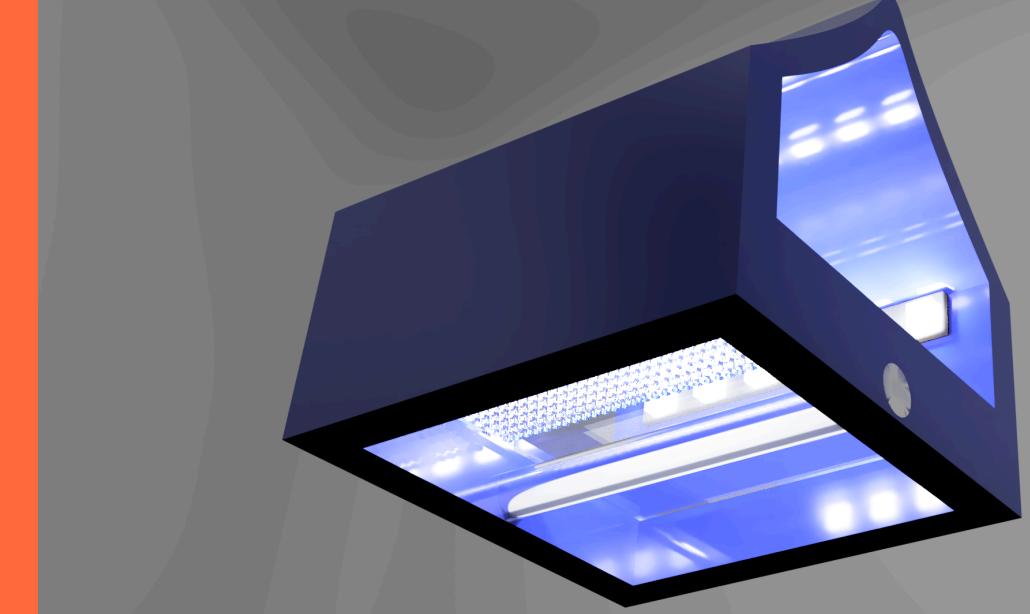


DLweek
2025

JIGGLE

SUSTAINABILITY



OPEN DEEP



BIN

SembWaste, one of three public waste collectors in Singapore, estimates that 60 per cent of material coming from recycling bins into its sorting facility cannot be recycled because of contamination and the inclusion of non-recyclables.

About 40 per cent of what is thrown into recycling bins cannot be recycled, said the Ministry of Sustainability and the Environment – NEA's parent ministry – on its Towards Zero Waste website.

Mr Ng Hiap Seng, 56, a supervisor who has been working for over two decades at SembWaste, said he has encountered soiled sanitary napkins and diapers coming through the sorting line as well. Increasingly, used masks have started showing up in bins.

NO ONE'S RECYCLING AT HOME PROPERLY !!!

Only 13% of S'pore's domestic waste was recycled in 2021, even as households throw out more rubbish

PROBLEM: CONTAMINATION OF RECYCLABLES

BASED ON STATISTICS, MOST OF THE CONTAMINATION TENDS TO OCCUR IN BLUE BINS.

40% OF ITEMS IN BLUE BINS IN HOUSING ESTATES CANNOT BE RECYCLED DUE TO CONTAMINATION.

CONSUMERS KNOWINGLY/ UNKNOWINGLY THROW POSSIBLY CONTAMINATED RECYCLABLES INTO BLUE BINS.

RECYCLABLES ARE MIXED WITH THE CONTAMINANTS AND ARE UNRECYCLABLE.

SOLUTION: SORTING BINS

TO REDUCE THE CONTAMINATION, WE CAN HELP PRE-SORT THE UNCONTAMINATED ONES FROM OTHERS.

WE CAN OFFER CONSUMERS BINS THAT HELP THEM SORT THE RECYCLABLES BEFORE THEY DISPOSE INTO BLUE BINS.

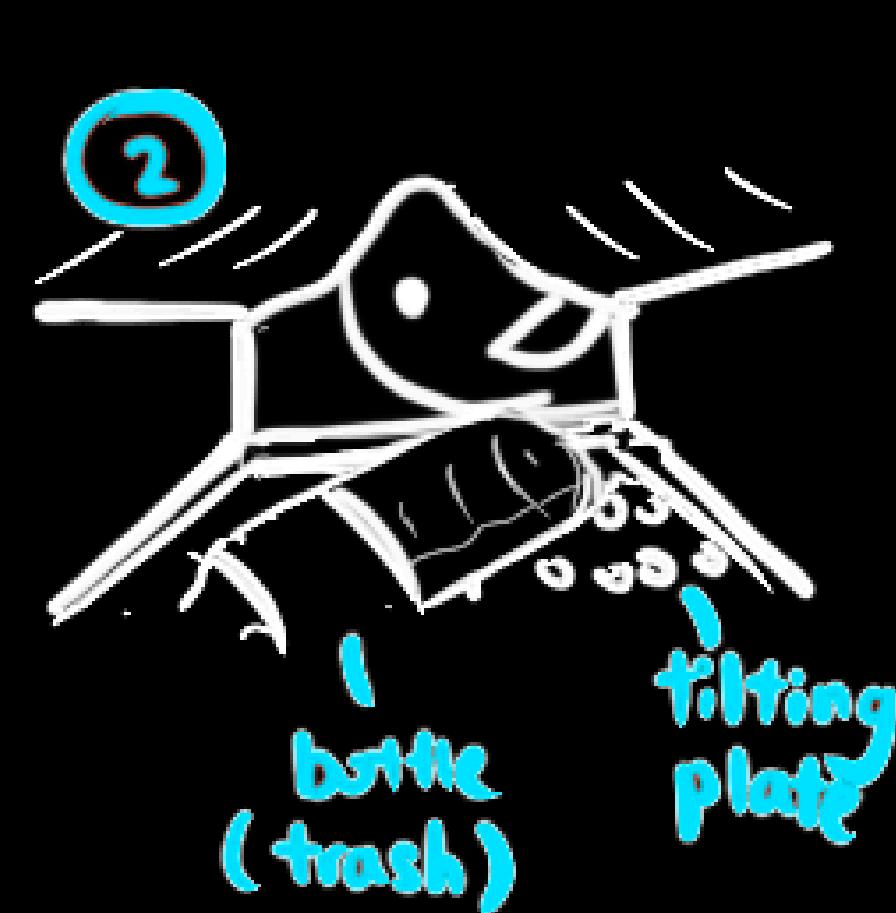
THESE BINS HAVE ESSENTIALLY TWO TRASH BAGS: ONE FOR GENERAL WASTE, THE OTHER FOR RECYCLABLES.

CONSUMERS WILL HAVE TWO SORTED BAGS TO BE THROWN INTO BLUE BINS AND GENERAL WASTE BINS.

PROCESS



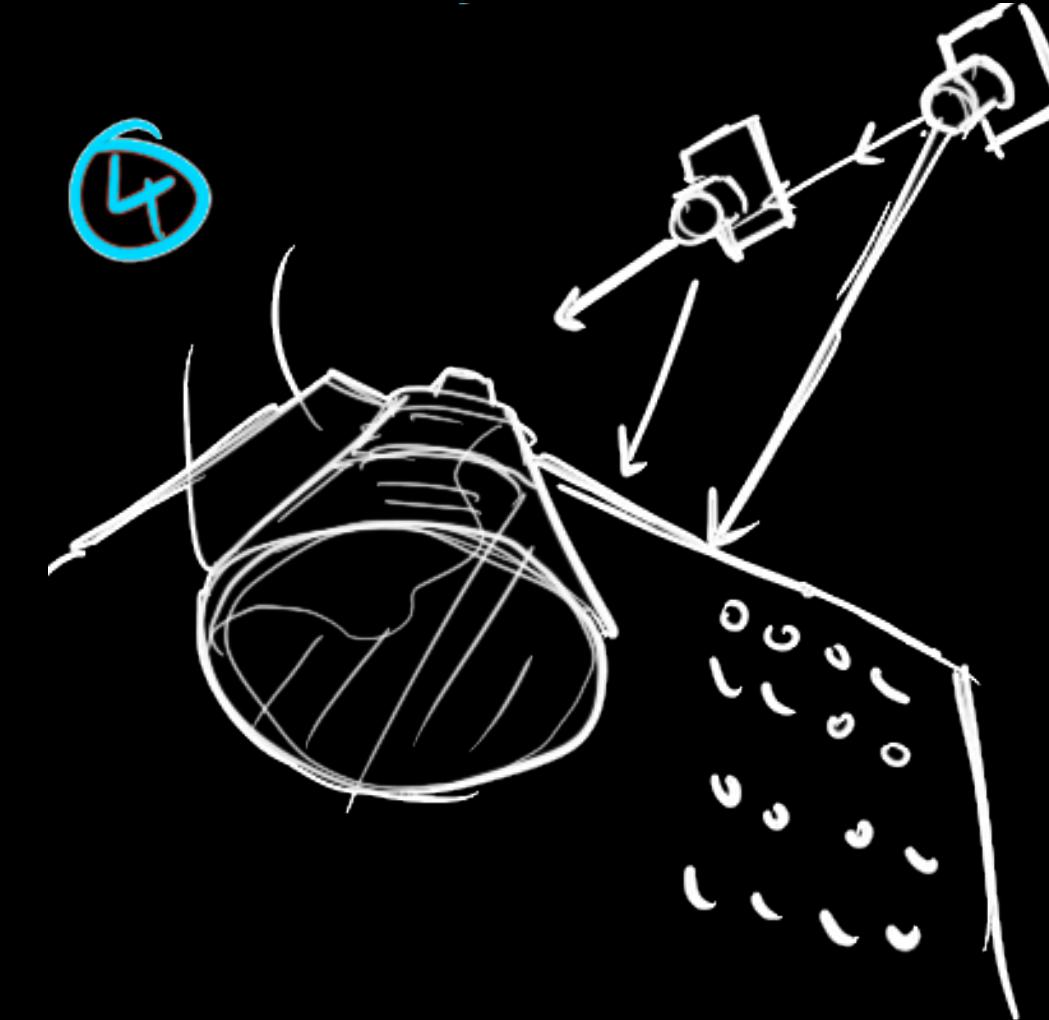
Trash is thrown
into bin, land onto
tilting disk



Disk will make
vibrations on the
object



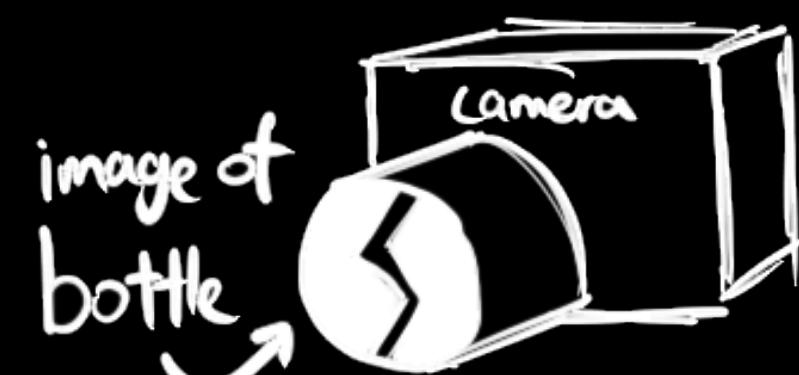
Visual sensor to
capture the
object



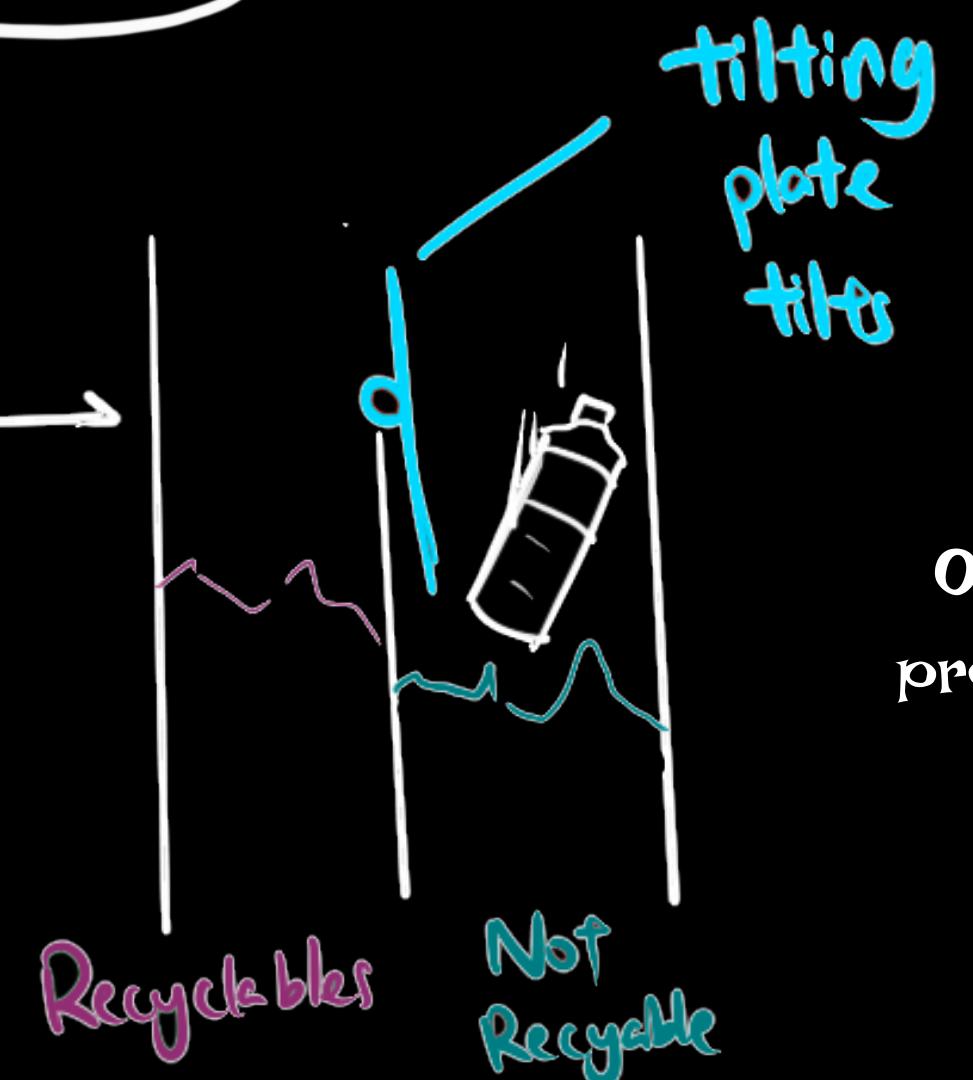
Feed data into
trained Model to
assess

Main Features

- Motion sensor triggering light
- Visual sensor for data input
- Tilting disk to create splashes
- Detect for presence of liquid
- Classify contamination result



Disk tilts and
place trash into
respective bag

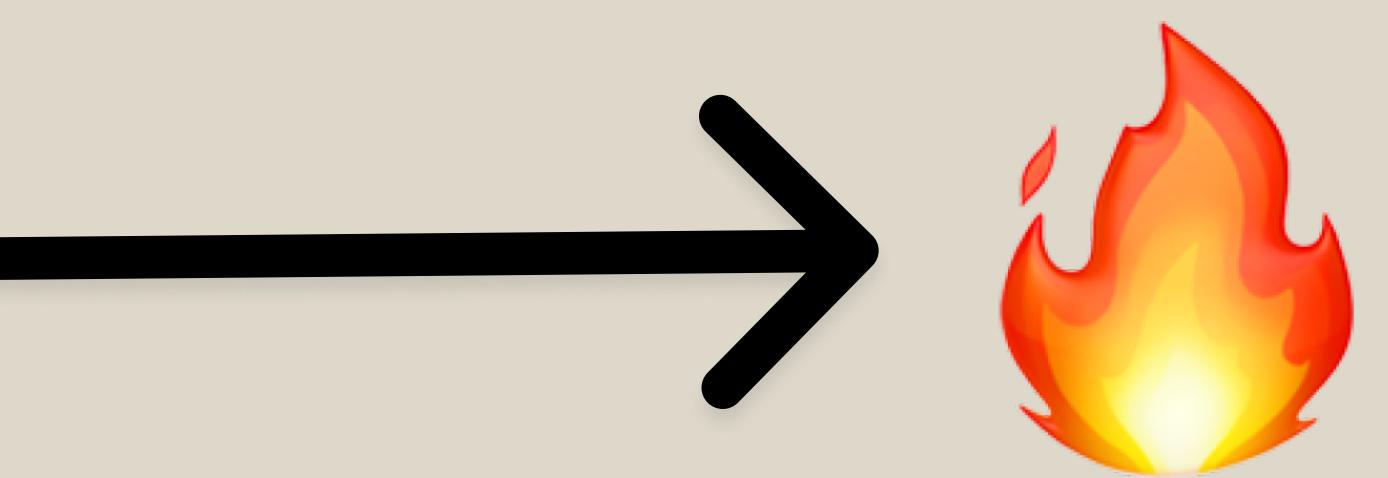
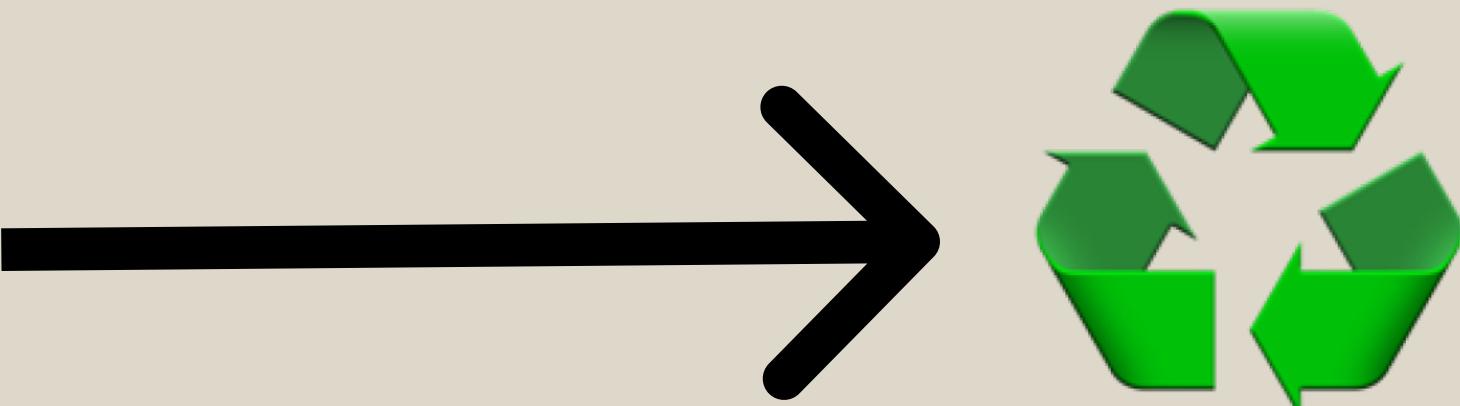


Obtain result of
presence of liquid

Open Deep

OUR SOLUTION

JIGGLE BIN



CNN-POWERED HOUSEHOLD TRASH-BIN

THAT CAN PROPERLY SORT WASTE

TRAINING DATASET

RECYCLABLE



IMAGES OF CLEAN PLASTIC,
PAPER, METAL, AND GLASS ITEMS
CLASSIFIED AS RECYCLABLE
FROM DATASET



TRAINING DATASET SOURCED FROM
[HTTPS://WWW.KAGGLE.COM/DATASETS/TECHSASH/WASTE-CLASSIFICATION-DATA](https://www.kaggle.com/datasets/techsash/waste-classification-data)

CONTAMINATED



ORGANICS



IMAGES OF EVERYDAY
FOOD AND ORGANIC
ITEMS CLASSIFIED AS
UNRECYCLABLES

AUGMENTATION

Series of augmentation on images in training set using PyTorch to teach model to recognise items under more varied and realistic conditions.



Resized Image

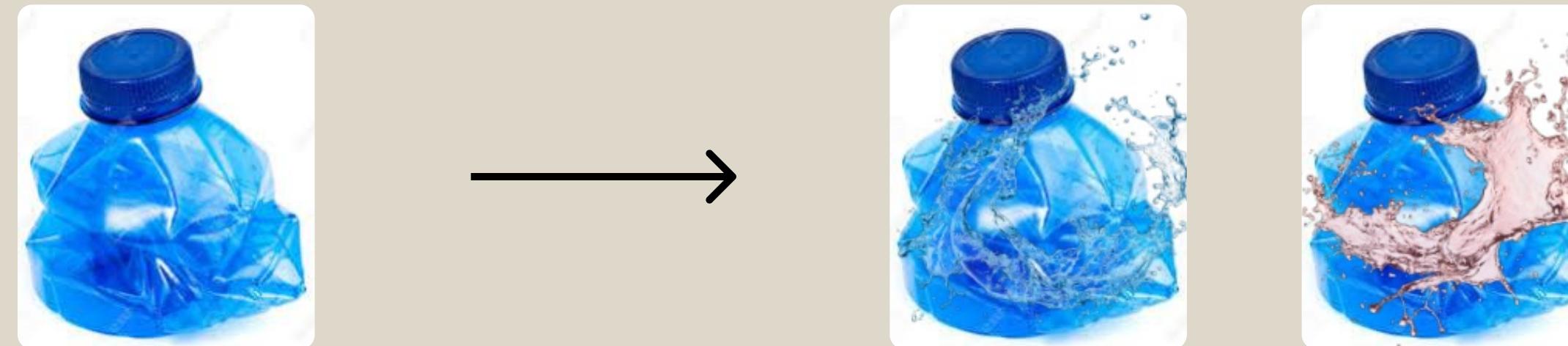
Horizontal Flip

Vertical Flip

Rotation

Affine

Normalisation

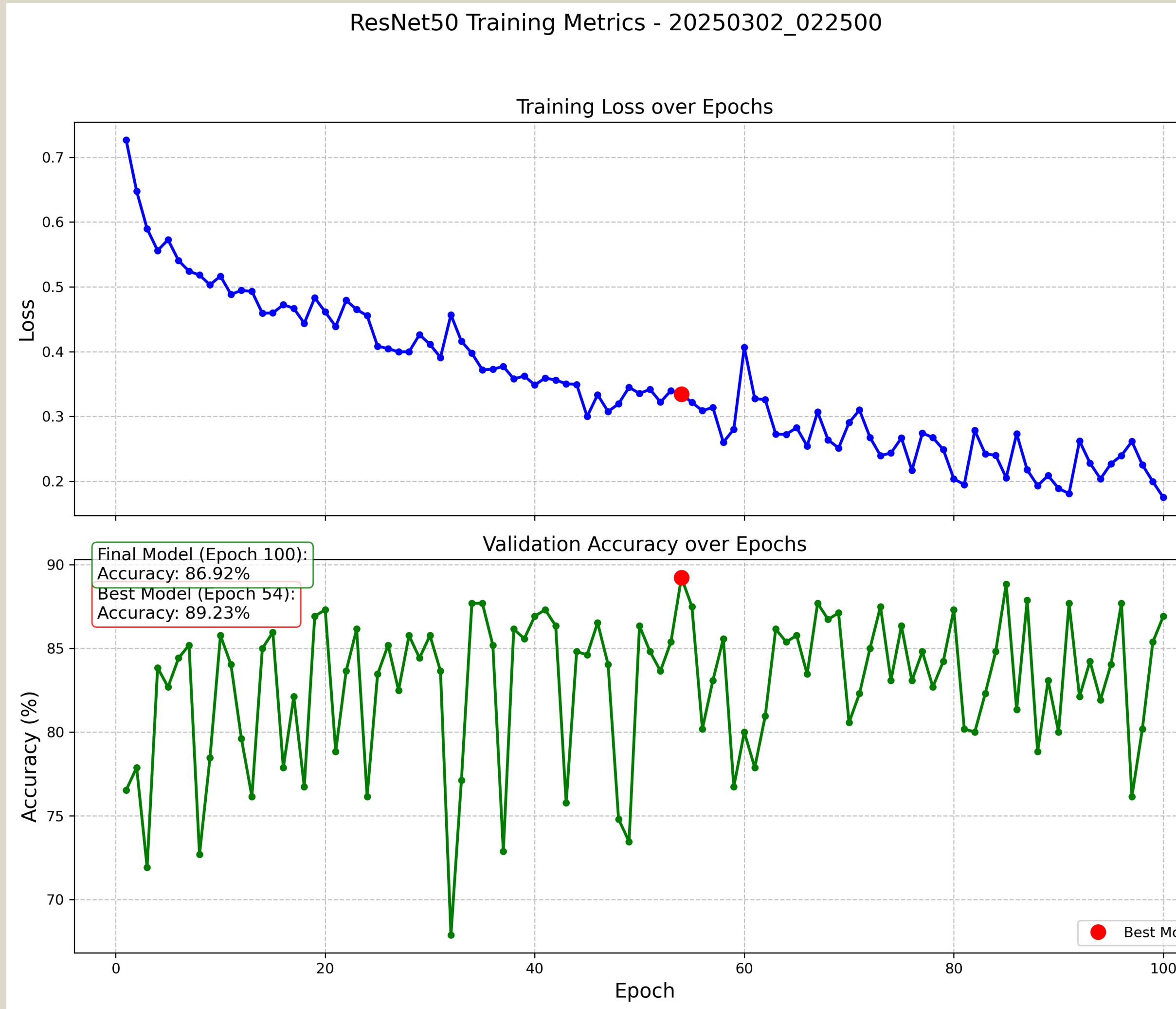


SYNTHESIS

PNGs of liquid splash overlaid on images of recyclable items to simulate liquid contamination.

MODEL TRAINING

Fine Tuning ResNet-50 on new data



We use an Resnet-50 model with ImageNet weights and change the final layer to a sigmoid layer.

- Training Data:
 - 478 not accepted
 - 477 accepted
- Test Data:
 - 251 not accepted
 - 305 accepted

We trained 100 epochs, and reached an accuracy of 89.23% in epoch 54 but we choose to use the final model (86.92%) as the difference in the loss more significant than the difference in accuracy.

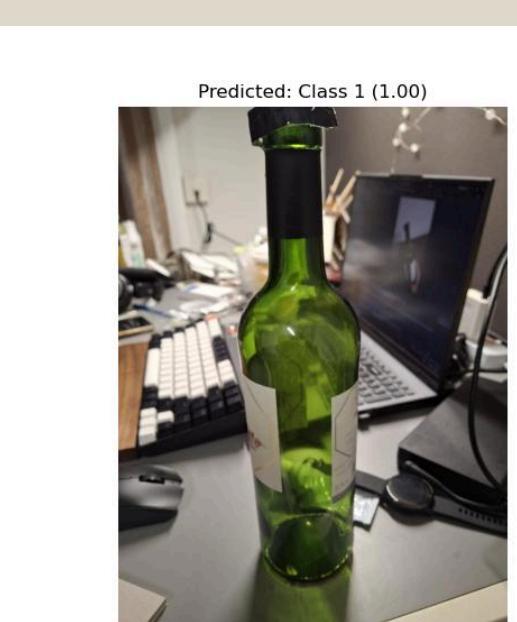
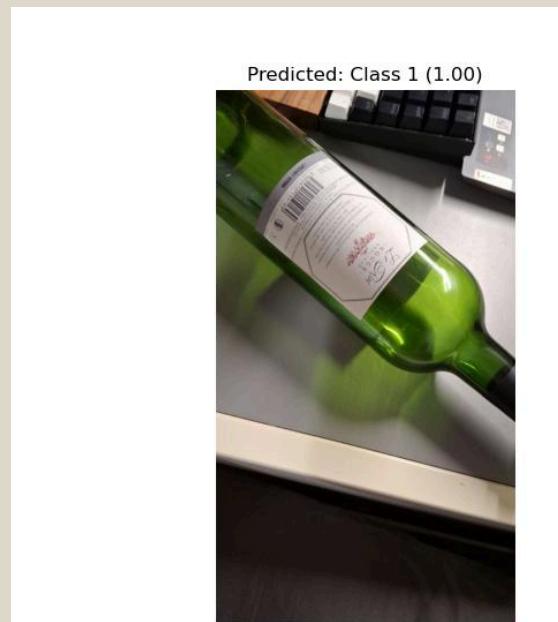


In general, the trained model could relatively accurately differentiate between clean and contaminated wastes. Correctly picking out food items and liquids as sources of contaminants.



When given images of the same clear plastic bag—one wet and one dry—the model correctly identified the wet bag as unrecyclable and the dry one as recyclable.

This shows that synthesized images with a liquid splash overlay effectively trained the model to detect liquid contamination in recyclable materials.



Given images of the same clear glass wine bottle cropped, lighted, and positioned differently the model was able to correctly identify it as recyclable.

This shows that the data augmentation done on the training data helped train the model to detect objects in different positions and environments.

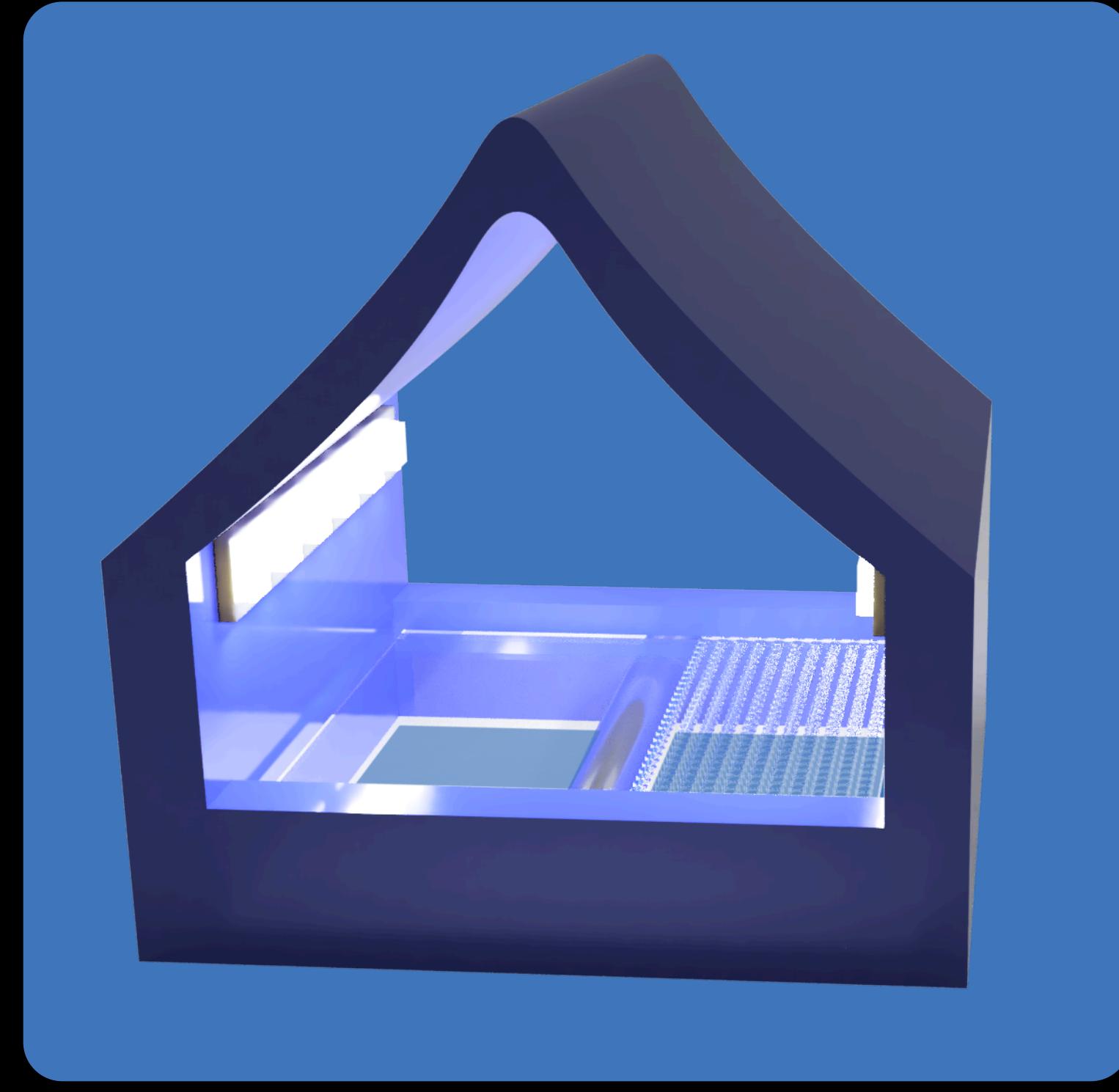
REVIEW

Performance on the model

(A prediction class value of 1 indicates that the object is recyclable, while 0 indicates that it is either unrecyclable or contaminated.)

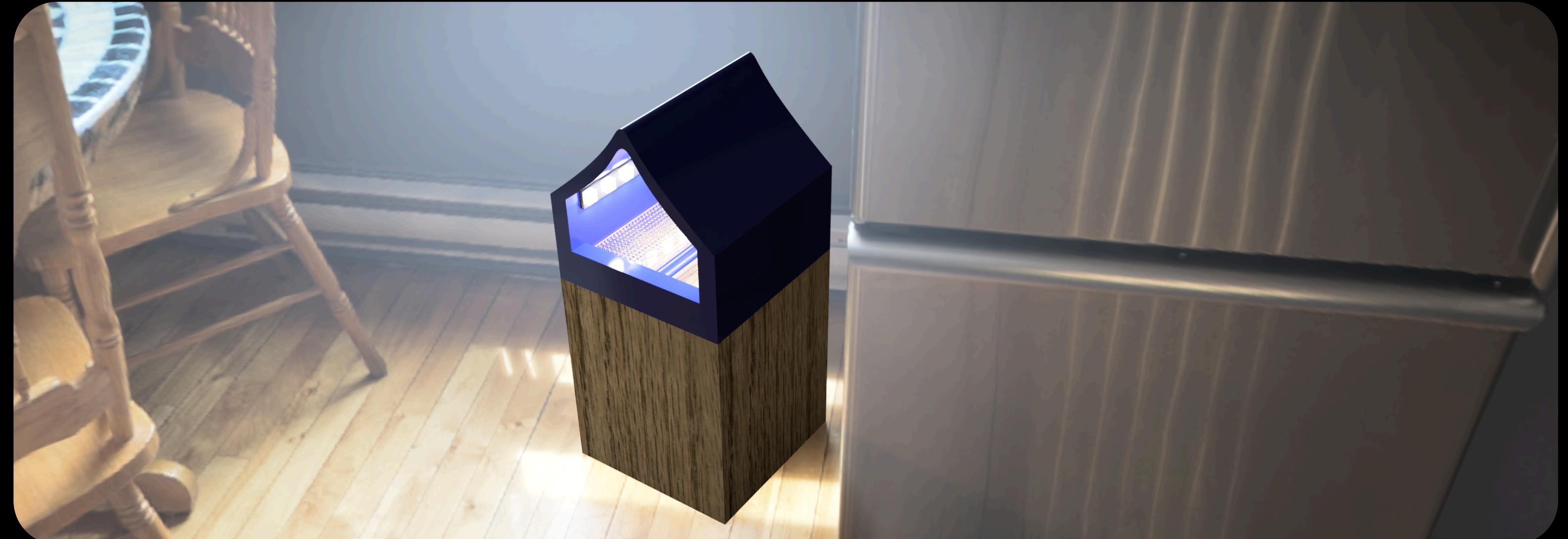
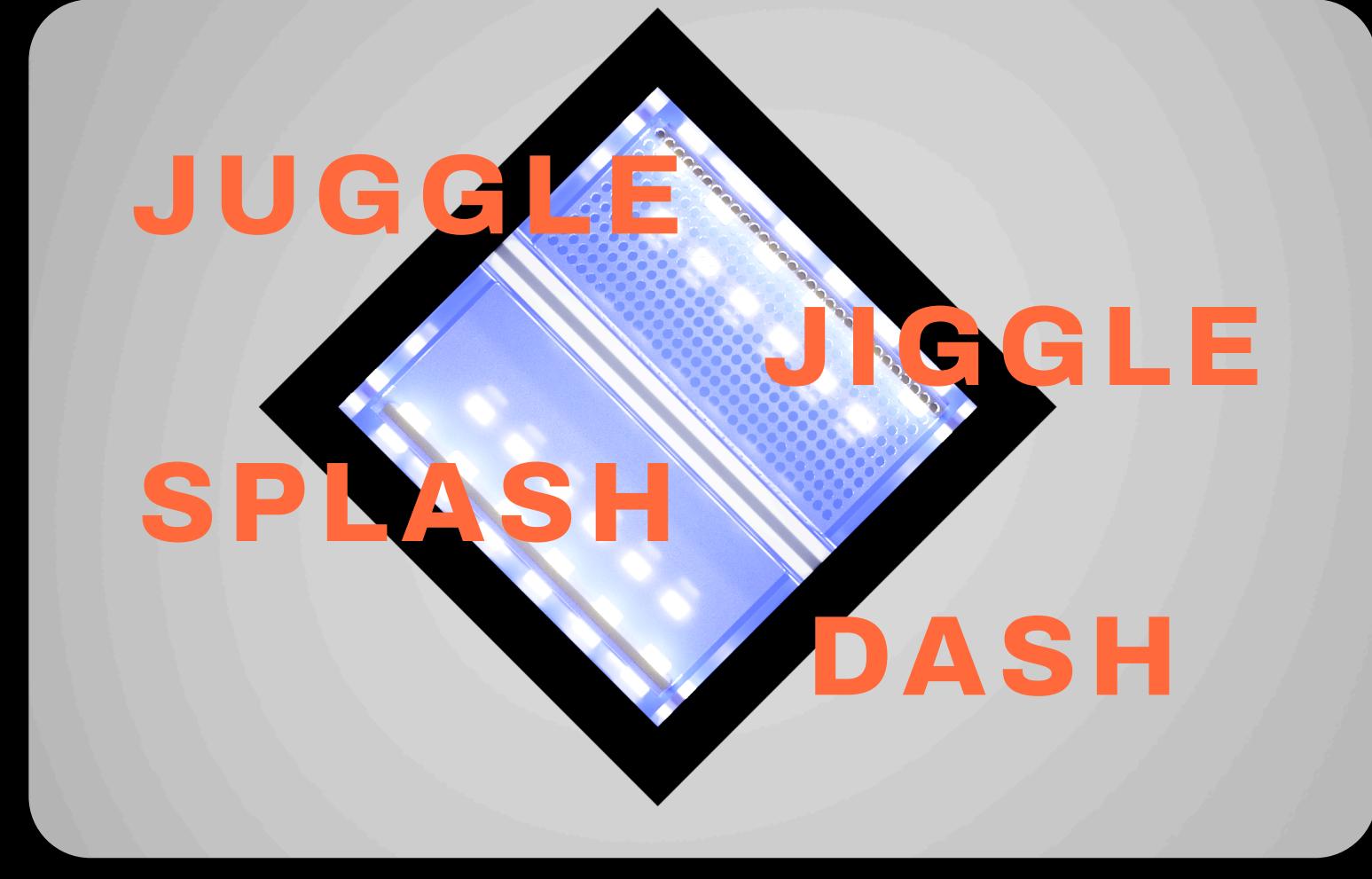
POTENTIAL PHYSICAL MODEL

Open Deep



JIGGLE BIN HAS

A DUAL COMPARTMENT SYSTEM TO SEPARATE WET
CONTAMINATED V.S. RECYCLABLE WASTE
THE SIDE ABOVE THE NON-RECYCLABLE COMPARTMENT
IS GRATED TO DISPOSE REMNENT LIQUID.



LIGHTSTRIPS AND CAMERA
TO ENSURE CLEAR IMAGE OF
WASTE IS TAKEN FOR
PROPER PROCESSING.

FUTURE IMPROVEMENTS

SCALABILITY

It can be scaled to neighbourhood bins. Since it only requires an addition of the tilting disk and visual sensor.

FURTHER SPECIALISATION

For different types of recycling bins, CNN model can be trained to specialise in detecting for one category of waste.

CURRENT LIMITATIONS

HALVED STORAGE

Storage of normal bins are halved since it is split into recyclables and general waste.

LIMITED DETECTION

Some liquids may not be detected due to its viscosity and the vibration of the tilting disk may not be sufficient to generate patterns of liquid.



THANK

YOU

DATASETS

Sekar, S. (2019). Waste Classification Data [Data set]. Kaggle. <https://www.kaggle.com/datasets/techsash/waste-classification-data>

King, A. (2023). Recyclable and Household Waste Classification [Data set]. Kaggle. <https://www.kaggle.com/datasets/alistaiking/recyclable-and-household-waste-classification>

BACKGROUND RESEARCH

Elangovan, N., & Wong, J.-M. (2023, May 12). The Big Read in short: Singapore's household recycling blues. TODAY. <https://www.todayonline.com/big-read/big-read-short-singapores-household-recycling-blues-2170326>

Tan, A., & Cheong, M. (2022, April 18). Recycle-me-not: What happens when the wrong things get recycled. The Straits Times. <https://www.straitstimes.com/multimedia/graphics/2022/04/recycle-me-not/index.html?shell=>

Begum, S. (2022, April 18). Only 13% of S'pore's domestic waste was recycled in 2021, even as households throw out more rubbish. The Straits Times. <https://www.straitstimes.com/singapore/environment/only-13-of-spores-domestic-waste-was-recycled-in-2021-even-as-households-throw-out-more-rubbish>