Lilia the Kitty Bank

Robotic Perception and Robot-Human Interaction II

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Introduction

Establishing a money-saving habit often involves overcoming various psychological and behavioral challenges. One of the significant struggles is the tension between immediate gratification and long-term financial goals. Behavioral economics and psychology literature, such as Thaler and Shefrin's seminal paper “An Economic Theory of Self-Control,” highlights how individuals typically exhibit present-biased preferences, prioritizing instant rewards over delayed benefits. This inclination can lead to impulsive spending and hinder the formation of a consistent saving habit. Additionally, external factors like unexpected expenses or social pressures may pose further obstacles.

Lilia ingeniously merges the realms of immediate gratification and long-term financial goals, serving as the most amusingly persistent smart coin bank ever devised. Empowered by generative AI, Lilia not only possesses a distinctive personality but also a voice that persistently nudges you for “offerings” and “donations” in the form of coins, making her an amusing yet relentless financial companion. Resist her demands, and brace yourself for a cascade of varied, increasingly irate voice lines, with the threat of escalating to incessant Line messages if patience wears thin. Soothing Lilia's demands is straightforward: a daily tribute of a coin, with a preference for the grandeur of ¥100 or ¥500 denominations. Perhaps, if luck favors, she may graciously accept smaller ones.

Amidst the daily whims, Lilia cleverly instills the habit of saving a fraction each day, offering immediate relief when pacified with a coin while nurturing a growing appreciation for her guardianship over your savings. Ensure a stash of coins is perpetually on hand for this entertaining yet effective savings companion!

In the following sections, the technical details of Lilia's implementation will be discussed: the design and modeling, required hardware, software implementation, and assembly of the components.

Design and Modeling

Lilia was modeled using Shapr3D, an iOS app for 3D modeling and design. Figure 1 presents the 3D model. The 2D drawings for the main body, top cover, and back cover are shown in Figures 2, 3 and 4, respectively.

The design focused on functionality. The coin hole is where one would expect: at the top. The square shape makes for a cute low-poly style cat, a stable base for Lilia, and an easy-to-3d-print model. The main body is divided into two areas: coin storage (in the front), and hardware compartment (in the back). The detachable parts are also for a higher quality-of-life experience: the back cover allows for easy retrieval of the hardware components, and the top cover allows for easy access to the coin storage area. Note that the hole between the inside walls is for the motion sensor to be able to sense the coins as they fall into storage.

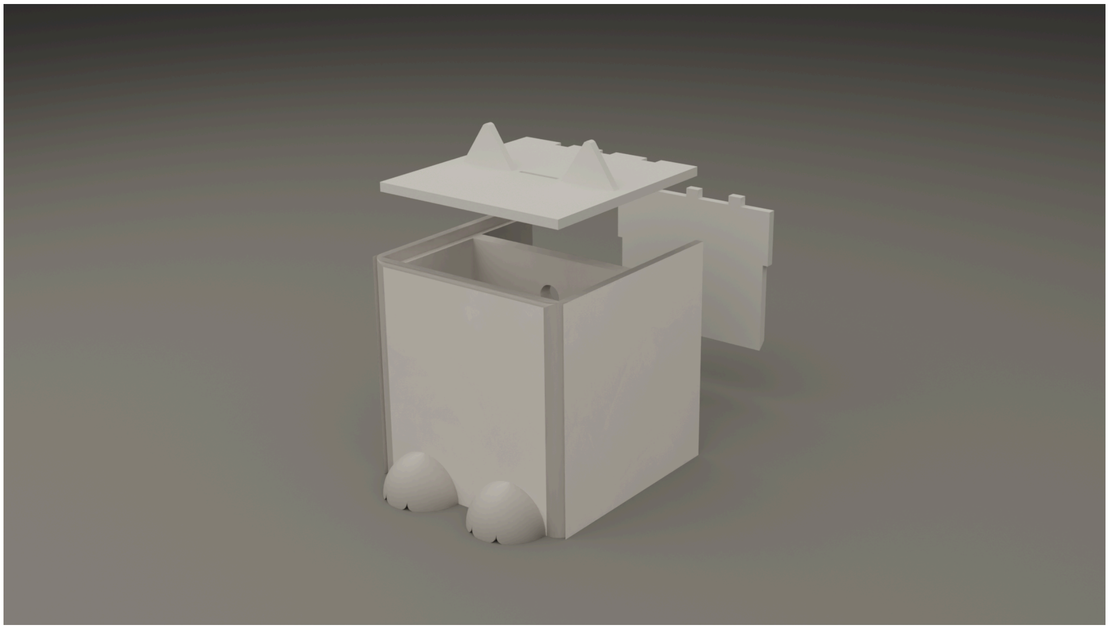


Figure 1: Lilia’s 3D model.

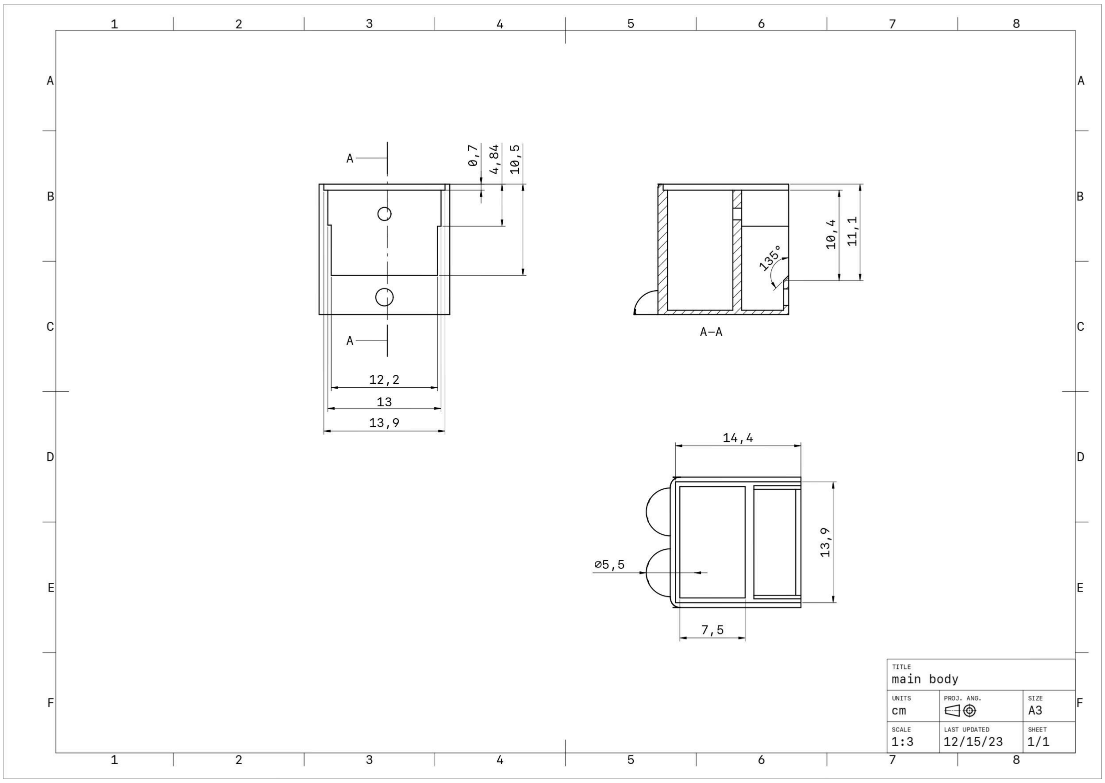


Figure 2: 2D drawing of the main body.

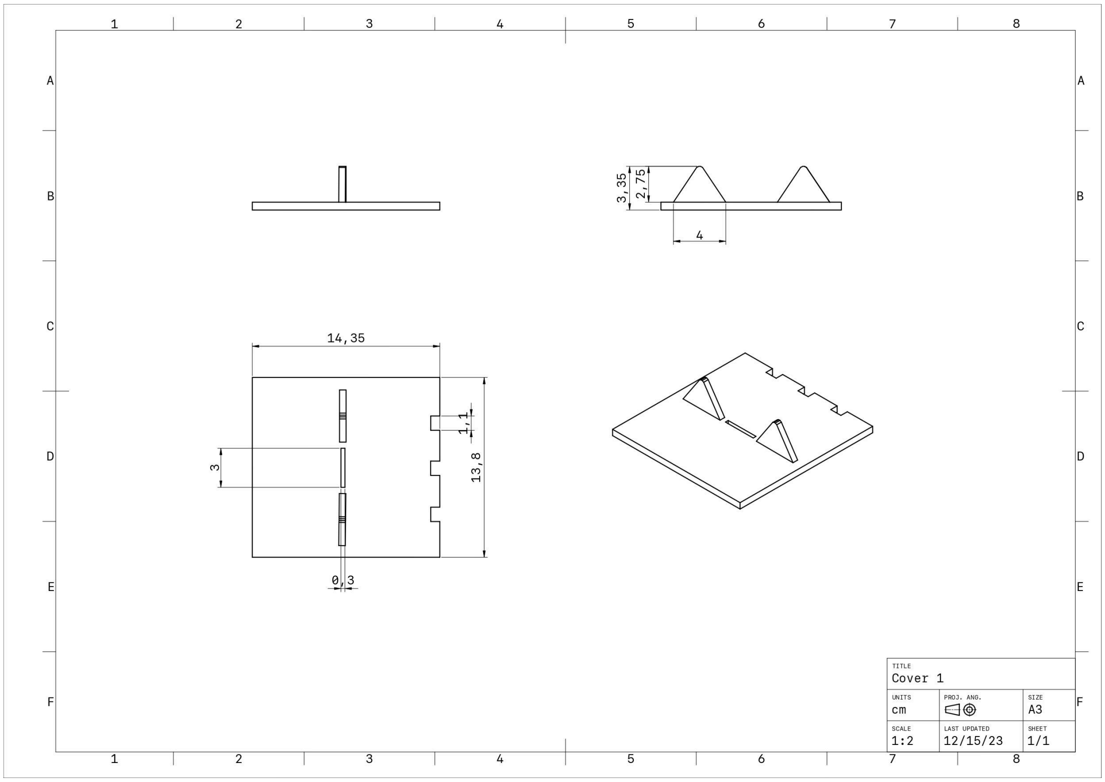


Figure 3: 2D drawing of the top cover.

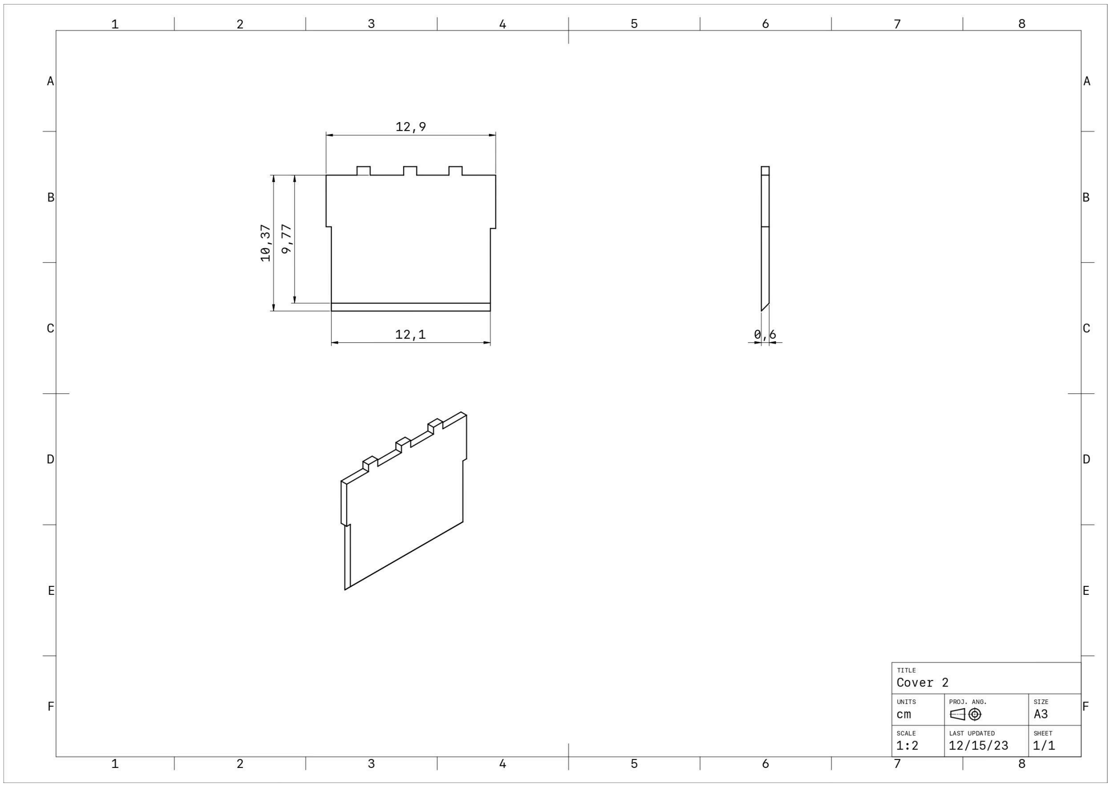


Figure 4: 2D drawing of the back cover.

Hardware

For the hardware, the following was used:

- Sony MESH Motion sensor and GPIO.
- Micro servo
- Jumper wires
- An Android device (tablet)

Although an android device was used, the MESH APP also works on iOS.

The motion sensor is used to detect coins as they fall through the coin hole. The GPIO is connected to the micro servo using jumper wires. It sends a PWM signal to the servo, causing it to activate. This is used for the tail motion. The Android device runs the MESH APP and connects to the sensor and GPIO via Bluetooth.

It's important to note that using a laser-based sensor would have been more reliable for detecting coins. The MESH motion sensor is a sonar sensor and fails to detect coins as they fall too quickly. Because of this, some modifications were required, as discussed in the assembly section.

Software

The software was developed inside Sony Mesh APP. It consists of 2 states: idle and active.

- Idle state: a continuous loop that only stops when the active state is triggered. It reactivates daily at 8am.
  - Daily at 8am: Lilia says good morning.
  - Every 15 seconds: Lilia meows.
  - Every 5 minutes: Lilia says something in a mad/annoyed/sad tone.
  - Every 1 hour: Lilia sends you a text message on LINE complaining that you haven't fed her coins yet.
- Active state: triggered when a coin is inserted (i.e., when the motion sensor detects motion). This state stops the idle state and makes Lilia say a variation of "Thank you" and wiggle her tail by sending a PWM signal to the micro servo via the GPIO.
  - Every 10 coins, Lilia sends a "thank you" text message on LINE.

All of Lilia's voice lines were generated using AI:

- Personality setting and voice line script using CHATGPT 3.5.
- AI generated speech using ElevenLabs and the Lilia voice.

For the MESH recipe, two custom blocks were created:

- Connector Node: this block passes the signal forward without changes. It's designed as a connection node for organizing the wires.
- Switch+10: same as the regular Switch, but with 10 outputs.

Figure 5 presents the MESH App recipe with an outline of the different states. Figure 6 presents a screenshot of the LINE conversation with Lilia's messages.

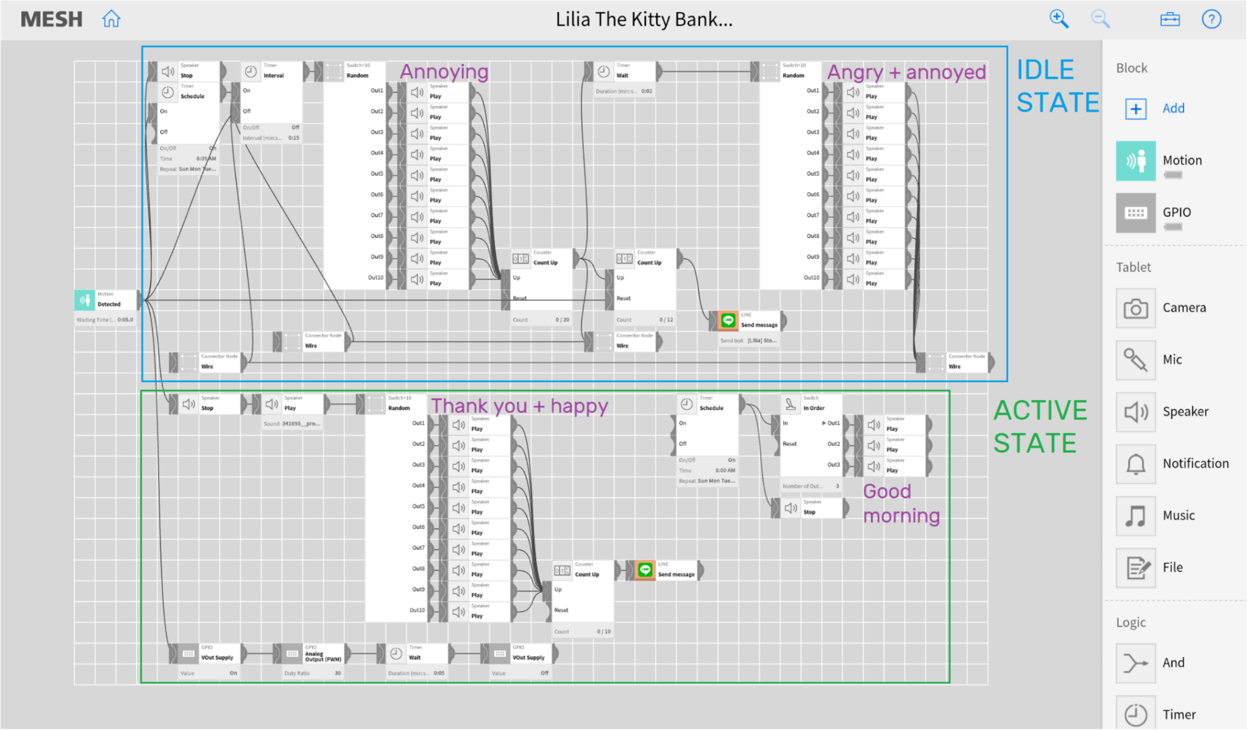
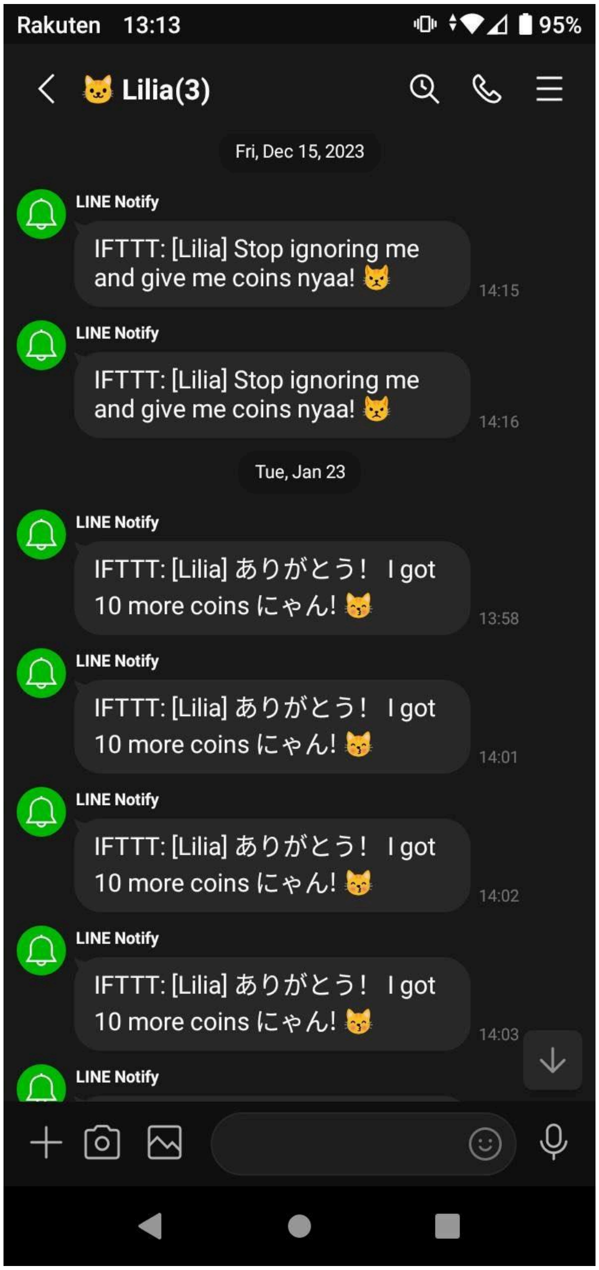


Figure 5: the developed MESH recipe. In blue, the idle state area. In green, the active state area. In purple, descriptions of the audios.



Rakuten 13:13 95%

🐱 Lilia(3)

Fri, Dec 15, 2023

LINE Notify
IFTTT: [Lilia] Stop ignoring me and give me coins nyaa! 😾 14:15

LINE Notify
IFTTT: [Lilia] Stop ignoring me and give me coins nyaa! 😾 14:16

Tue, Jan 23

LINE Notify
IFTTT: [Lilia] ありがとう！ I got 10 more coins にゃん! 😽 13:58

LINE Notify
IFTTT: [Lilia] ありがとう！ I got 10 more coins にゃん! 😽 14:01

LINE Notify
IFTTT: [Lilia] ありがとう！ I got 10 more coins にゃん! 😽 14:02

LINE Notify
IFTTT: [Lilia] ありがとう！ I got 10 more coins にゃん! 😽 14:03

LINE Notify

Figure 6: screenshot of the LINE conversation containing Lilia's messages.

Assembly

Assembly of Lilia's components was easy. The 3D model was 3D printed, and the hardware was positioned inside the hardware compartment. Figures 7 and 8 show the 3D printing result. Figures 9, 10, and 11 show the interior compartments. Note that for the coins to be more reliably detected, a small ramp made of cardboard was attached near the motion sensor hole. This way, coins slide and fall at a reduced speed from free fall and increase the chances of detection.

A face was hand-drawn and glued to the front side. Figure 12 shows Lilia's new expression.

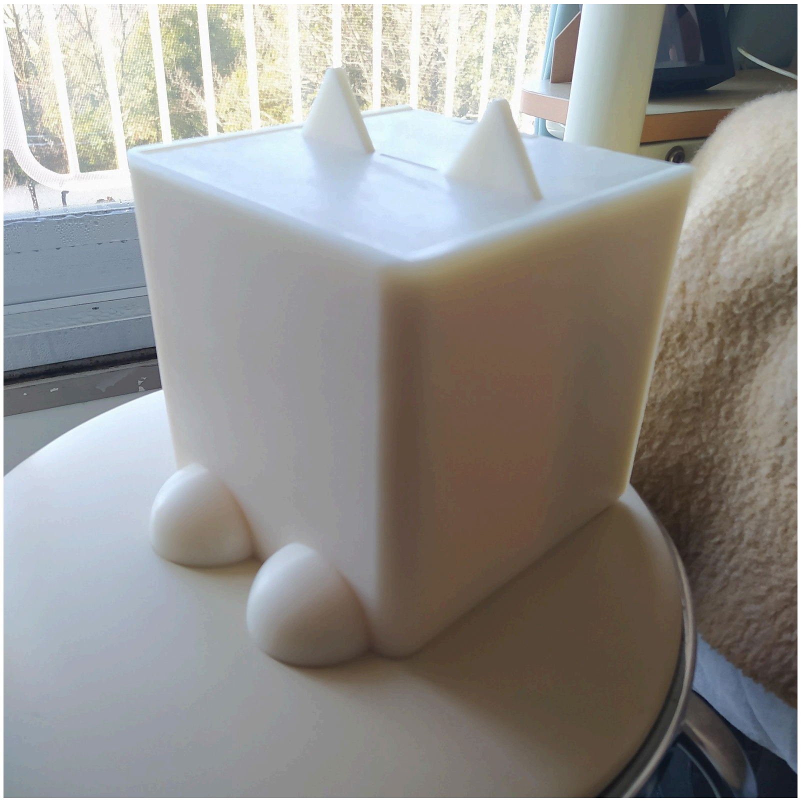


Figure 7: Results of 3D printing (front)

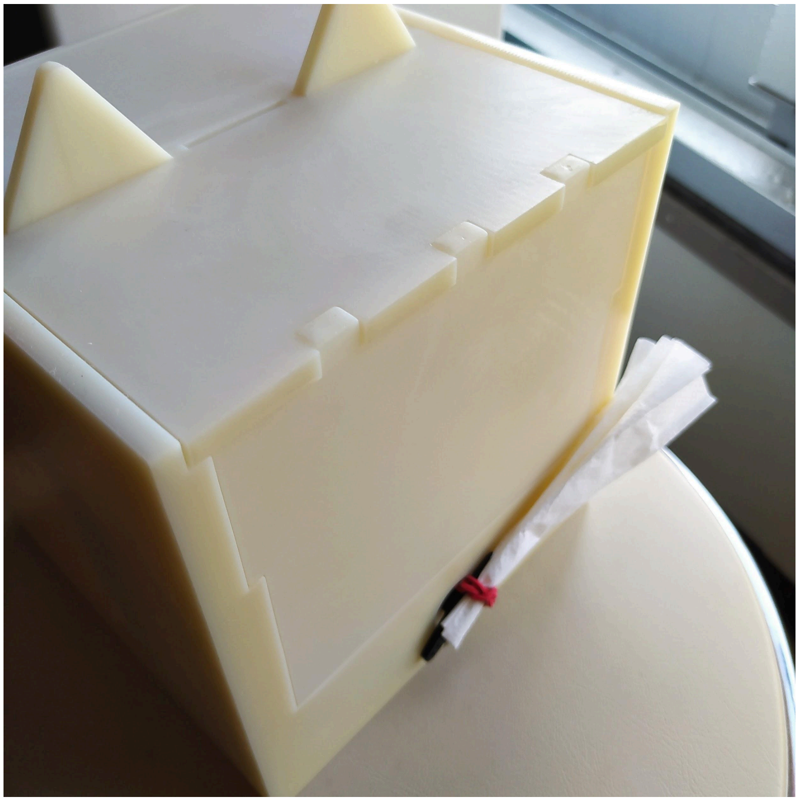


Figure 8: results of 3D printing (back) with attached tail made with a folded napkin.

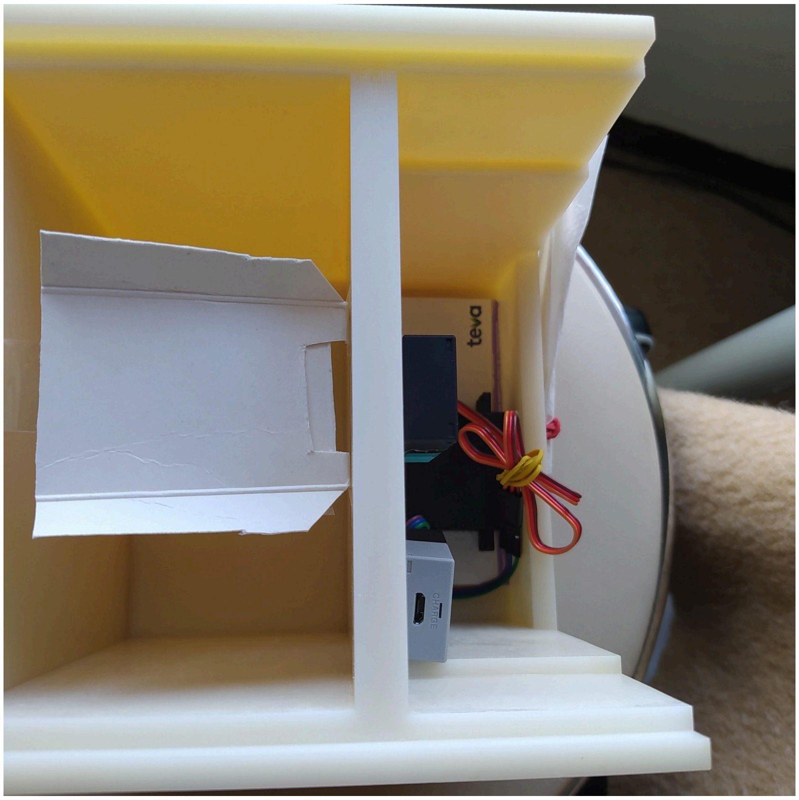


Figure 9: top-view of the inside compartments.

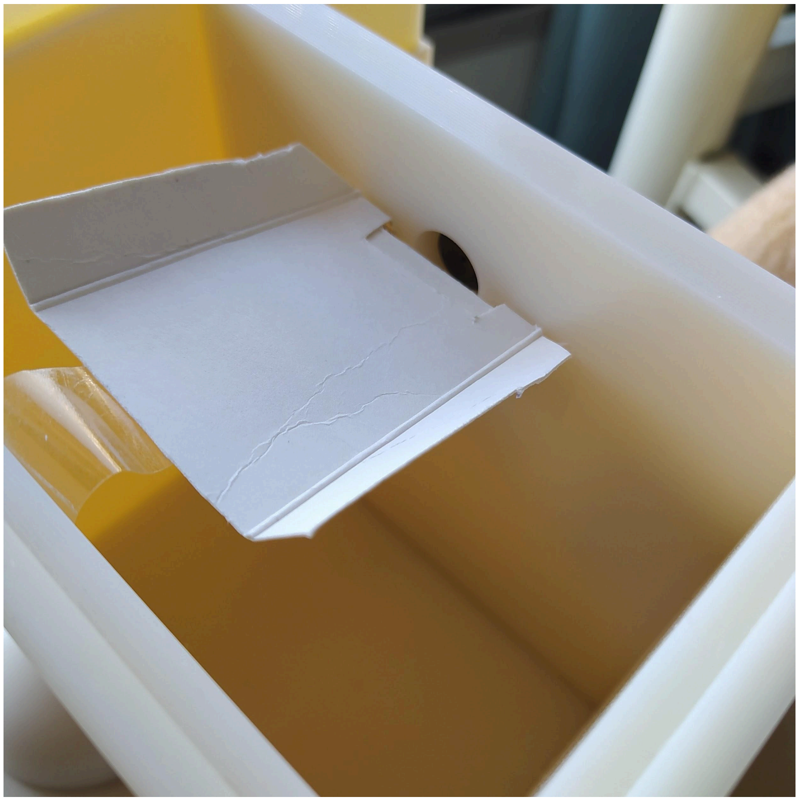


Figure 10: cardboard ramp attached to facilitate coin detection.

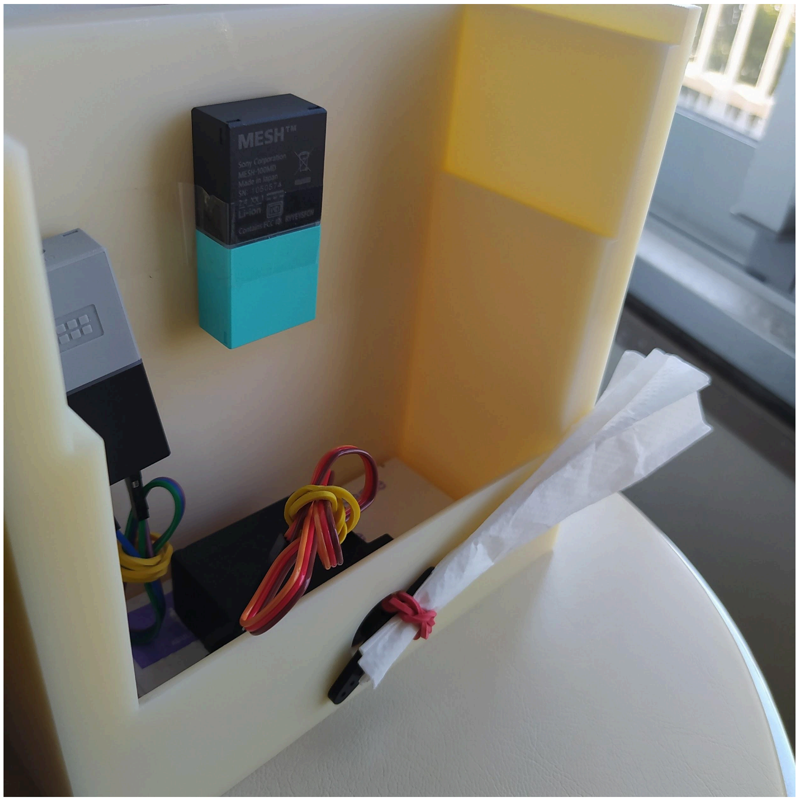


Figure 11: hardware compartment.

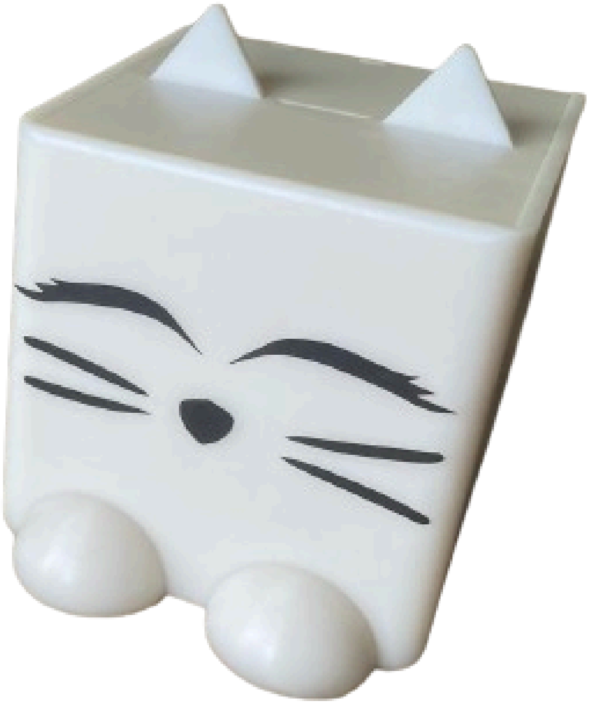


Figure 12: hand-drawn face for Lilia.

Conclusions

This project met my expectations. MESH is extremely limited in what it offers, both on the hardware side and the software side. The motion sensor is unreliable for fast moving objects, and there's no laser-based sensor for quick on/off detection. The MESH App itself is an outdated piece of software, with unreliable controls (e.g., more often than not you will connect the wrong blocks, or it'll select and delete the wrong blocks because of a huge offset on you the location where you tapped) and very limited logic. I often had to implement workarounds for simple logic, like a loop feedback. And the worst of all: the canvas size is hard-coded and can't be expanded.

Although the custom blocks could solve some of these issues, as they allow JavaScript programming, the documentation on how to do so is short and confusing. The English translations are full of grammar mistakes, making it hard to follow.

Despite all that, the project still met its goal. As it stands, this is a proof-of-concept for a smart kitty bank powered by AI. Although all voice lines were pre-recorded, the original idea was to have chatbot integration with ChatGPT, which was not possible due to the many MESH limitations. The motion sensor should be swapped for a reliable laser-based sensor. A better hold for the hardware should be used too, as cardboard and tape is useful for a prototype, but not a final product.

In any case, even after returning all the hardware, Lilia still functions as a regular coin bank! Saving up money couldn't be easier than this.