# Lesson 1 The Musical Magic Mirror

"Mirror, Mirror, on the wall, who's the fairest of them all?" I am sure you've been very familiar with this line since it comes from the classic childhood fairy tale *Snow White and the Seven Dwarfs*.
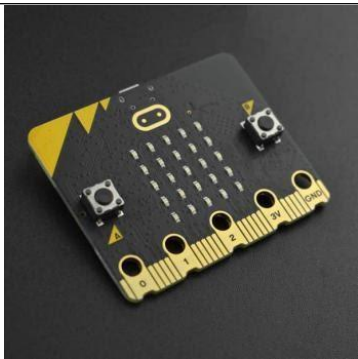


Now, with HUSKYLENS, you can make a real magic mirror like this by yourself. Getting the mirror to talk is a bit difficult, but letting a buzzer make a sound is easy. So let's make a musical magic mirror that can express its attitude by playing different music!

## Learning Objectives

1. Understand the working principle and application scenarios of face recognition
2. Learn to use the face recognition function of HUSKYLENS
3. Learn to use HUSKYLENS to make a musical magic mirror

# Preparation

| | |
|---|---|
|  |  |
| HUSKYLENS ×1 | IO Extender for micro:bit ×1 |
|  |  |
| micro:bit v2 ×1 | cards with a human face print on them |

Tips: In order to facilitate teaching, we specially prepared cards with a human face printed for HUSKYLENS to learn and recognize. Of course, HUSKYLENS can also learn to recognize real human faces.

# Learning Content

## The working principle and applications of face recognition

Like other biological characteristics of the human body (fingerprint, iris, etc.), the face is inherent, unique, and not easily copied. It is the first kind of image that has been studied, and also the widely used one in the field of computer vision. This project is making use of the **face recognition** of HUSKYLENS.

## 1. What is face recognition

Face recognition is a biological recognition technology for identity recognition based on information about facial features. It uses a camera to collect images and videos containing human

faces and automatically detects and tracks the faces, then performs a series of analytical techniques of the detected faces.
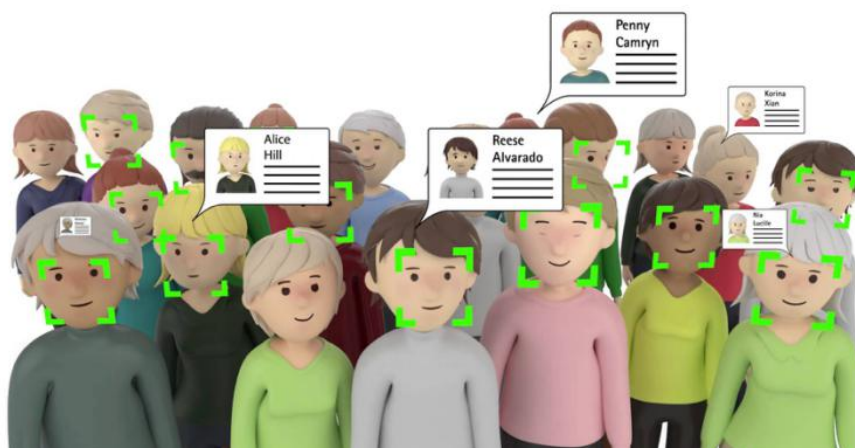


## 2. The working principle of face recognition

There are 4 key steps in the process of face recognition:
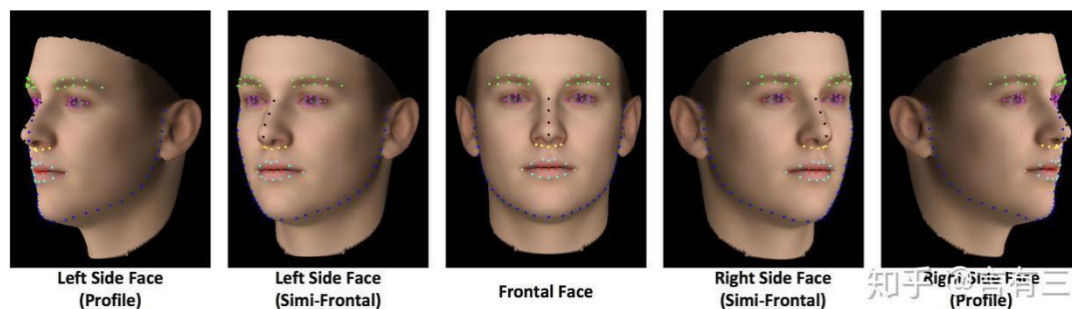


Here is a brief description of these 4 steps.

**Face detection**: Find the position of the face in the picture, usually marked with a box.



**Face alignment**: Identify faces from different angles by locating feature points on the face.

| Left Side Face (Profile) | Left Side Face (Simi-Frontal) | Frontal Face | Right Side Face (Simi-Frontal) | Right Side Face (Profile) |

**Face coding**: It can be simply understood as extracting face information and converting it into information that can be understood by a computer.



$$[-0.23, -0.54, ..., 0.27]$$

**Face matching**: Match the face information to an existing database, which to obtain a similarity score and give the matching result.
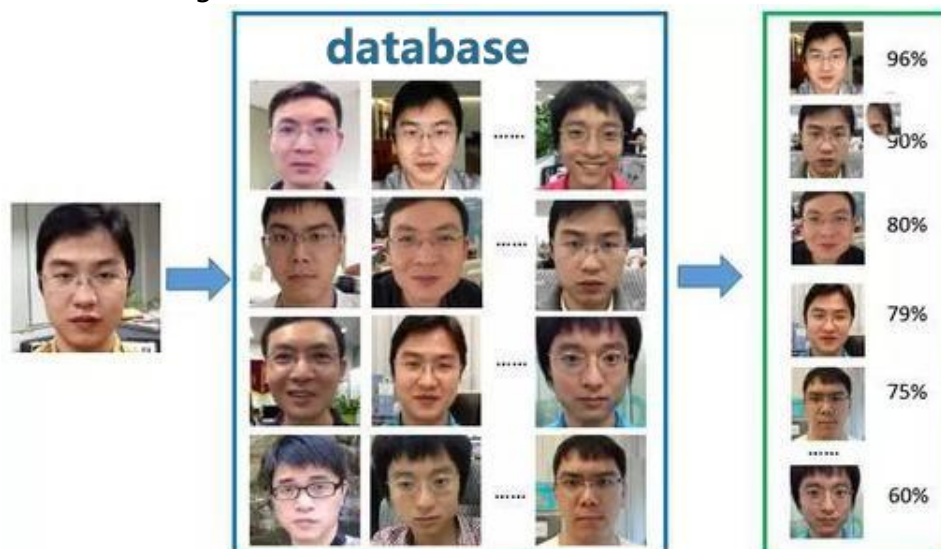


Face recognition is also considered to be one of the most difficult research topics in the field of biometric and even in the field of artificial intelligence. **The difficulty of face recognition** is mainly caused by the characteristics of the face as a biological feature.

**Similarity:** There is just a little difference between different individuals. The facial structure of all faces is similar, and even the appearance and structure of human facial organs are very similar. Such a feature is advantageous for using human faces for positioning, but it is disadvantageous for using human faces to distinguish human individuals.

**Variability:** The shape of the human face is very unstable, and people can produce many expressions through facial changes. Observing the face from different angles, the visual image of the face will also be very different. In addition, face recognition is also affected by various factors such as lighting conditions (such as day and night, indoor and outdoor, etc.), face coverings (such as masks, sunglasses, hair, beards, etc.), age and other factors.

## 3. Main application scenarios of face recognition technology

**Access control system**: In areas protected by security, the identity of entrants can be identified through face recognition, such as prisons, detention centers, communities, schools, etc.

**Camera surveillance system**: For example, surveillance of people in public places such as banks, airports, stadiums, shopping malls, supermarkets, etc., to achieve the purpose of identity recognition, or installing surveillance systems at airports to prevent terrorists from boarding the plane.

**Network application**: Use face recognition to assist the use of credit cards for online payment, to prevent non-credit card users from impersonating the owner and to prevent counterfeit claims in social security payment, etc.

Face recognition is currently widely used in all walks of life, such as student attendance systems, cameras, unlocking mobile phones, and all-in-one verification machines.



In addition to the above several application scenarios, where else can you list the use of face recognition technology in your life?
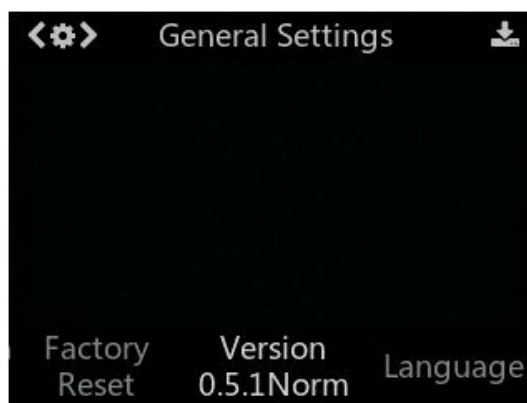
## Upgrade firmware

Before using HUSKYLENS, it is recommended that you upgrade the firmware to the latest version to get the latest features and the most stable experience. If your HUSKYLENS is already the latest version of the firmware, there is no need to update it.

This tutorial requires a firmware version of at least V0.5.1, this version integrates all functions (including object classification).

## 1. Check the firmware version number

1. Toggle the function button to the right until the last option "general setting", short press the function button to enter the secondary menu;

2. Toggle the function button to the right until you reach the "version" option, you can see the version number. As shown in the figure below, the version number is 0.5.1Norm.



## 2. Firmware upgrade

If your firmware version is lower than V0.5.1 or you are a user of HUSKYLENS for the first time, please refer to the WIKI website for firmware burning and language setting.

## HUSKYLENS Face Recognition Function Demonstration

The reason why HUSKYLENS can distinguish faces is mainly because of its built-in machine learning function. It is like a database collector, which can manually input the specified face information and mark this information.

How does it work? Take out your HUSKYLENS first, and let's do it together!
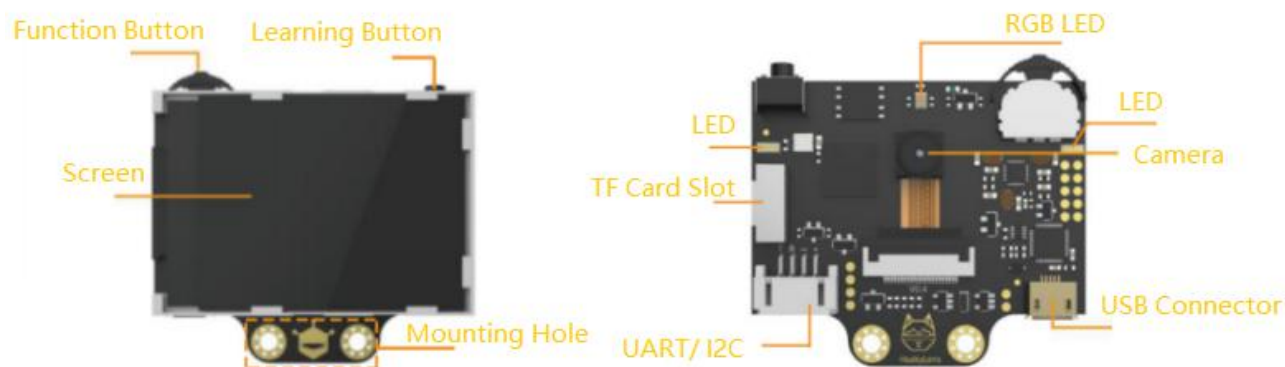
## 1. Power on

HUSKYLENS comes with an independent USB power port. Power on the board via a USB cable.
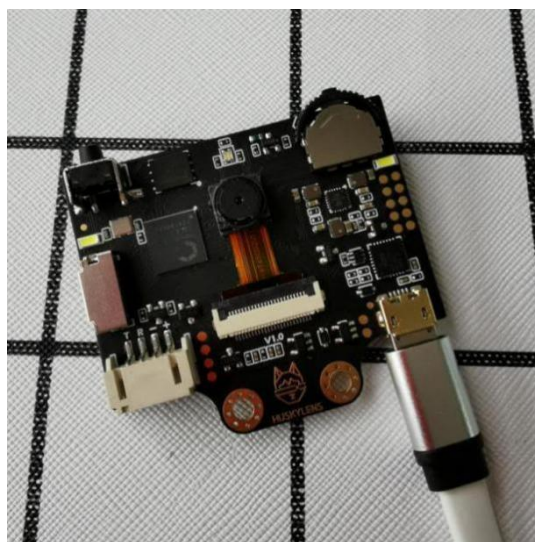


## 2. Select the "Face Recognition" function

Toggle the "Function Button" to the left until "Face Recognition" is displayed at the top of the screen.

## 3. Face learning

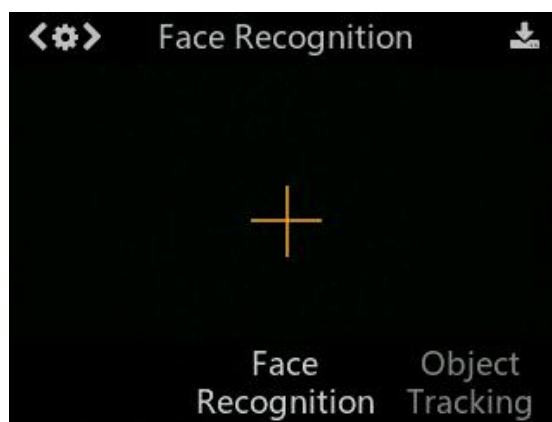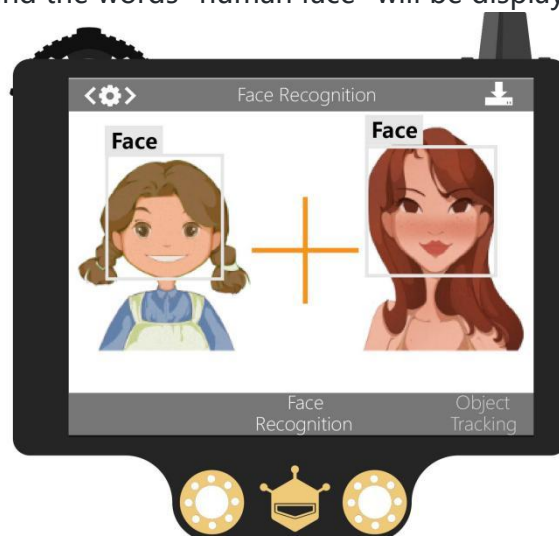Point HUSKYLENS at the human face area, the screen will automatically select all the detected faces with a white frame, and the words "human face" will be displayed respectively.



Align the "+" in the center of the HUSKYLENS screen with the face that needs to be learned, short press the "learning button" to complete the learning. If the same face is recognized, a blue frame will appear on the screen and display "Face: ID1". This shows that HuskyLens has learned the face and can recognize it now.
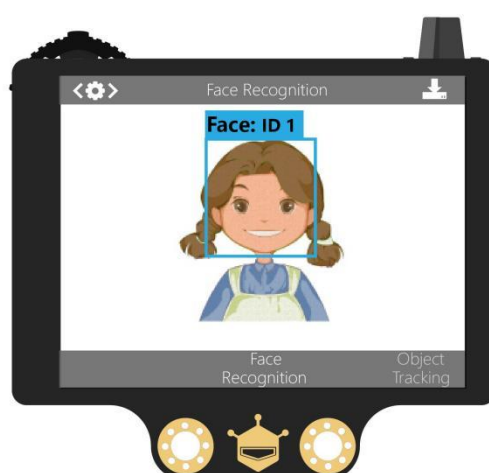


\* Keep pressing the "learning button", you can record faces from multiple angles.

\* If there is no "+" in the center of the screen, it means that HUSKYLENS has been learned under this function (learned state). At this time, short press the "learning button", the screen will prompt "press again to forget!". Short press the "learning button" again before the end of the countdown to delete what learned last time.

## Project Practice

After learning the basic operation of the HUSKYLENS camera, let's finish the production of the musical magic mirror together~

The first function to be realized is that when the camera recognizes faces, it can distinguish between learned and unlearned faces in the terminal. The second is to add music to achieve different music playback, at least two. At last, you can also find a small mirror to build the exterior. This will be done in two tasks.

**Task 1: Distinguish human faces**

First, learn how to use the HUSKYLENS camera to recognize and distinguish human faces, also be able to make judgments. When the learned faces are recognized, there should be some feedback.

**Task 2: Add music**

After learning how to distinguish faces and perform the feedback function, you can add more functions on this basis, such as being able to play different music after identifying different faces.

## Task 1: Distinguish human faces

## Hardware Connection

Note: HUSKYLENS sensor uses the I2C interface, you need to pay attention to the line sequence when wiring, and do not connect it wrongly or reversely. At the same time, you need to set the protocol type to I2C on HUSKYLENS.
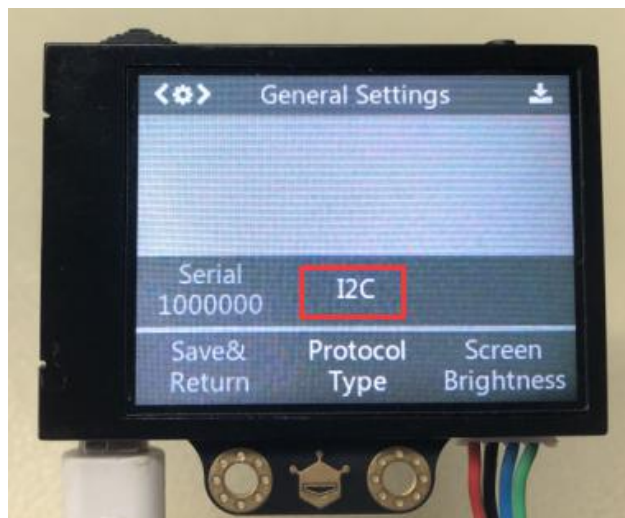


# Program Design

**Function Description:**

The default camera for distinguishing faces here has learned the specified face information (for the specific learning process, please refer to the HUSKYLENS face recognition function demonstration in this chapter). When the camera sees the face again, it will judge whether it is the learned face. By displaying different patterns on the main control screen, the display process is more intuitive. When a smiling face is displayed on the main control panel, it means that the learned face has been recognized; when a crying face is displayed, it means that the face has not been learned.
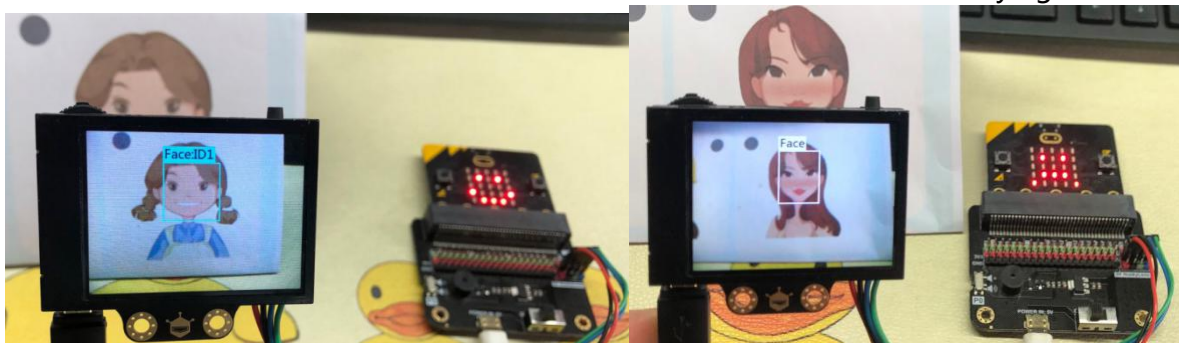
**Program Flowchart:**
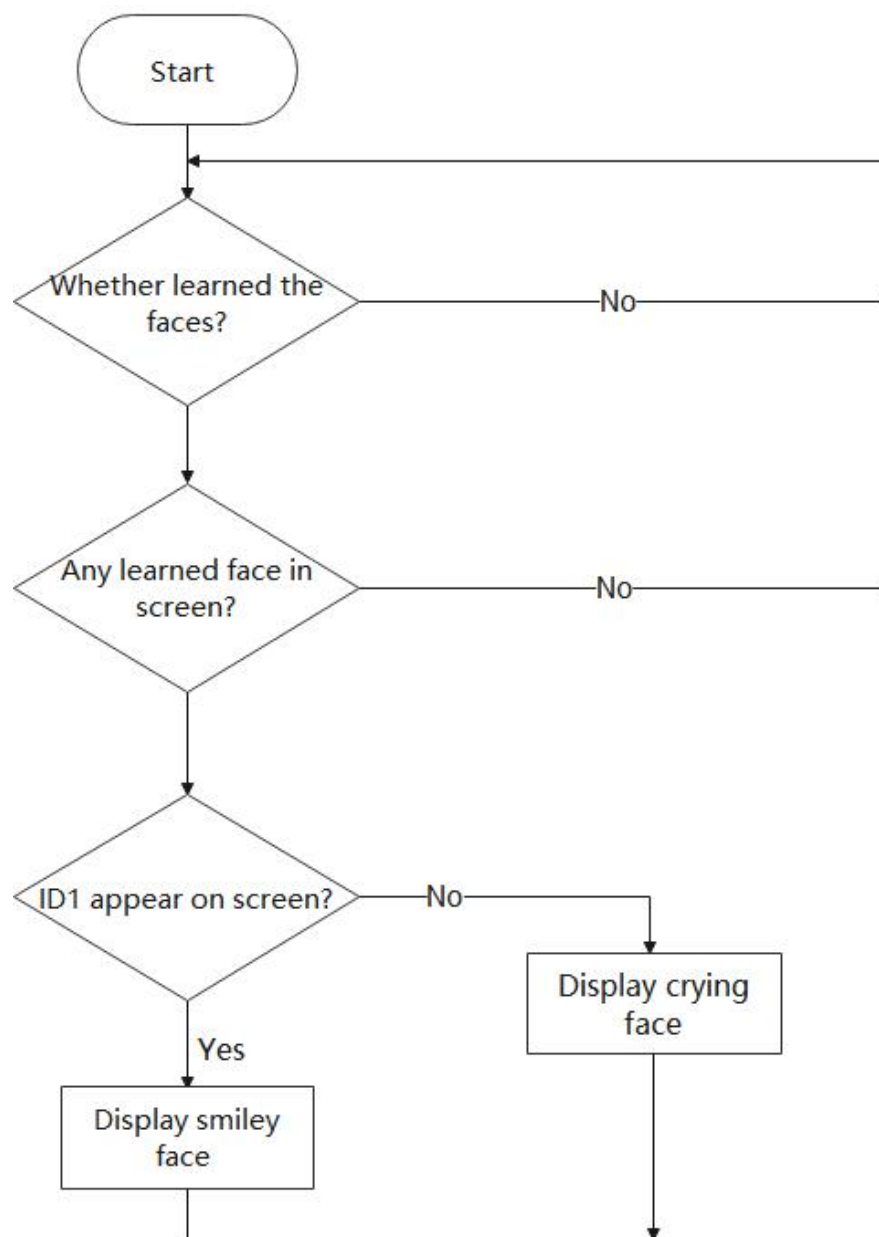
**Program Example**
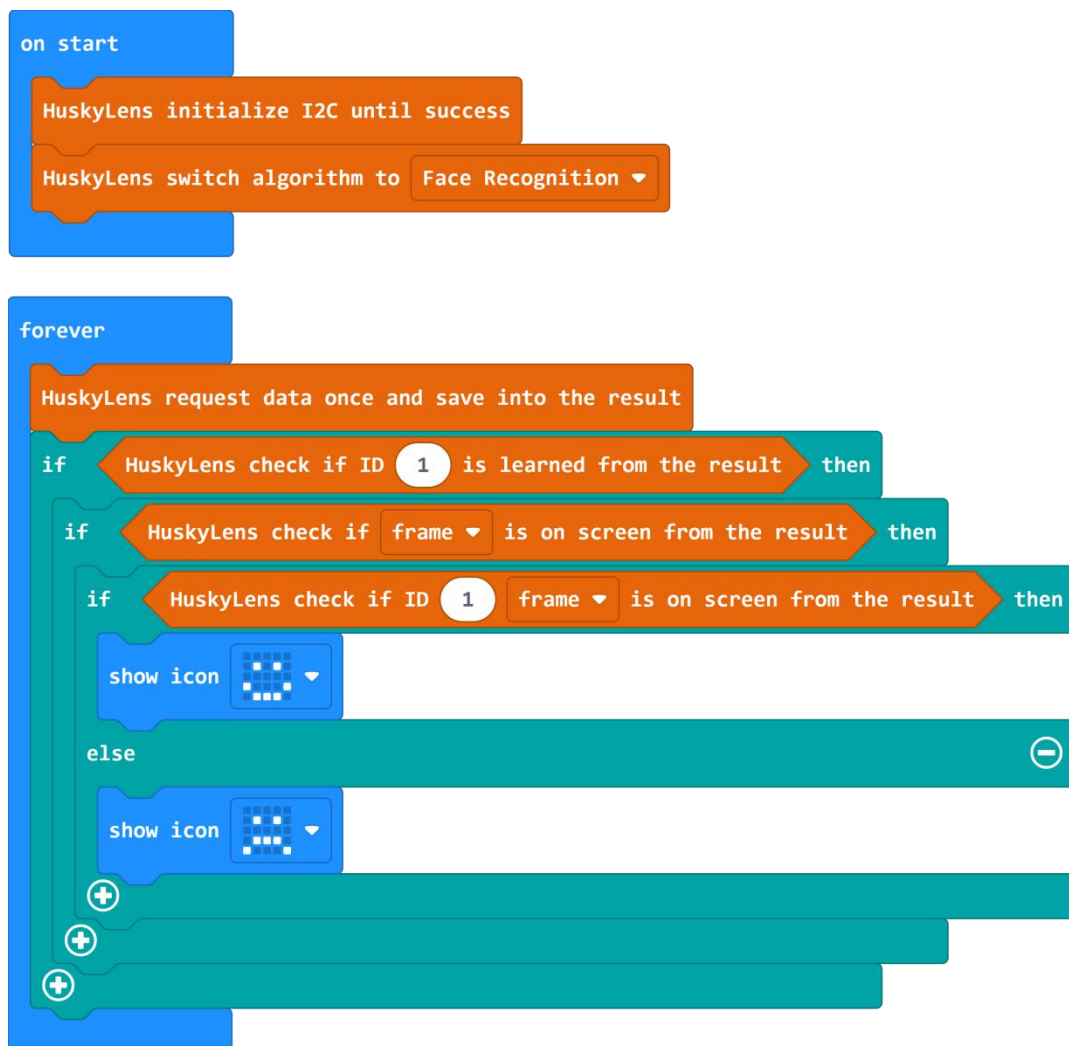




For users who are not familiar with the use of micro:bit, please refer to the introductory tutorial of micro:bit.

## Operating Effect

Run the program, when HUSKYLENS detects a face that has been learned, it will display a smiling face, and if it detects a face that has not been learned, it will switch to a crying face.



Note: When running the program, in addition to powering the IO expansion board, HUSKYLENS also needs a separate power supply.

# Task 2: Add music

## The program design

### Function Description:

Here, we can add a piece of music under the smiling face and crying face. For example, "Dashing thr'o the snow, In a one horso open sleigh." in the music "Jingle Bells" and "Twinkle Twinkle little star, how I wonder what you are!" in "Little Star".

**How to add music?** The buzzer that comes with the IO expansion board is used here, turned on the switch that controls the buzzer while in use.

**How to find the music score?** Search for the notation of "Jingle Bells" and "Little Stars" on the Internet, and cut out the paragraphs you need.



**How to write a program?** In MakeCode, it has instructions for playing notes, which are divided into three scales of low, mid and high, and 7 different beats.

**How to match music scores with instructions?** Here is a simple identification method, take note 2 as an example, as shown in the following table.

| Bass | 2 | One beat | 2 |
|------|---|----------|---|
| Alto | 2 | Half beat | 2 |
| Treble | 2 | Quarter beat | 2 |

**Program Flowchart:**
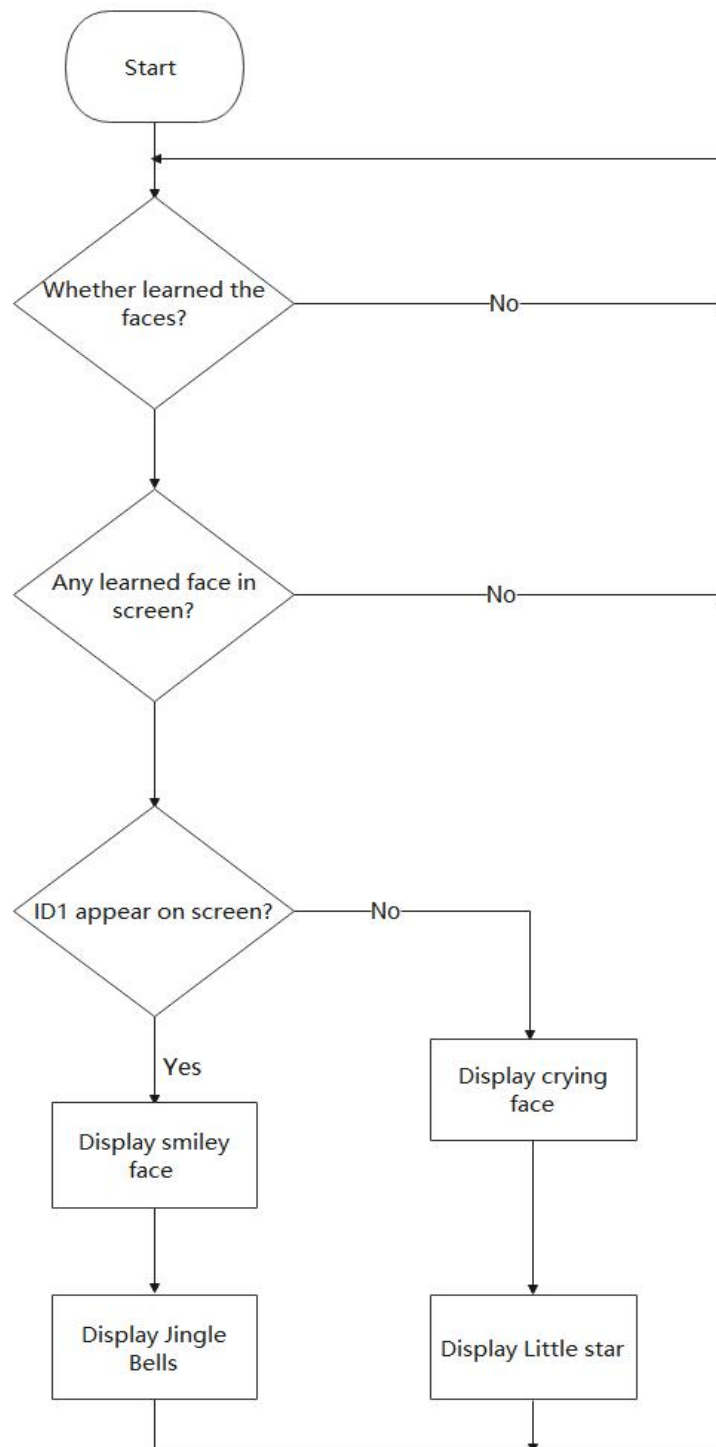
Start

Whether learned the faces? —No—

Any learned face in screen? —No—

ID1 appear on screen? —No—

Yes

Display smiley face

Display crying face

Display Jingle Bells

Display Little star

## Program example:

```
on start
    HuskyLens initialize I2C until success
    HuskyLens switch algorithm to  Face Recognition ▼
```

```
forever
    HuskyLens request data once and save into the result
    if   HuskyLens check if ID  1  is learned from the result   then
        if   HuskyLens check if  frame ▼  is on screen from the result   then
            if   HuskyLens check if ID  1   frame ▼  is on screen from the result   then
                show icon  ▼
                call Jingle Bells
            else                                                          ⊖
                show icon  ▼
                call Litter Star
            ⊕
        ⊕
    ⊕
```

```
function  Jingle Bells  ⌃
    play tone  Low G    for  1/2 ▼ beat
    play tone  Middle E for  1/2 ▼ beat
    play tone  Middle D for  1/2 ▼ beat
    play tone  Middle C for  1/2 ▼ beat
    play tone  Low G    for  1   ▼ beat
    play tone  Low G    for  1/4 ▼ beat
    play tone  Low G    for  1/4 ▼ beat
    play tone  Low G    for  1/2 ▼ beat
    play tone  Middle E for  1/2 ▼ beat
    play tone  Middle D for  1/2 ▼ beat
    play tone  Middle C for  1/2 ▼ beat
    play tone  Low B    for  1   ▼ beat
    play tone  Low B    for  1/2 ▼ beat
```

```
function  Litter Star  ⌃
    play tone  Middle C for  1 ▼ beat
    play tone  Middle C for  1 ▼ beat
    play tone  Middle G for  1 ▼ beat
    play tone  Middle G for  1 ▼ beat
    play tone  Middle A for  1 ▼ beat
    play tone  Middle A for  1 ▼ beat
    play tone  Middle G for  2 ▼ beat
    play tone  Middle F for  1 ▼ beat
    play tone  Middle F for  1 ▼ beat
    play tone  Middle E for  1 ▼ beat
    play tone  Middle E for  1 ▼ beat
    play tone  Middle D for  1 ▼ beat
    play tone  Middle D for  1 ▼ beat
    play tone  Middle C for  2 ▼ beat
```

## Operating Effect

Run the program, when the camera detects a face that has been learned, it will play the music "Dashing thr'o the snow, In a one horso open sleigh." If the camera detects other faces, it will play the music "Twinkle Twinkle little star, how I wonder what you are!". Isn't it very interesting?

At last, you can also try to let it learn your face, find a small mirror, hide the hardware behind the mirror, expose the camera to collect face information, and build a musical magic mirror that can recognize you!



# Project Review

Through the musical magic mirror project, we not only learned the working principle of face recognition, but also learned the instruction application of HUSKYLENS face recognition algorithm.

In the field of artificial intelligence visual recognition, face recognition is an indispensable part, and there are also variable application scenarios. Let's brainstorm together, think about what other face recognition applications that we can make.

# Project Development

In this project, we combined face recognition with music to make a fun musical magic mirror. In fact, when you think about it, HUSKYLENS will make a sound when it recognizes an unknown face. Isn't this an access control alarm system?