Experiment 2: Supermarket Intelligent Replenishment System

一、Scene Description

According to IHL's research report, the retailer's capital cost of goods management has reached 7 trillion yuan per year. These losses come from the loss of goods, the wrong placement of goods, inaccurate goods statistics and some other losses. In order to reduce the losses caused in the replenishment process, this experiment built an intelligent replenishment robot system, which can replenish the goods more accurately and efficiently, reducing the loss of goods.

二、Experiment Principle

The intelligent replenishment robot system built in this experiment uses image segmentation technology, image recognition technology, and camera calibration to realize automatic replenishment of the robot. The robot uses a visual sensor to obtain a picture of the goods, uses image segmentation technology to divide the goods in the picture, uses image recognition technology to identify the type of each goods, obtains the position of each goods in the robot arm space coordinate system, and finally the robot grabs the goods to corresponding location on shelf.

Image segmentation is a technique and process

that divides an image into several specific areas with unique properties and proposes objects of interest. It is a key step from image processing to image analysis.

Image recognition technology is an important field of artificial intelligence. It is a technique for identifying targets and objects in various modes. To achieve image recognition, you need to go through the following process:

1. Create a large number of image data sets;
2. Create a model for image classification;
3. Image preprocessing;
4. Classify the processed images and train a classification model;
5. Test the trained classification model and evaluate the model.
6. Apply the classification model.

The purpose of camera calibration is to let the robot know the position of the object in the picture in the coordinate of the robot.

三、Experiment Equipment

Equipment Image	Name	Number

	Dobot Magician Lite	1
	Gripper	1
	Camera	1
	Power Adapter	1
	Tape-C Cable	1
	Goods Models	4
	Map	1
	Shelves	1

四、Experiment Steps

1. Scene Create

（1）Diagram of the placement of robotic arms, goods models, and shelves, as shown below.

Figure 2.1 The map of intelligent replenishment system

（2）Physical map of supermarket intelligent replenishment system is shown in figure 2.2.

Figure 2.2 The physical map of intelligent replenishment system

2. Program Design

Step 1: Read the flow diagram of the automatic replenishment procedure in the supermarket, as shown in Figure 2.3.

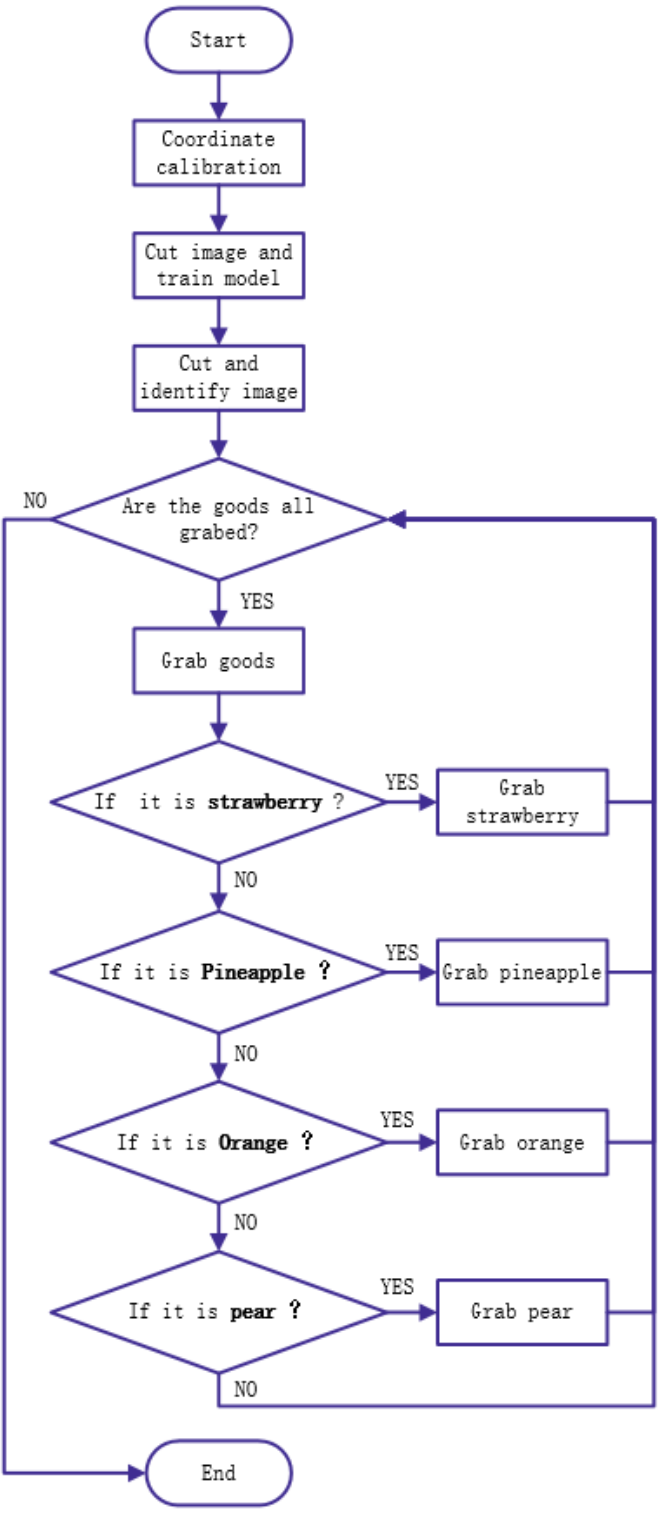


Figure 1.3 The flow diagram of intelligent replenishment system

Step 2:Connect robot, as shown in figure 2.4.

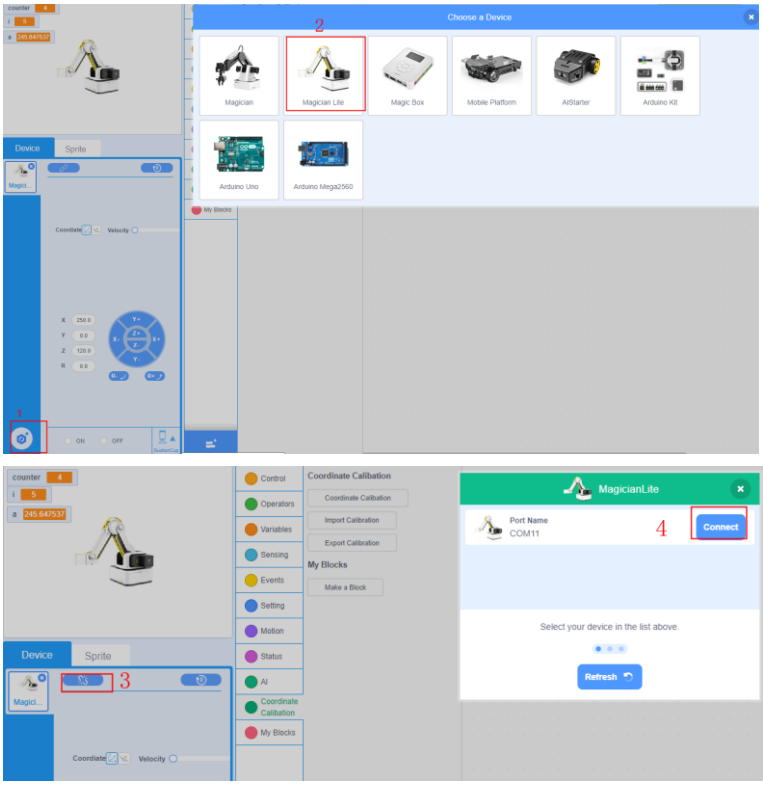
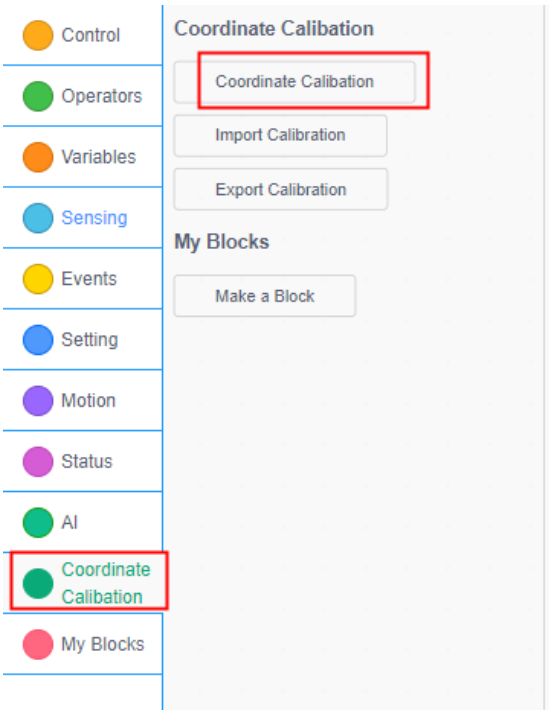
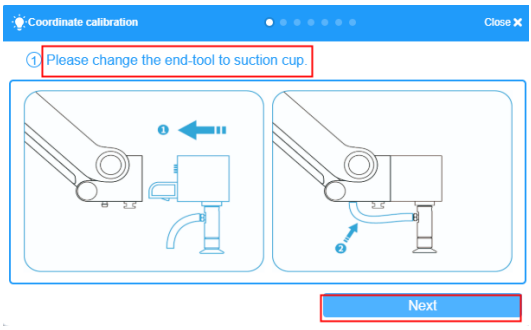
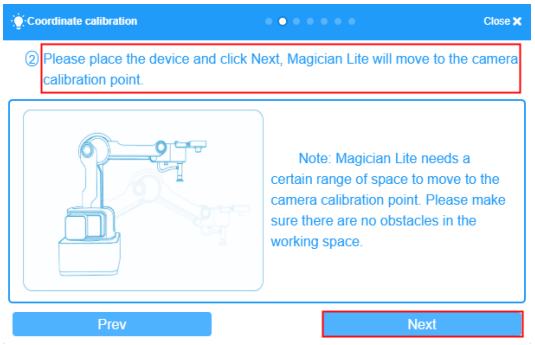


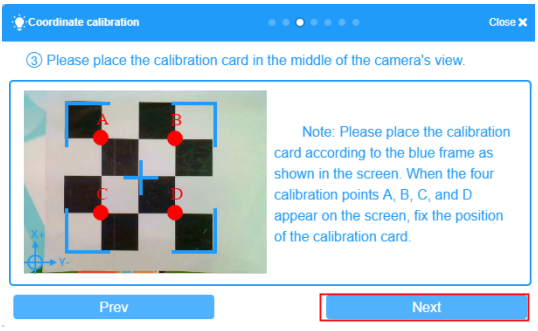
Figure 2.4 Connect Device

Step 3: Coordinate calibration. Replace the end of the robot with a suction cup, open DobotBlock to connect the robot, click "coordinate calibration" function, place the calibration card under the camera, and move the robot arm to A, B, C, D according to the prompts to complete the calibration, as shown in Figure 2.5.


Control
Operators
Variables
Sensing
Events
Setting
Motion
Status
AI
Coordinate Calibation
My Blocks
Coordinate Calibation
Coordinate Calibation
Import Calibration
Export Calibration
My Blocks
Make a Block


Coordinate calibration
Close
① Please change the end-tool to suction cup.
Next


Coordinate calibration
Close
② Please place the device and click Next, Magician Lite will move to the camera calibration point.
Note: Magician Lite needs a certain range of space to move to the camera calibration point. Please make sure there are no obstacles in the working space.
Prev
Next


Coordinate calibration
Close
③ Please place the calibration card in the middle of the camera's view.
A
B
C
D
Note: Please place the calibration card according to the blue frame as shown in the screen. When the four calibration points A, B, C, and D appear on the screen, fix the position of the calibration card.
Prev
Next

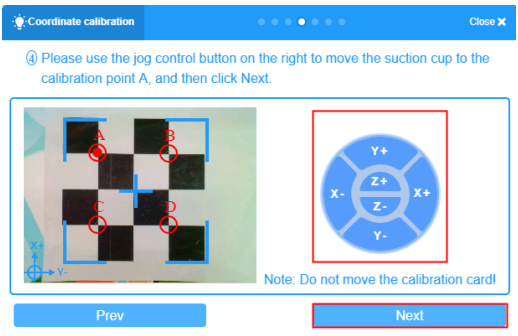


Figure 2.5 Coordinate calibration

Step 4: Cut image and train model

1) Add AI expansion module, select "AI" tab, and click "New classification data", as shown in Figure 2.6.

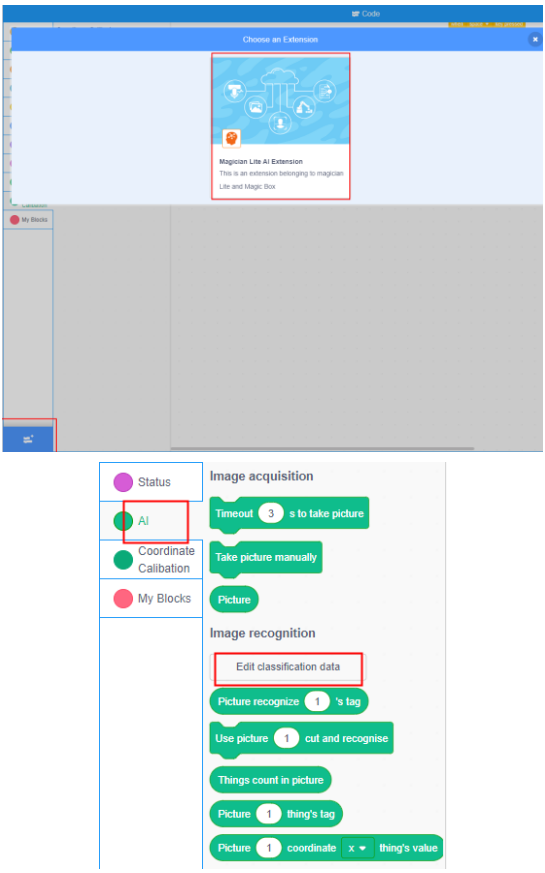


Figure 2.6 New classification data

2) Cut image. After turning on the camera, select the image cutting mode and move the robot arm to adjust the position of the camera until each

goods is cut by a rectangular frame, as shown in Figure 2.7.

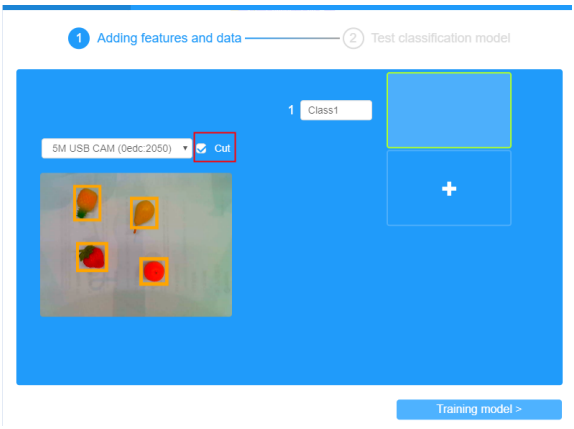


Figure 2.7 Cut image

3) Create a data set. Click + to create a new data set and create a label for each data set, as shown in Figure 2.8

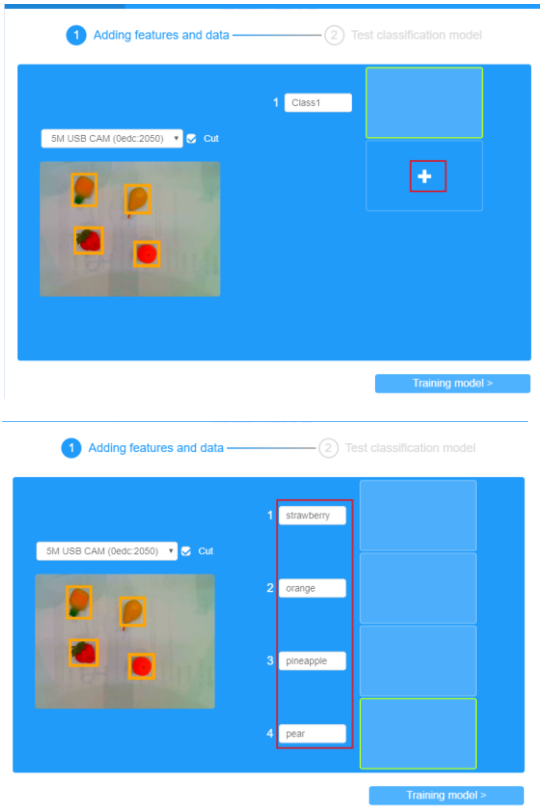


Figure 2.8 Create image label

4) Collect goods image data. Click the data

set box first, and then click the corresponding goods to save the goods image in the corresponding data set, as shown in 2.9.

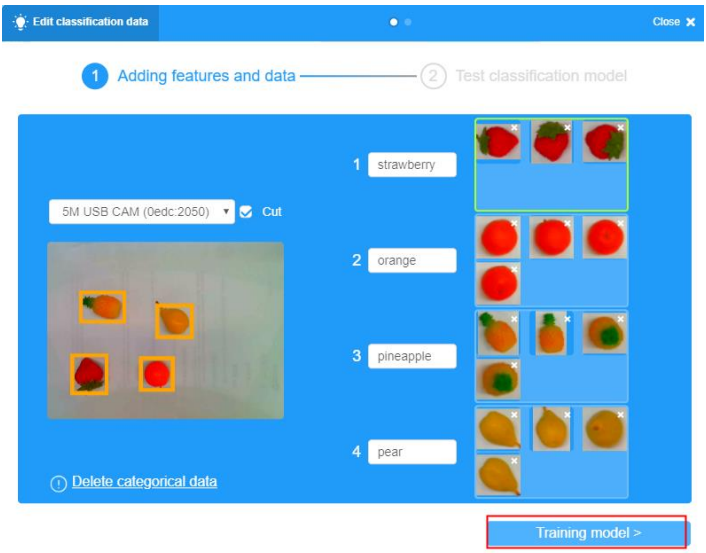


图 2.9 采集商品图像数据

5）Train the model. After collecting the goods image data, click **Training model** to enter the training model interface. Click the screenshot to cut, each goods will be cut by a rectangular box of different colors, check whether the color of the rectangular box of each goods is consistent with the word corresponding to its label, if they are consistent, click **Finish** to complete the training, otherwise return to the previous step to collect data again 2.10 shown.

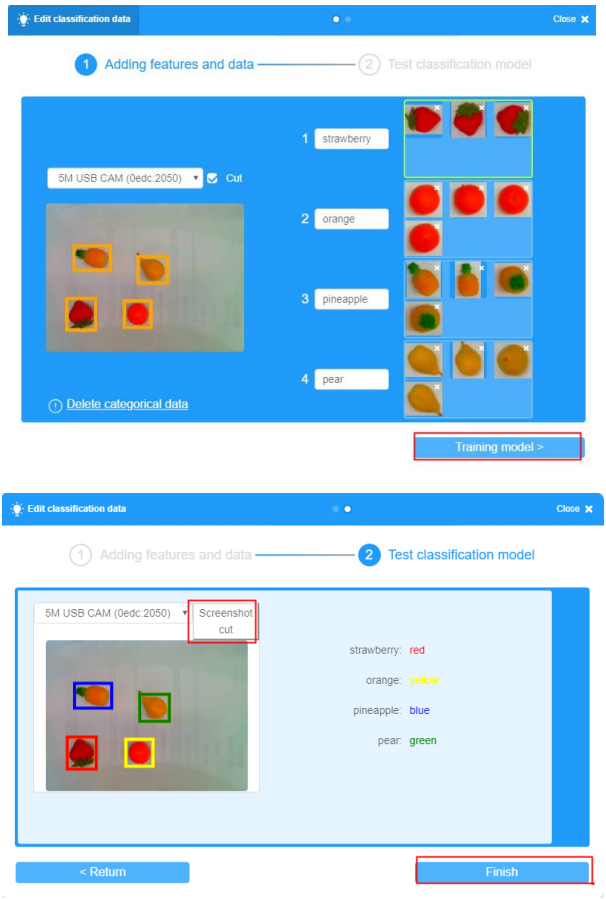


Figure 2.10 Train model

Step 5: Initialize the position of the robot and obtain an image of the goods, as shown in Figure 2.11

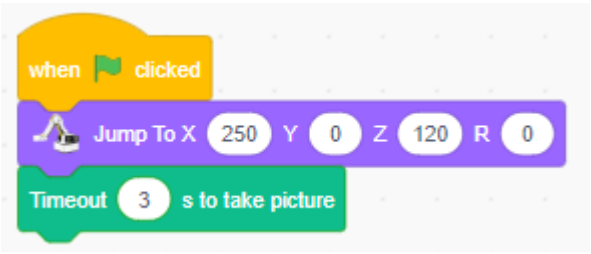


Figure 2.11 Initial robot

Step 6: Define the variable counter to store the total number of goods after being cut. After the goods is cut, the goods is numbered in the order of 1 to counter. Define the variable **i** to represent the number of the goods being grabbed, the initial

value is set to 1, as shown in Figure 2.12

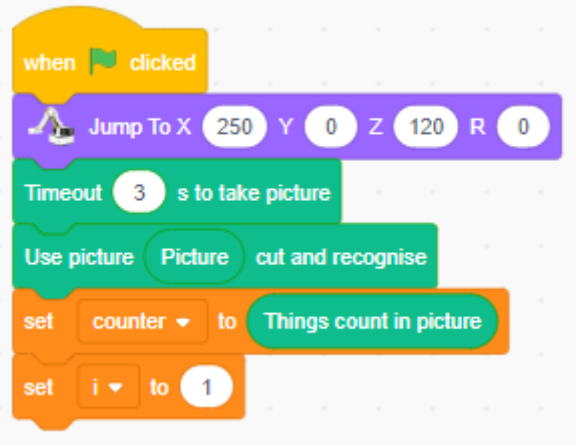


Figure 2.12 define a variable

Step 7: Grab goods. Set Z to -10, as shown in figure 2.3.

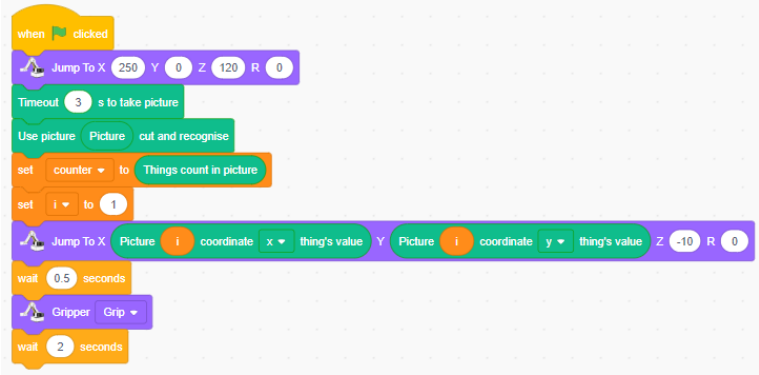


Figure 2.13 Grab goods

Step 8: Whether the grabbed goods is **strawberry**, if it is a strawberry, place the goods in the corresponding area of the strawberry on the shelf, as shown in 1.14 below.

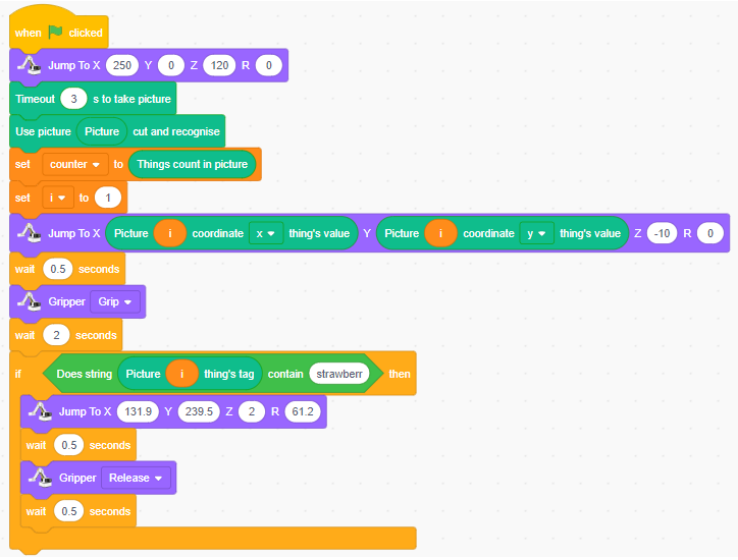
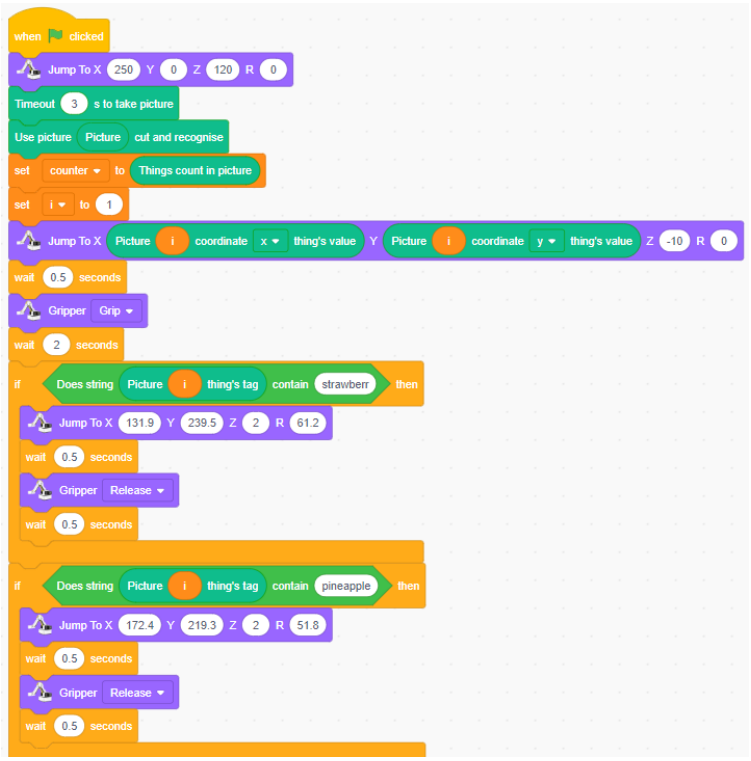


Figure 2.14 Grab strawberry

Step 9: If it is not a strawberry, determine whether the goods being grabbed is another goods, and then place it in its corresponding shelf area, as shown in Figure 2.15.



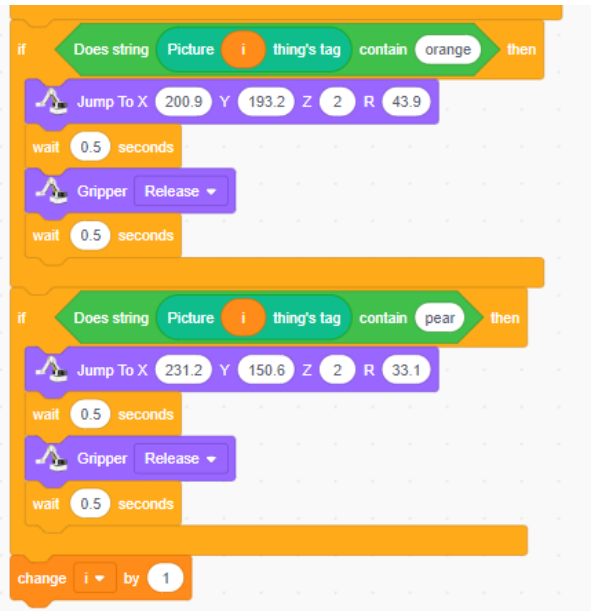
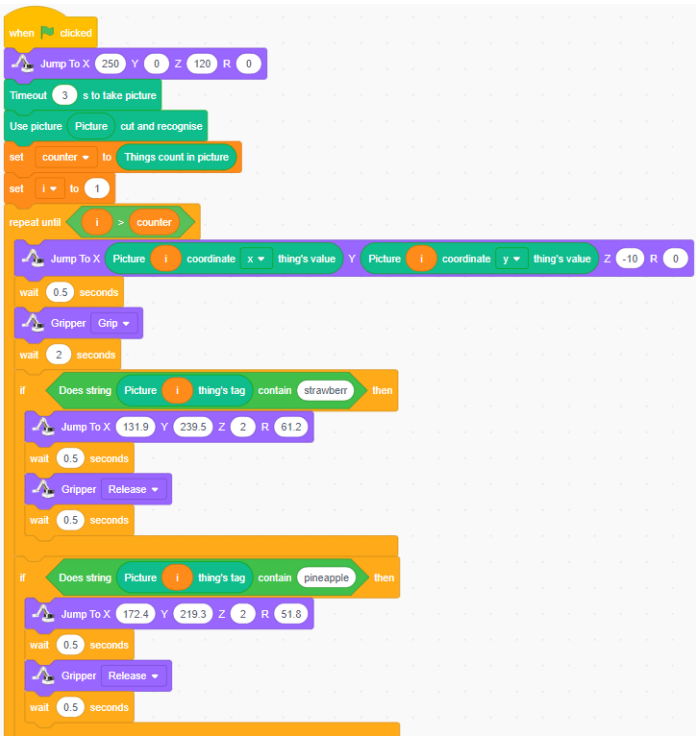


Figure 2.15 Grab other goods

Step 10: After grabbing a goods, add 1 to the goods number, and judge whether the goods is all sorted. If there are still goods, continue to grab the goods to the corresponding shelf area until all the goods are grabbed. As shown in Figure 2.16.



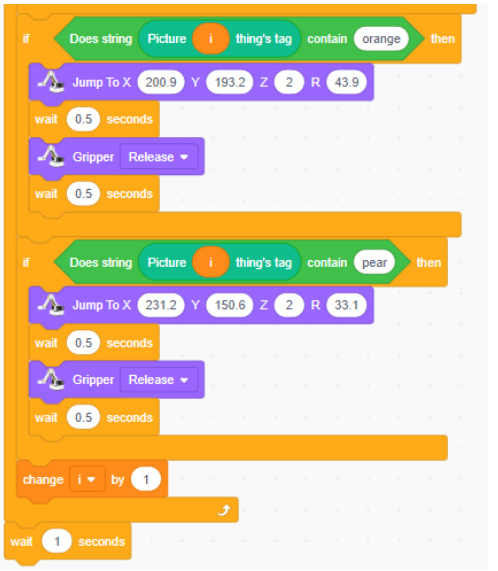


Figure 2.16 Repeat command