector (x17)

< Layout Material >

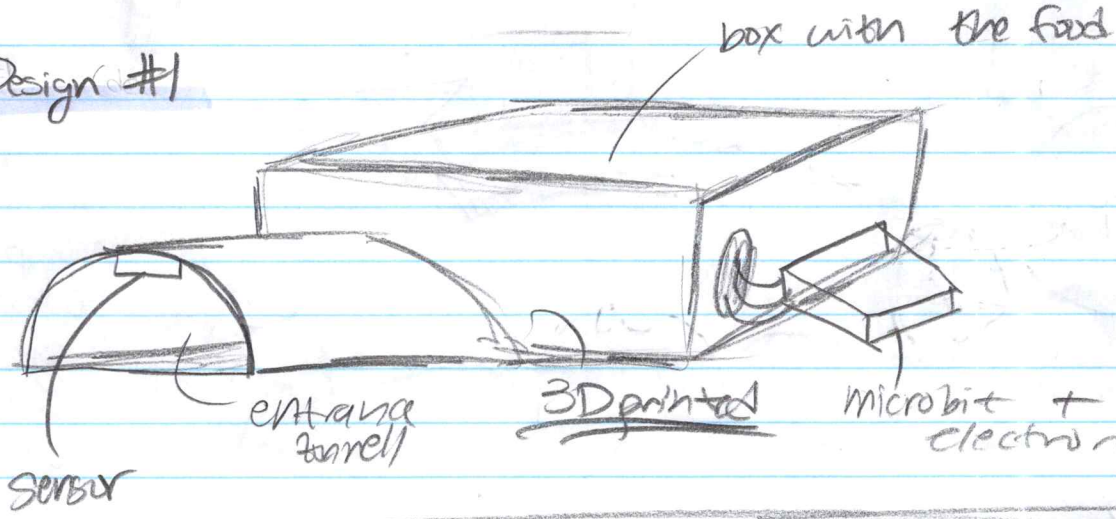
Dec 1, 2025



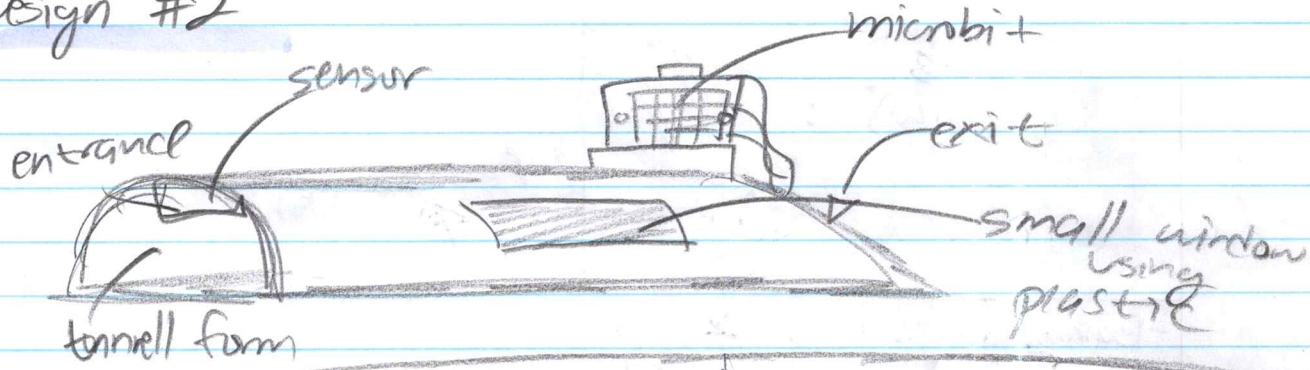


Dec 5, 2025

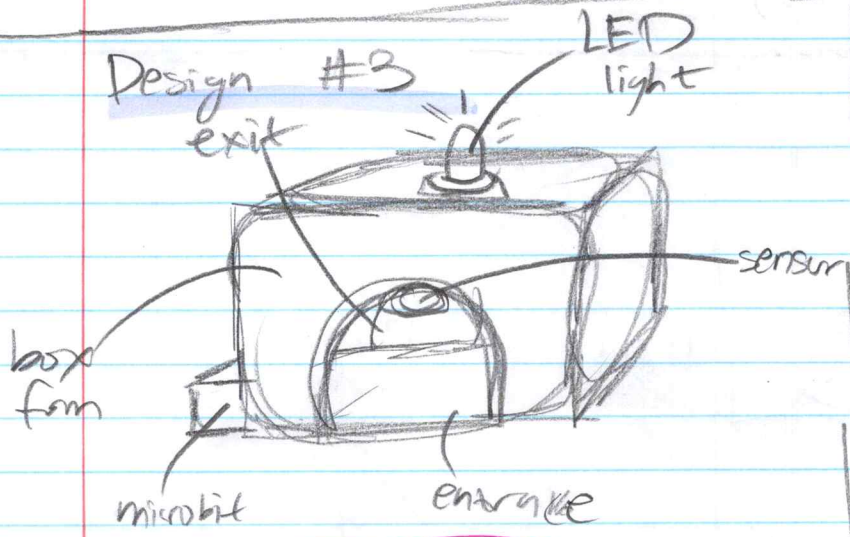
Design #1



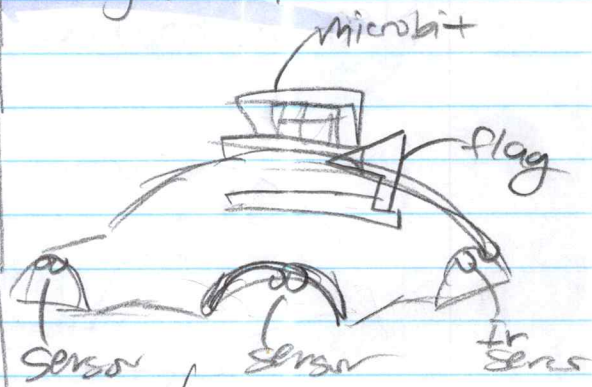
Design #2



Design #3



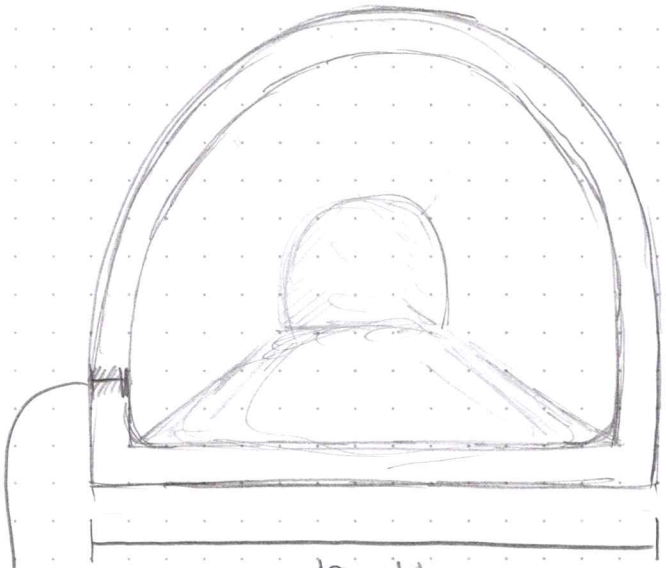
Design #4



4 entrances

Final design = #4

SmartPestSense



Height

60 mm
(6 cm)

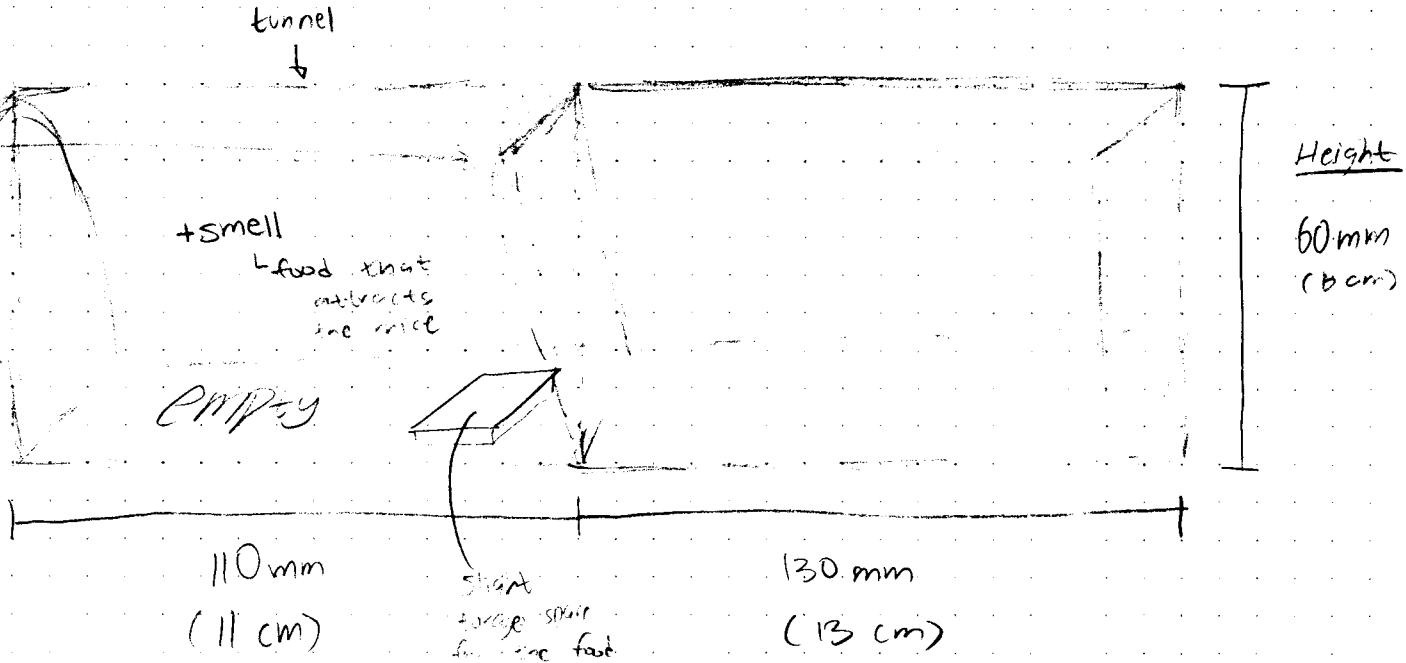
length

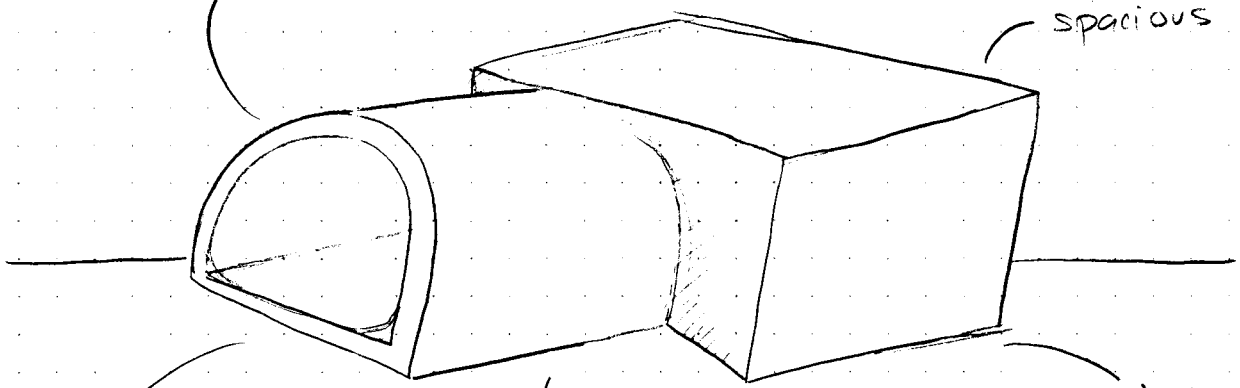
80 mm
(8 cm)

width

4 mm
(0.4 cm)

Inside


tunnel
+smell
└food that
attracts
mice
empty
Height
60 mm
(6 cm)
110 mm
(11 cm)
130 mm
(13 cm)



rounder entrance to mimic the house mouses' home entrances

semi-circle opening

spacious + cozy

Designed with Fusion 360

Printed using Bamboo Lab A1 3D printer

structurized to attract the mice

color

↳ grays/browns to blend in the environment

↳ house mouses prefer dark secluded areas

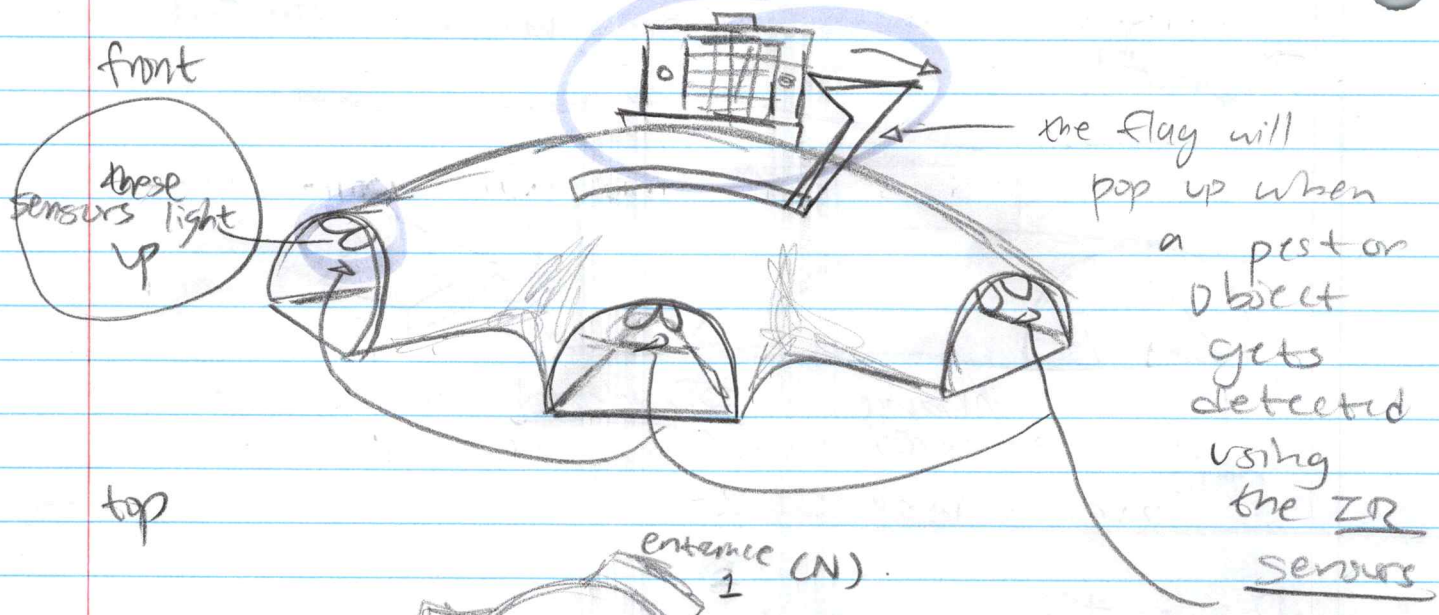
↳ they can see blues and greens

↳ hints at dark olive or green filament

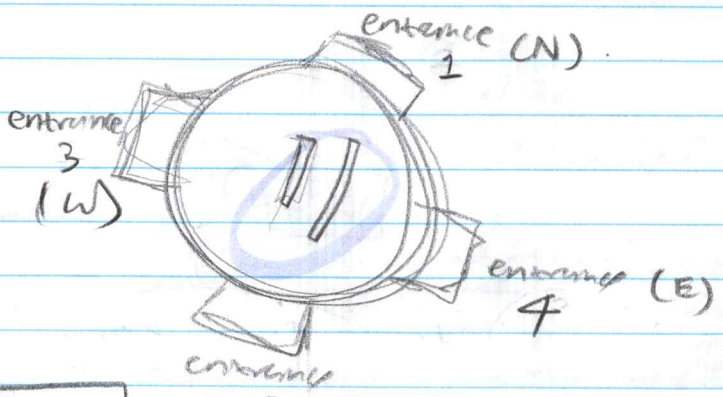
↳ vibrant colors ✕

Dec 10, 2026

front

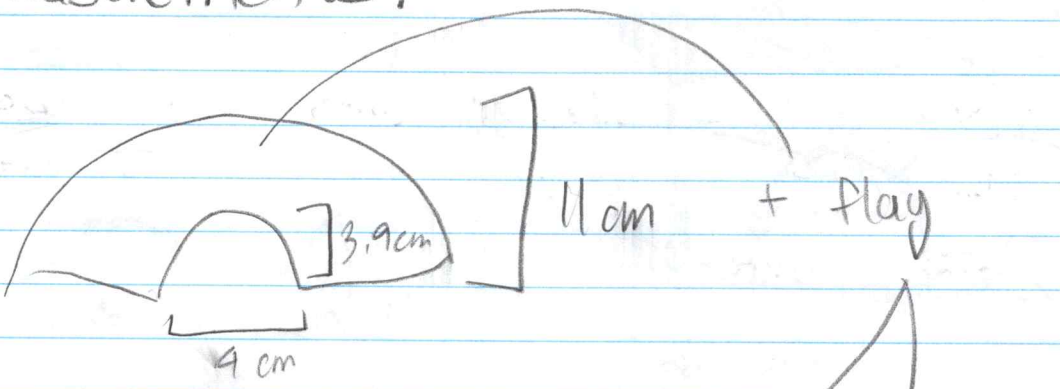


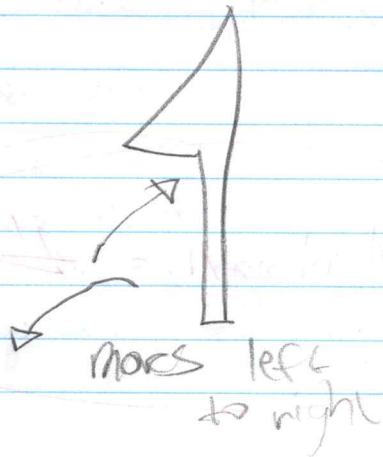
top



- Bamboo lab A1
- ~~Fusion360~~

Measurements:

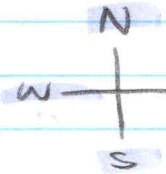




Reasoning for design:

4 entrances

↳ we can detect where the mice came from



We are able to see 4 directions using the 4 directions. That enables us for easier data collection.

Dome shaped

↳ Dome shapes seem to be more efficient. Their structure is more stronger than cubes or pyramids which may be too much filament. It's the easiest and strong + cool structure.

Inspiration

↳ I was inspired by the Micky Mouse Club House along with the Teletbby house. Both of them were dome shaped and unique.

Summary

↳ The overall design is relevant and suitable to detect mice. Many other mice devices seem to have rarely any character or shape. I wanted to create a more innovative and unique device/process.

December 21, 2025

-3D printed design

- time: 10 hours (successful)

↑ design was too big → had to print in different ways

↓ lots of design trial and errors (about 5 total prints)

January 5, 2026

- Code using Micropython and MicroCode

↓ coded for IR sensors (detection using IR light)

January 7, 2026

Testing 1: the fingers were detected well, except that some bugs were occuring

↑ random errors + non-proper detection

January 8, 2026

Testing 2: IR sensors were able to detect very well → but sometimes it would detect weird objects

↓ lag

January 12, 2026

Testing 3: fixed code from the past two failures and IR sensors detect accurately

January 15, 2026

Testing 4: works accurately
↳ able to detect fingers properly
↓
green lights show up

January 20, 2026

Webpage Coding
↳ using vibe coding + MicroPython + Arduino IDE + ESP32

Jan 30, 2026

Tested webpage with wifi + http://10.0.0.1
↓
- Sucessfully counts the # of detections

Feb 15, 2026

Finally attached all pieces together and tested

testing was accurate but some limitations and crashes happened.

Overall, the SPS device is accurate and is suitable for real life use:

limitations -

- design: the amount of time it took to print out the dome
- code errors + inaccuracy: some crashes

future work:

- Data collection: now we have the app we can gather further data for accuracy.
- Eco-friendly material: switch to filaments that are safer for the environment.
- Graphs: a wide overview of the data + allows for us to know the gradual change + progress of the device.

Coding

Microbit V2 ← uses MicroCode

like scratch

↓

block coding

ESP-32 ← uses HTML + MicroPython

↓

actual coding where I have to create

IR sensors

optosensor device

↓

infrared light

↳ light and optics

electromagnetic spectrum

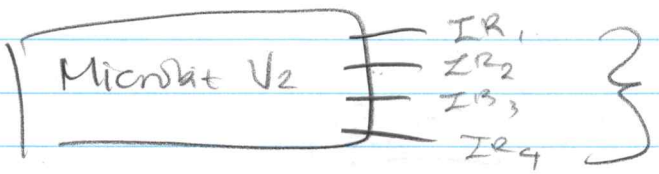
object

detects object using light and distance

knob

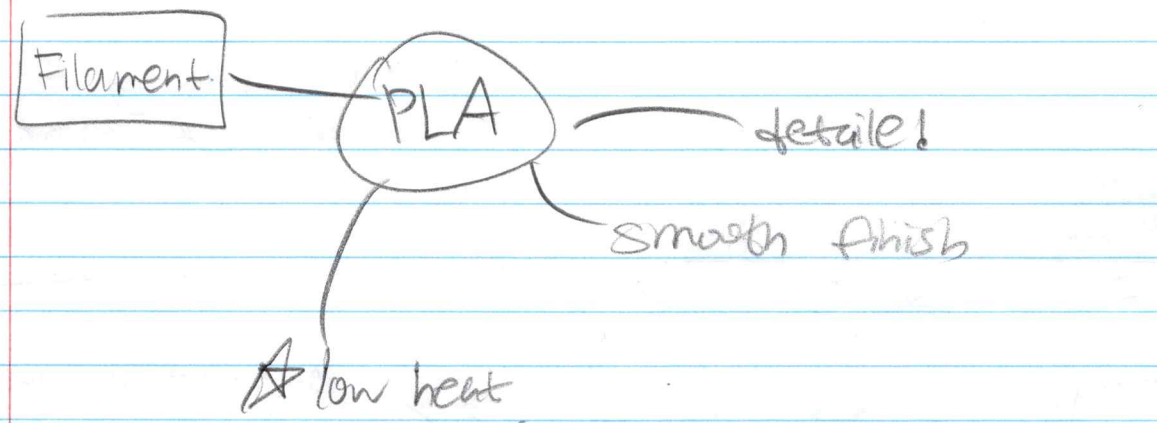
↳ we can adjust to find the distance we'd like

lots of trial and error



all of these IR sensors will be located at each of 4 entrances

Material Details

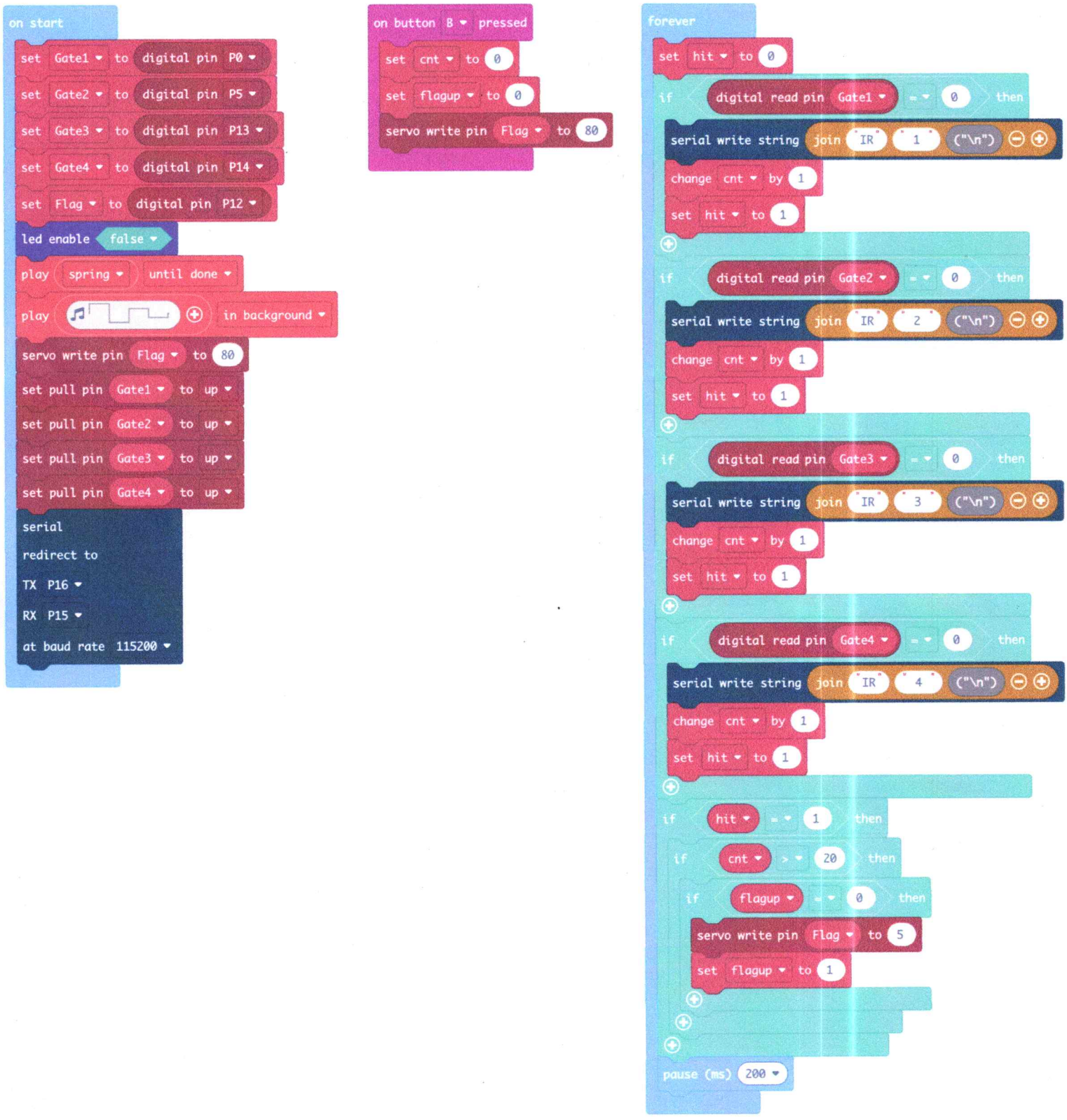


we can harm the environment from melted plastic + microplastics

Future work #1:

Eco-friendly material usage

PHA or other biodegradable filaments


on start
set Gate1 to digital pin P0
set Gate2 to digital pin P5
set Gate3 to digital pin P13
set Gate4 to digital pin P14
set Flag to digital pin P12
led enable false
play spring until done
play in background
servo write pin Flag to 80
set pull pin Gate1 to up
set pull pin Gate2 to up
set pull pin Gate3 to up
set pull pin Gate4 to up
serial
redirect to
TX P16
RX P15
at baud rate 115200
on button B pressed
set cnt to 0
set flagup to 0
servo write pin Flag to 80
forever
set hit to 0
if digital read pin Gate1 = 0 then
serial write string join "IR" "1" ("\n")
change cnt by 1
set hit to 1
if digital read pin Gate2 = 0 then
serial write string join "IR" "2" ("\n")
change cnt by 1
set hit to 1
if digital read pin Gate3 = 0 then
serial write string join "IR" "3" ("\n")
change cnt by 1
set hit to 1
if digital read pin Gate4 = 0 then
serial write string join "IR" "4" ("\n")
change cnt by 1
set hit to 1
if hit = 1 then
if cnt > 20 then
if flagup = 0 then
servo write pin Flag to 5
set flagup to 1
pause (ms) 200

```
input.onButtonPressed(Button.B, function () {
    cnt = 0
    flagup = 0
    pins.servoWritePin(Flag, 80)
})
let hit = 0
let flagup = 0
let cnt = 0
let Flag = 0
let Gate1 = DigitalPin.P0
let Gate2 = DigitalPin.P5
let Gate3 = DigitalPin.P13
let Gate4 = DigitalPin.P14
Flag = DigitalPin.P12
led.enable(false)
music.play(music.builtinPlayableSoundEffect(soundExpression.spring), music.PlaybackMode.UntilDone)
music.play(music.createSoundExpression(WaveShape.Square, 400, 600, 255, 0, 100, SoundExpressionEffect.Warble,
InterpolationCurve.Linear), music.PlaybackMode.InBackground)
pins.servoWritePin(Flag, 80)
pins.setPull(Gate1, PinPullMode.PullUp)
pins.setPull(Gate2, PinPullMode.PullUp)
pins.setPull(Gate3, PinPullMode.PullUp)
pins.setPull(Gate4, PinPullMode.PullUp)
serial.redirect(
SerialPin.P16,
SerialPin.P15,
BaudRate.BaudRate115200
)
basic.forever(function () {
    hit = 0
    if (pins.digitalReadPin(Gate1) == 0) {
        serial.writeString("IR" + " 1 " + ("\n"))
        cnt += 1
        hit = 1
    }
    if (pins.digitalReadPin(Gate2) == 0) {
        serial.writeString("IR" + " 2 " + ("\n"))
        cnt += 1
        hit = 1
    }
    if (pins.digitalReadPin(Gate3) == 0) {
        serial.writeString("IR" + " 3 " + ("\n"))
        cnt += 1
        hit = 1
    }
    if (pins.digitalReadPin(Gate4) == 0) {
        serial.writeString("IR" + " 4 " + ("\n"))
        cnt += 1
        hit = 1
    }
    if (hit == 1) {
        if (cnt > 20) {
            if (flagup == 0) {
                pins.servoWritePin(Flag, 5)
                flagup = 1
            }
        }
    }
    basic.pause(200)
})
```