User Guide

Version 2.3

28 Mac 2020

BY TENSORFACTORY

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Contents:

1.0 Overview

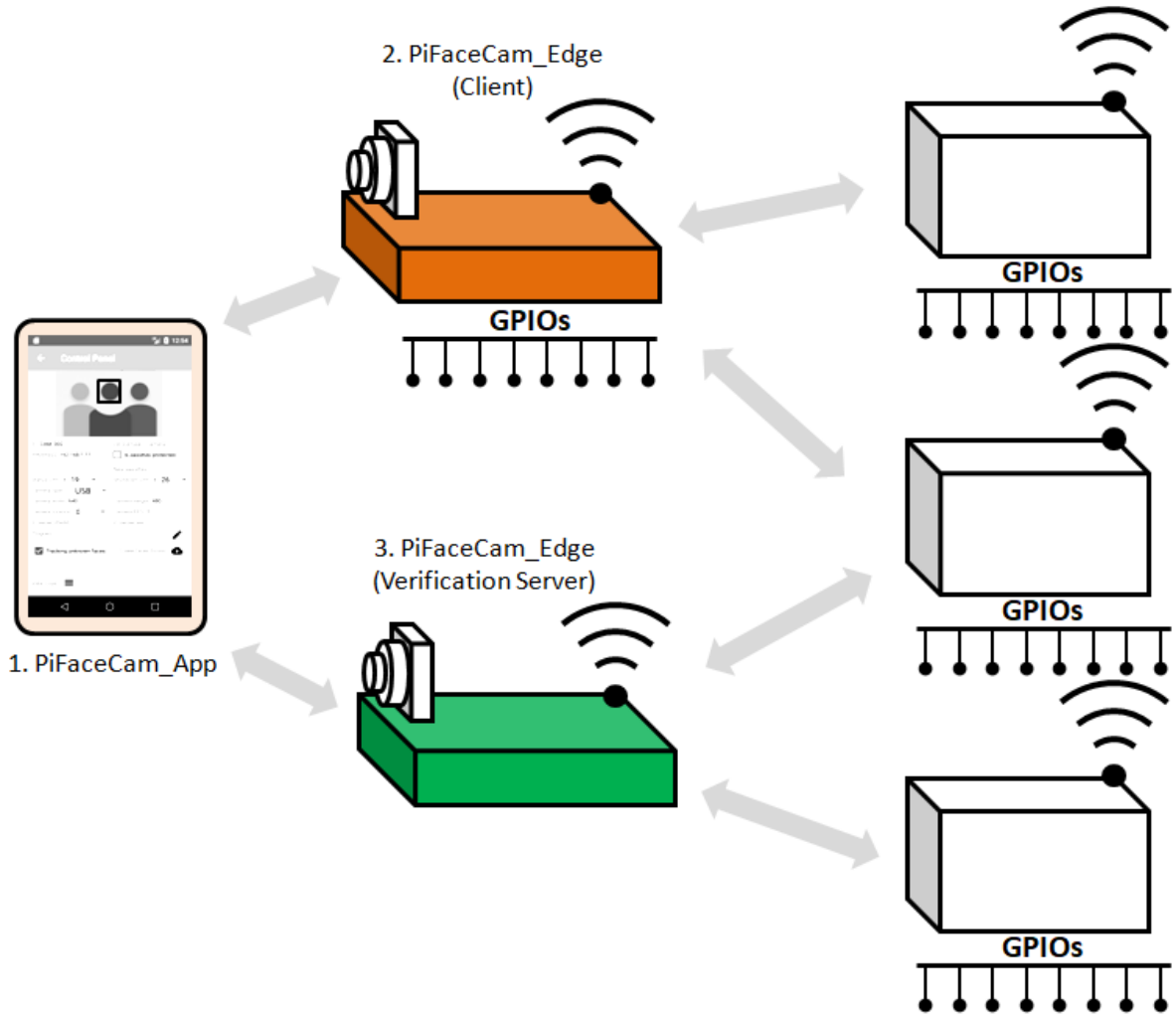


Figure 1.0

1.1 PiFaceCam system

PiFaceCam system uses deep neural network for high accuracy facial recognition. It is designed to run efficiently in Raspberry (Pi3 Model B+ and Pi4).

PiFaceCam system consists of 3 components.

1. **PiFaceCam_Edge Client**: Runs in Raspberry Pi* with camera(s) attached. It performs facial recognition and can be programmed to carry out instructions using simple scripts. It can also be programmed to send facial data to other devices.

2. **PiFaceCam_Edge Verification Server**: Runs in Raspberry Pi* with camera(s) attached. It acts as verification server where clients send images for verifications. It compares the faces in received images with those detected in front of the camera(s) and return the verification results to clients.

3. **PiFaceCam_App**: Runs in Android devices (currently only support android devices). It is for managing and controls all PiFaceCam edge devices connected through local network.

* Pi3 Model B+ or Pi4

1.2 Features

- Facial recognition based on assigned face ids and carry instruction per scripts.
- Supports stereo camera setup where 2 cameras (1 Picamera + 1 USB camera) are used to capture images of a person at different angles, as a layer of security against simple photo attack.
- Comprehensive tools for collecting, editing and organizing face ids.
- Simple scripting format for automating the PiFaceCam edge device.
- User-friendly tools to create, edit and manage scripts/programs.
- Remote monitor, manage and control multiple devices.
- Built-in functions to control GPIOs, communicate with JSON-server and sending out emails.

2.0 PiFaceCam Edge Setup

2.1 Hardware requirement

PiFaceCam edge runs on Raspberry Pi3 Model B+ or Pi4. As facial-recognition is computationally heavy, proper heat management is required. Standard cooling fan with heat sink on CPU was tested to be sufficient.

By default, GPIO 19 and 26 are reserved for status and shutdown purpose. GPIO 19 should be connected to a LED via a resistor. The LED will blinks during system loading and on continuously when system is ready. LED blinks indefinitely signify error has occurred. GPIO 26 will trigger program exit when connect to high. This can be used to trigger system shutdown (as in "wrapper.py").

2.2 Software

2.2.1 Getting system ready of PiFaceCam Edge (Client/Verification server)

This PiFaceCam edge was developed for Raspbian Buster with desktop (Kernel version: 4.19). You will also need to install the following supporting libraries.

1. Pyhton3 (develop in version 3.7.3)
2. Tensorflow 1.X (develop in version 1.15)
3. OpenCV for python (develop in version 4.2.0)
4. Scikit-learn (develop in version 0.22)
5. Pycryptodomex (develop in version 3.9.6)

2.2.2 Installing PiFaceCam Edge (Client/Verification server)

After you have installed all the necessary libraries, copy the whole "pifacecam_edge" folder from github (https://github.com/tensorfactory/PiFaceCam) into the home directory.

If you don't want to go through all the trouble of installing all the necessary components, we are sharing out SD Card's image file at github as well. Please take note that we are using 16GB SD Card, therefore you will need a larger memory card to flash the image.

After flashing your SD Card, remember to reclaim the missing disk space by running raspi-config -> Advanced Options -> Expand Filesystem Ensures that all of the SD card storage is available.

2.2.3 Naming your device

The default device id is "CAM001". The first thing you need to do is to give your device a unique name (Maximum 10 characters) by placing it in the "id.txt" file. Later you can change it from PiFaceCam app.

If there is more than one device with the same id on the network, PiFaceCam app may not be able to communicate with any of the devices consistently and prompts "wrong passkey" error. Therefore, it is very important to ensure all PiFaceCam edge devices connected to the same network having a unique id.

2.2.4 Main program

In the "pifacecam_edge" folder, you will see "PiFaceCam_Edge_X_X_X.so". This is the PiFaceCam edge program. To use it, first import "PiFaceCam_ Edge _X_X_X" to your project and call the "run()" method.

Once started, "run()" will not return until user terminates it by setting the "shutdown" GPIO pin to high. We can make use of this to trigger the shutdown of raspberry pi when PiFaceCam edge exits, as in below example.

```
import PiFaceCam_Edge_2_0_0
import os

if __name__ == "__main__":

    PiFaceCam_Edge_2_0_0.run()
    os.system("sudo shutdown -h now")
```

(wrapper.py)

Note: By default PiFaceCam edge will run in client mode. It can be switch to run in verification-server mode using PiFaceCam app (Professional Edition).

3.0 PiFaceCam App

3.1 Requirements

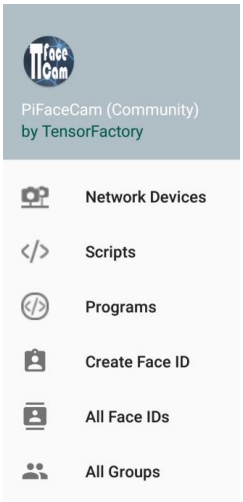
Requires Android OS Marshmallow and above. The device will require network connection to communicate with PiFaceCam edge devices. It allows you to control and manage all connected PiFaceCam edge devices.

3.2 Versions

There are 2 versions of PiFaceCam app, PiFaceCam (Community) and PiFaceCam (Professional).

Features	Community	Professional
Create and manage scripts / programs.	Yes	Yes
Create and manage face ids.	Limited to 20	Not limited
Setting and manage of attached PiFaceCam edge devices.	Yes	Yes
Setting facial recognition criteria.	Yes	Yes
Enabling face verification server mode.	No	Yes
Price	Free Download from Google Play Store.	Paid Please check Google Play Store for more info.

3.3 Overview



From the main page, you will be able to navigate to all available features.

1) Network Devices:
   a) Scan/access all connected PiFaceCam edge devices.
   b) Change settings of connected PiFaceCam edge devices.
   c) Load face ids and scripts/program to PiFaceCam edge devices.

2) Scripts:
   a) List and manage of all scripts.
   b) Create and edit scripts.
   c) Export/import scripts to file.

3) Programs:
   a) List and manage of all programs (Which are combinations of one or more scripts).
   b) Create and edit programs.
   c) Export/import programs to file.

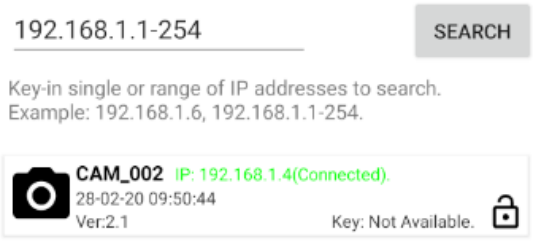
4) Create Face ID:
   a) Create face ids from camera or image gallery.
   b) Edit face ids.

5) All Face IDs:
   a) Shown all available face ids.
   b) Export / import face ids to file.

6) All Groups:
   a) List and manage of all groups (Which are combinations of one or more face ids).
   b) Export / import groups to file.

3.3.1 Network Devices

3.3.1.1 Search for devices



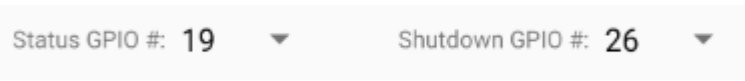
You can search all PiFaceCam edge devices that are connected to the local network. Or, if you already know the ipaddress of the device, you can key-in the exact address.

All connected PiFaceCam edge devices will be listed here. You can access the device by clicking on the list. The padlock symbol will indicate if the connected device is passkey locked which will require the correct passkey to access. Once clicked, you will reach the control panel.

3.3.1.2 Setting device id

From here, you can change the device ID. (The maximum character for device ID is 15. Extra characters will be trimmed.)

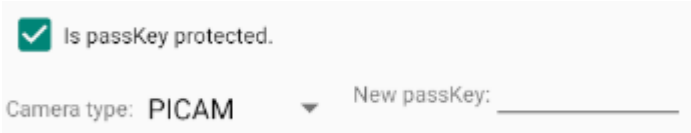
3.3.1.3 Status LED and device shutdown pin



You can set the GPIO pins number for device status and device shutdown. The device status pin will be connected to a LED via a resistor. Blinking indicates loading and continuous on indicates device is ready. The shutdown pin will cause the PiFaceCam edge program to exit

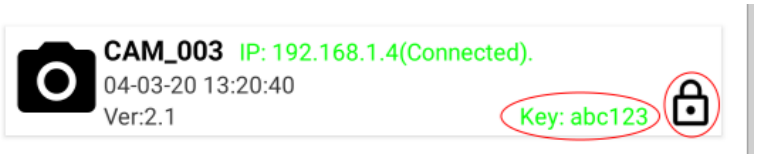
when connected to high. This can be used to trigger the Pi system shutdown as shown in "wrapper.py".

3.3.1.4 Setting passkey



By default, the attached PiFaceCam edge device is not passkey protected. To enable passkey protection, check the "Is passkey protected checkbox", provide a passkey and click the settings upload button.

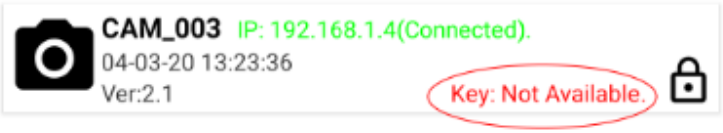
 (Setting upload button)

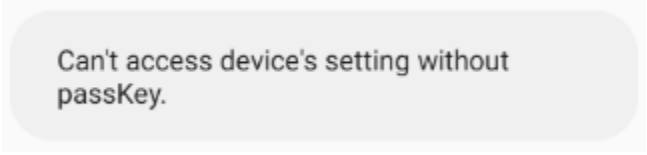


Once a passkey was set, you will notice the lock icon in the network devices list. The passkey will also be saved in this PiFaceCam app.

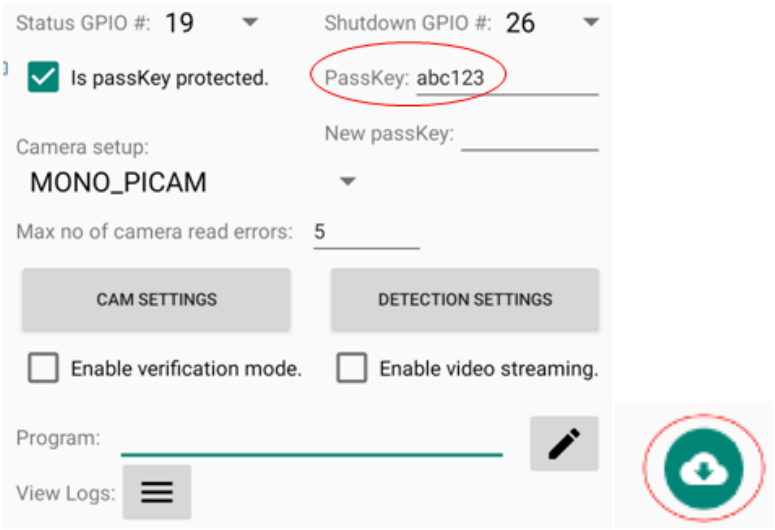
3.3.1.4.1 Missing passkey

If for some reasons, you have deleted the device from the list and try to add it back by searching for it again, you will notice PiFaceCam app no longer has the passkey.



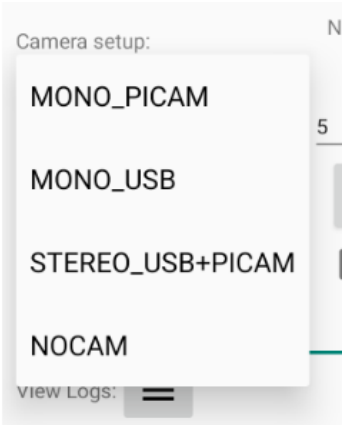


In this event, if you try to connect to the device by clicking on the list, you will get a "Can't access device's setting without passkey" message.



In order to resolve this, you need to key in the correct passkey. After that, click on the setting download button (above) to re-initiate the setting download from edge device process.

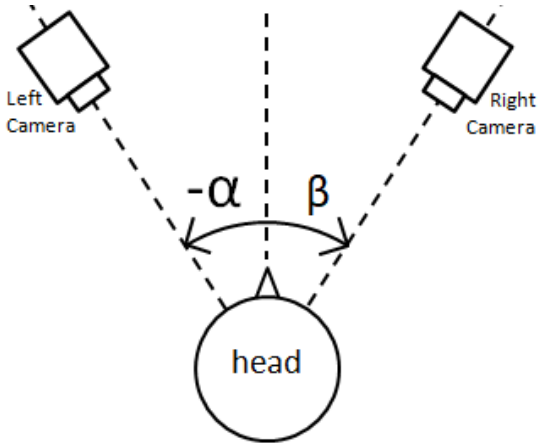
3.3.1.5 Camera setup



At the start of PiFaceCam edge program, it will check for any attached cameras. PiFaceCam edge allows one (mono) or two (stereo) cameras setup. For two cameras setup, you need to have a Picamera and a USB camera attached to the Raspberry PI. **Note: PiFaceCam edge does not support two USB cameras or two Picameras.**

All available setup options will be shown in PiFaceCam app. If you use a single generic USB camera, choose "MONO_USB" option. If you are using single Picamera, choose the "MONO_PICAM" option and choose "STEREO_USB+PICAM" if using a two cameras setup.

3.3.1.5.1 Stereo camera



Cameras layout (top view)

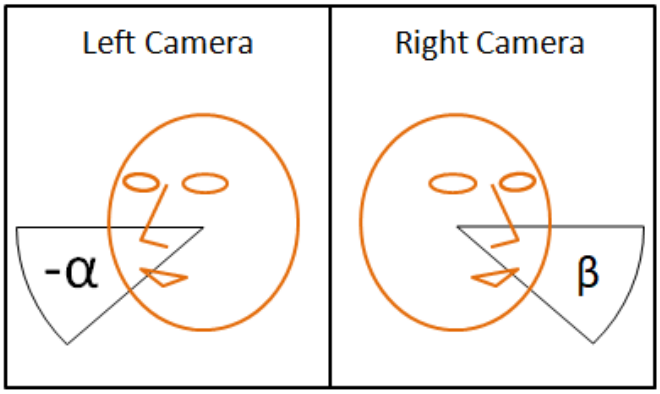


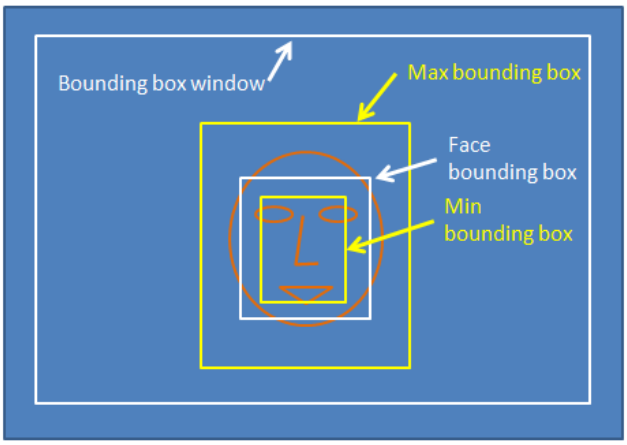
Image from left and right cameras

To defense against attack using photo, you can use stereo cameras setup. It works by detecting the face angles from the left and right camera, -α & β. The difference of these angles (β – (-α) = β + α) should be about the same as the angle between the left and right camera.

For this example, the left and right cameras were placed 40˚ apart, β – (-α) will be close to 40˚. However, if a photo (instead of a 3D face) was placed in front of both cameras, both cameras will measure the same face angle and β – (-α) will be close to 0˚.

More about setting an acceptable range for β – (-α), named as "delta angle", later in detection setting section.

3.3.1.6 Face bounding box and constrains



Bounding box constrains

The face bounding box is area tracked and used by PiFaceCam for facial recognition. This bbox will appear in the live-feed video if you enable "Show bounding boxes" in the camera setting page.

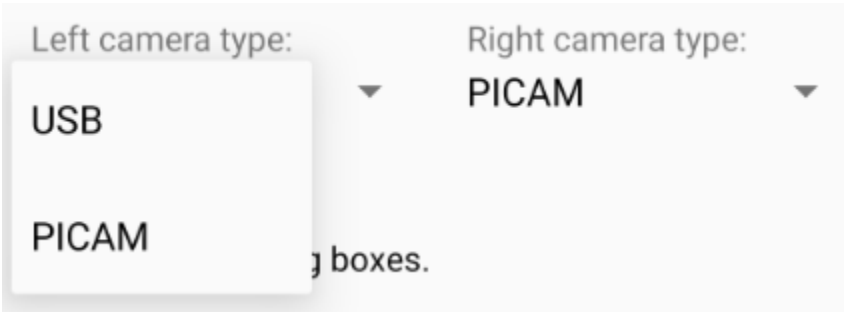
This face bbox will be in white color. However, if it failed any of the dimensional criteria (smaller than the min bounding box, larger than the max bounding box, touching or went outside the bounding box window, or if it is stereo camera setup, failed any of the delta dimension ranges), it will change to red color.

If it is in client mode (not operating as verification server), it will turn green when the face match any of the registered face ids.

3.3.1.7 Camera settings

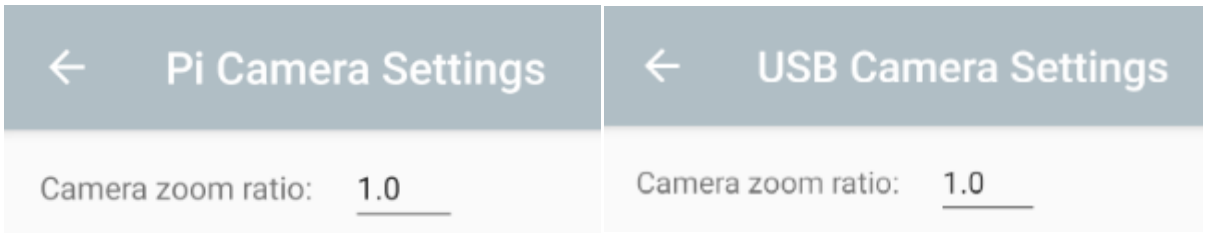
You can change the camera settings by clicking on the "CAM SETTINGS" button.

3.3.1.7.1 Camera type



If you are using stereo camera setup, make sure you choose the correct camera for left and right as per shown in 3.3.1.5.1, as swapping the cameras will gives negative delta angle value.

3.3.1.7.2 Zoom ratio

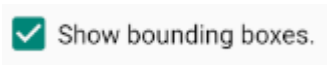


You can change the zoom ratio of each camera. The zoom ratio can range from 0.5 to 2.0. A zoom ratio of 0.5 will reduce the camera output size by halve and zoom ratio or 2.0 will double the camera output size.

For stereo camera setup, the zoom ratio of each camera will follows what was set in MONO_PICAM and MONO_USB.

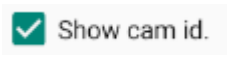
Note: For stereo camera setup, it is important to use this zoom ratio setting to match both cameras (Picamera and USB camera).

3.3.1.7.3 Items to display in the live video feeds

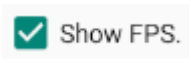


If selected, will display face bounding boxes.

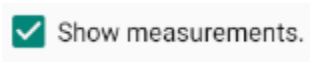
If selected, will display recognized face ids (only in client mode).



If selected, will display the device's id.



If selected, will display the average frame per seconds.



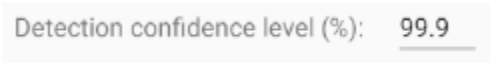
If selected, will display the delta values between left and right cameras (only for stereo camera setup).

If selected, will display the min/max bounding boxes and window bounding box.

3.3.1.8 Detection settings

You can change the detection settings by clicking on the "DETECTION SETTINGS" button.

3.3.1.8.1 Detection confidence level

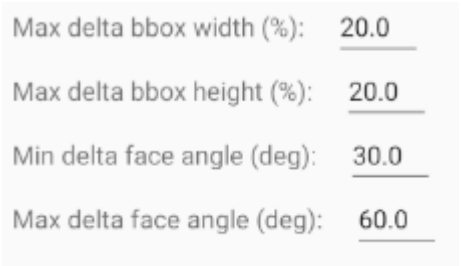


You can adjust the confidence level of facial recognition. Setting it at 99.9% will mean PiFaceCam edge will only return positive if it is 99.9% certain the recognition is correct. This value was calibrated using “VGGFace2” dataset.

3.3.1.8.2 Bounding box constrains setting

You can limit the size of face bounding box and also constrain it to within a window in the camera's frame. The value is set in ratio of the image width or height.

3.3.1.8.3 Delta between left and right cameras (for stereo cameras only)



If it is a stereo camera setting, you can constrain the difference between the left and right cameras.

3.3.1.9 Verification mode (only available in Profession version of PiFaceCam App)

In verification mode, you need to provide the port number and verification token. The verification token will be used by the client during request.

Once setup, the PiFaceCam edge will act as a verification server. Any client can send to it a reference image for verification. The verification server will return if the person currently in front of the camera matches the person in the reference image.

3.3.1.9.1 Information to server

To request for verification, the client needs to send the reference image, the token, and a boolean indicating if a returned image is required, in JSON format to server.

Element	Key	Value
Token	"token"	string
Image	"image"	Reference image (base64 string)
If need to return image	" need_return_image"	boolean

The image bytes have to be converted to base64 string (see below example). The length of this JSON bytes needs to be included at the beginning of the packet when send to verification server. The length value is encoded in a big-endian ordering 4 bytes.

```
# --------Load image bytes from file--------
img_filestream = open(image_file_pathname, "rb")
ori_image_bytes = img_filestream.read()
img_filestream.close()
# --------Convert to base64 string--------
ori_image_base64 = base64.b64encode(ori_image_bytes)
ori_image_base64_str = ori_image_base64.decode('utf-8')

# --------Compose JSON packet-----------
JSON_dict = {"token": server_token,
             "image": ori_image_base64_str,
             "need_return_image": need_return_image}

JSON_str = json.dumps(JSON_dict)

# --------Convert to binary string and add length of packet-----------
JSON_bytes = JSON_str.encode("utf-8")
len_of_packet = len(JSON_bytes)

len_of_packet_bytes = pack('>I', len_of_packet)
total_bytes = len_of_packet_bytes + JSON_bytes
```

```
# ------------Send packet to verification server----------------
server_address = (server_ipaddress, server_port)
sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)



sock.connect(server_address)
sock.sendall(total_bytes)
```

3.3.1.9.2 Information returned from server

Returned JSON object from verification server to client.

Key	Value
"isSuccessful"	True / False
"errMessage"	Error message if isSuccessful is False
"noOfFaces"	Number of faces detected. Only faces that passed the dimensional constrain check.
"imageWidth"	Width of the image from PiFaceCam_Edge.
"imageHeight"	
"faces"	List of faces detected. Only faces that passed the dimensional constrain check.
"returnImage"	Returned image (base64 string)

Faces list.

Key	Value
"top"	Top y-coordinate of face bounding box.
"left"	Left x-coordinate of face bounding box.
"width"	Width of face bounding box.
"height"	Height of face bounding box.
"confPercentage"	Confidence level (%) of face matches image sent.

Similarly, the first 4 bytes of the returned packet indicates the length of packet.

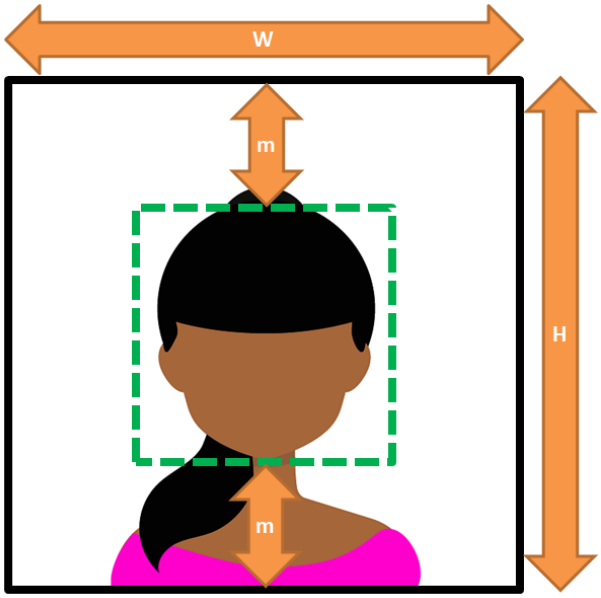
```
# -------------Receive reply from server-----------------
len_of_packet_bytes = sock.recv(4)
len_of_packet_int = unpack('>I', len_of_packet_bytes)[0]

received_data = b''
while len(received_data) < len_of_packet_int:
    packet = sock.recv(len_of_packet_int - len(received_data))
    if not packet:
        break
    received_data += packet

sock.close()

#------------Decode received binary string to JSON object---------
received_data_string = received_data.decode("utf-8")
```

```
received_data_JSON_obj = json.loads(received_data_string)


# -------------Retrieve verification results---------------
isSuccessful = received_data_JSON_obj.get("isSuccessful")
if isSuccessful:
    noOfFaces = received_data_JSON_obj.get("noOfFaces")
    imageWidth = received_data_JSON_obj.get("imageWidth")
    imageHeight = received_data_JSON_obj.get("imageHeight")

    if noOfFaces > 0:
        faces = received_data_JSON_obj.get("faces")
        for face_idx, face in enumerate(faces):
            face_top = face["top"]
            face_left = face["left"]
            face_width = face["width"]
            face_height = face["height"]
            confPercentage = face["confPercentage"]

            print("Face {}: confident {:.2f}%".format(face_idx, confPercentage))
    else:
        print("No face detected.")

    if need_return_image:
        returned_image_base64_str = received_data_JSON_obj.get("returnImage")
        returned_image_base64 = returned_image_base64_str.encode("utf-8")
        returned_image_bytes = base64.b64decode(returned_image_base64)

        returned_image_array = np.frombuffer(returned_image_bytes, np.uint8)
        returned_image_np = cv2.imdecode(returned_image_array, cv2.IMREAD_COLOR)

        cv2.imshow("Returned image", returned_image_np)
        cv2.waitKey(0)
        cv2.destroyAllWindows()

else:
    print("Server return error message :" + received_data_JSON_obj.get("errMessage"))
```

For complete code example, go to the following link.

"https://github.com/tensorfactory/PiFaceCam/example_verification_client/example_verification_client .py"

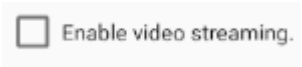
3.3.1.9.3 Guidelines for preparing reference image.



The reference image used for verification has to meet the following guidelines, failing which may affect the accuracy or getting rejected by the verification server.

1) The face (green box) has to be at the center of the image.
2) The image has to be square (W = H).
3) The margin (m) between face and border of image has to be within 10~25 % of the image size (H). (Example, if the image size is 500pixels x 500pixels, then ***m*** has to be within the range of 50 to 125pixels.)
4) Image size (W and H) has to be within the range of 320 to 512 pixels.

3.3.1.10 Video streaming



Once enabled, it will start to stream live video from port 9090. The video can be access using from URL such as http://169.254.121.52:9090/video where in this case the "169.254.121.52" is the ipaddress of the PiFaceCam edge device.

3.3.1.11 Program

Click on the “Pencil” icon to select a program you want to run on the connected device.
Note: Delete the program's name at the edit box and click upload button will remove any program at the connected device.

3.3.1.12 View log

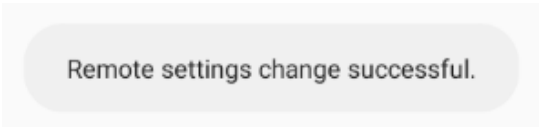
You can access the error/warning logging of remote device here.

Note: If error occurred which prevents communication between the edge and app, you will not able to view the log from the app, you can still retrieve the logs from "info_log.txt" stored in the same directory as PiFaceCam_Edge. This file will be refreshed during the start of PiFaceCam_Edge program.

3.3.1.13 Settings upload

 (Setting upload button)

After you have made any changes, you need to click the setting upload button to upload everything to the connected device before those changes will take effect.



If successful, you will see a "Remote settings change successful." message.

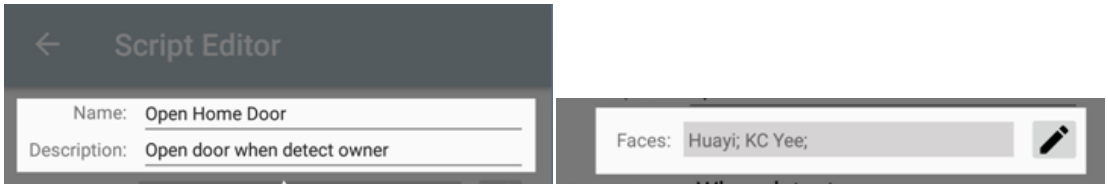
Note: During setting upload, all face ids from your face ids list will be uploaded to the connected device.

3.3.2 All Scripts

You will see all your created scripts (if available) listed here. Click on "+" button to add scripts. You have option to import from a ".srp" file or create from scratch.

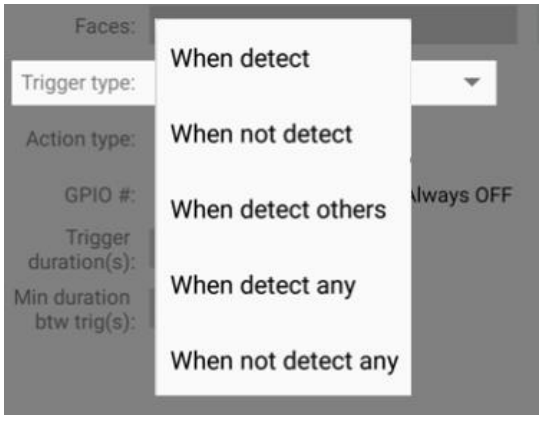
You can export any of the scripts to file by clicking on the share button at the top.

3.3.2.1 Creating a new script



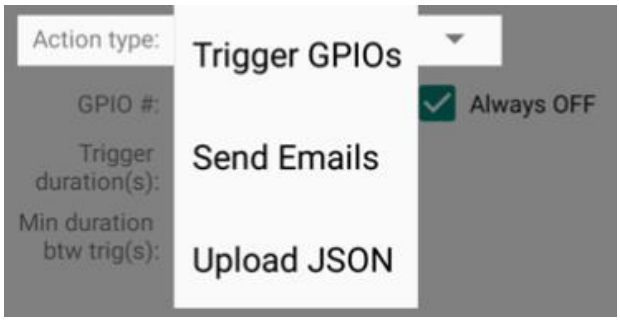
To create a new script, first give your script a meaningful name and description.

Next Click on "pencil" icon to select face-ids that you will be using in this script.

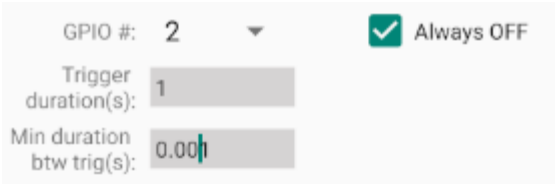


Select a trigger type.

1) Action is triggered when any of the selected faces are detected,
2) action is triggered when the none of selected faces are detected,
3) action is triggered when any faces other than those that were selected are detected,
4) action will triggered when detect any faces and
5) action will be triggered when no face is detected.

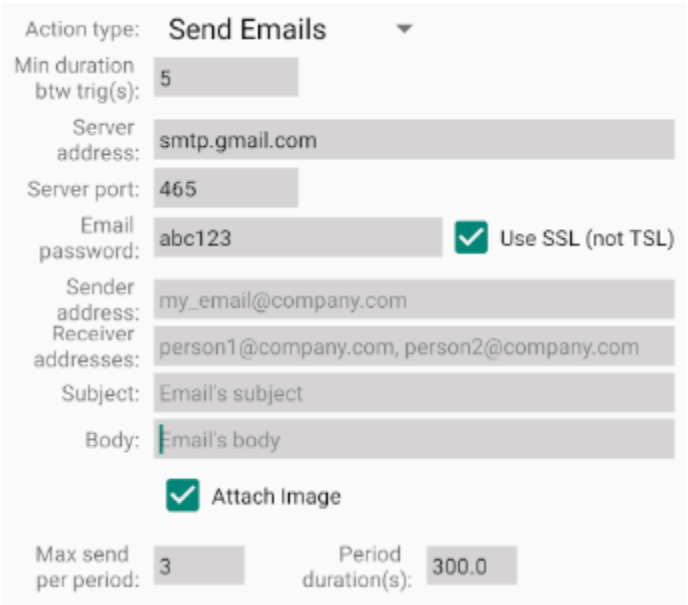


Next is to select the action type. You have options of triggering a GPIO, sending an email or upload face id list and a key value to a JSON server.



For GPIO, you can select any GPIO pin to trigger but it has to be different from the status and shutdown pin. You can also select always OFF or always ON mode. In always OFF mode, the pin will be always at low state until it is trigger and vice versa.

You can set the trigger duration and the minimum time interval between triggers "Min duration btw trig(s)". However, as with other temporal settings, their accuracies are not very reliable and shall not be depended on for any application.



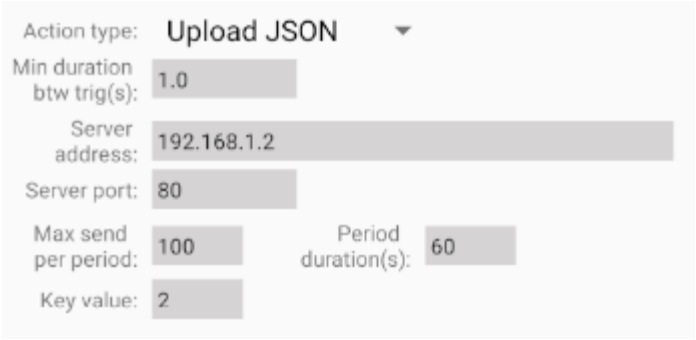
For action type of sending email through a smtp server. You have to provide the necessary smtp server information.

For security protocol, you can choose between SSL and TSL. Uncheck the "Use SSL" checkbox will select TSL protocol.

You have the option to provide a short email subject and body, and to include an attachment of the image that triggers this action.

In this example (above), to prevent multiple emails send when this script is triggered continuously, we set minimum time interval between triggers "Min duration btw trig(s)" to 5 seconds, meaning after the first email sent, it will wait for 5 seconds before the next triggering can happen. Also we set the max send per period to 3 and the period to 300 seconds (5 minutes) which means, in every 5 minutes, the script can only send a maximum of 3 emails. The counter will reset after each 5 minutes period.

Note: For email sending, the edge device needs connection to internet.



For action type "Upload JSON", a JSON packet will be send to the JSON server with the following format.

```
{       "device_id": device_id,
        "num_of_faces": num_of_faces,
        "faceID_list": faceID_list,
        "key_value": key_value,
        "time_stamp": time_stamp    }
```

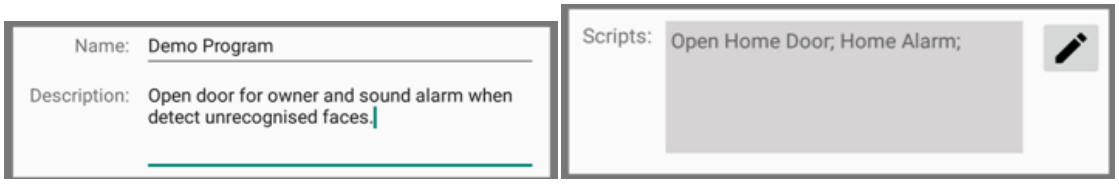
"faceID_list" is list of face ids in the image that trigger this action. "key_value" is an arbitrary integer value to pass over to JSON server for identification. "time_stamp" is the number of seconds that have elapsed since January 1, 1970, 00:00:00 (UTC). Please see an example of implementation in our github folder.

3.3.3 All Programs

You will see all your created programs (if available) listed here. Click on "+" button to add programs. You have option to import from a ".prg" file or create from scratch.

You can export any of the programs to file by clicking on the share button at the top.

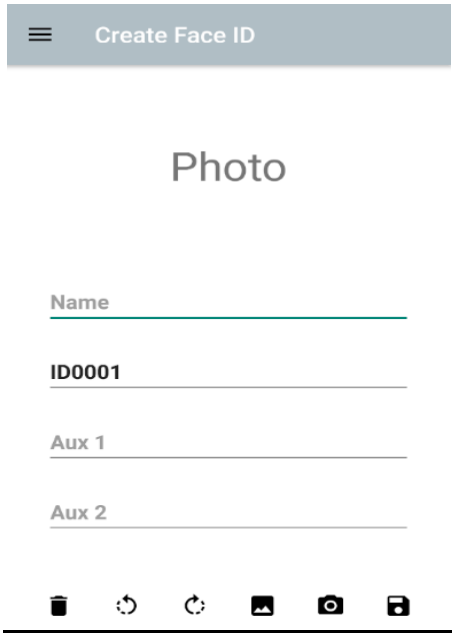
A program is a group of scripts. As each script is a unit of detection-action pair, using program will allow us to implement multiple scripts at once.



To create a new program, first give you program a meaningful name and description. Next click on "pencil" icon to select scripts that you want to include in this program.

Note: In event you are making any changes to the face ids or to the scripts after you have created a program, you need to replace all those changes in the scripts and the affected program, and re-upload the program to all edge devices before those changes can take effects.

3.3.4 Create Face ID

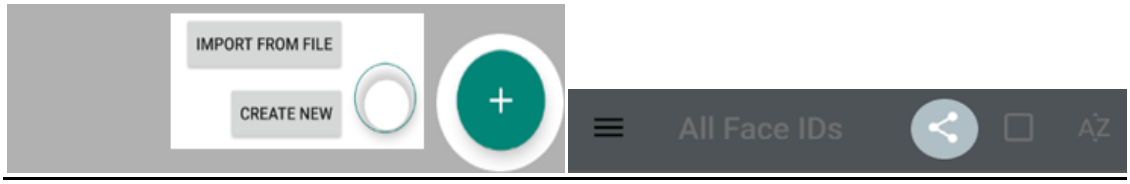


Click on “Photo” or the gallery or camera button to start import face photos of this person. Name is compulsory and ID is auto-generated (can be altered). All imported face photos will be shown at the top and rejected photos will have a red cross.

You can delete a selected photo by clicking on the dustbin. (Long click will delete all photos). You can also rotate the selected photo by clicking at the rotation button at the bottom.

Note: If you import more than 5 photos, PiFaceCam app will choose the best 5 photos to used (saved).

3.3.5 All Face IDs

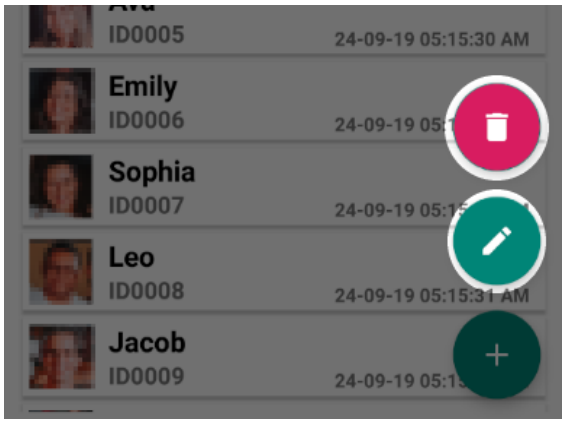


You will see all your created scripts (if available) listed here. Click on “+” button to add face ids. You have option to import from a “.fig” file or create from scratch.

You can export any of the face-ids to file by clicking on the share button at the top.

Long click on any face id to start selection.

Click on any item will open edit dialog.



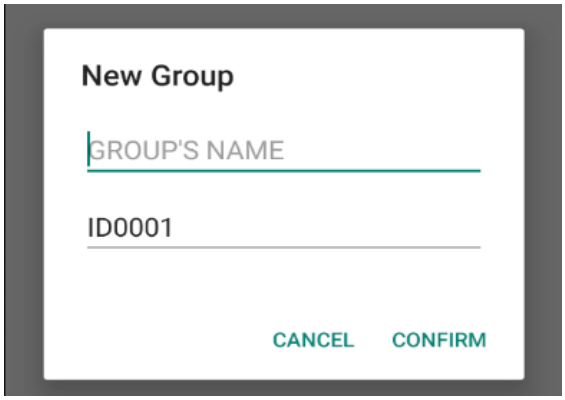
You can also delete or edit selected face id by clicking on the “dustbin” or “pencil” button.

3.3.6 All Groups

Group is a collection of face ids. This is to help us organize our face-ids.

You will see all your created groups (if available) listed here. Click on “+” button to create new group. You have option to import from a “.grp” file or create from scratch.

You can export any of the groups to file by clicking on the share button at the top.



If you choose to create new one, you will be prompted for a name.

Start adding face IDs as member of this group by clicking on the "+" button. Long click on any face id to start selection. You can delete selected IDs or continue to add more. Remember to save changes before leaving.

4.0 Implementation Examples

4.1 Case 1: Simple auto door unlocking and alerting (buzzer and email).

In this example, we would like to automate our office's door locking so that only authorized personnels can enter and would like to receive an email if detect unauthorized person. We will be using a Raspberry Pi (3B+ or 4B) with PiCamera attached.

Requirements:

- Keeping list of face ids of authorised personnels.
- When detect any of the authorised personnels, trigger door unlock for 3 seconds by setting GPIO 4 to high for 3 second.
- At the same time we would like to have a buzz of 1 second whenever door unlock is triggered. This is done by setting GPIO 5 to high for 1 second.
- When there an unauthorised person trying to enter, we would like our HR department to be alerted through email (hr_manager@company.com). The email should include an image of the person face.

Step 1) Setting up the PiFaceCam edge to auto-start everytime we power ON the Raspberry Pi.

a) Create a script file “launcher.sh” with below lines

```
#!/bin/sh
sleep 10
cd /
cd home/pi/pifacecam_edge
sudo python3 wrapper.py
```

b) Make the launcher script an executable, with command "chmod 755 launcher.sh"

c) Make a directory for the any errors in crontab to go

Navigate back to your home directory:
cd
Create a logs directory:
mkdir logs

d) Add to Your Crontab. To brings up a crontab window, run

sudo crontab -e

e) Now, enter the line:

@reboot sh /home/pi/pifacecam_edge /launcher.sh >/home/pi/logs/cronlog 2>&1

Step 2) Setting up the face-ids of authorised personnels.

a) Following instructions from section 3.3.4 , create a face id for each of the authorised persons.

b) Create a group for these ids (name it something like "department A") following section 3.3.6.

Step 3) Creating scripts.

There are three detection-actions in this implementation. 1) Detect authorised personnels, unlock door, 2) detect authorised personnels sound buzz and 3) detect un-authorised persons, send email. We will create 3 scripts, one for each of the detecion-action as per section 3.3.2.

i) Script 1:
Name: Unlock door (Department A)
Description: ON GPIO 4 for 3 seconds when detect authorised personnels.
Faces: Select face ids from group "department A"
Trigger type: Select "When detect"
Action type: Select "Trigger GPIOs"
GPIO#: Select number 4
Check "Always OFF"
Trigger duration(s): 3
Min duration btw trig(s): 0.01

ii) Script 2:
Name: Sound buzzer (Department A)
Description: ON GPIO 5 for 1 second when detect authorised personnels.
Faces: Select face ids from group "department A"
Trigger type: Select "When detect"
Action type: Select "Trigger GPIOs"
GPIO#: Select number 5

Check "Always OFF"
Trigger duration(s): 1
Min duration btw trig(s): 0.01

iii) Script 3:

Name: Send email (Department A)
Description: Send email to HR manager when detect unauthorised persons.
Faces: Select face ids from group "department A"
Trigger type: Select "When detect others" (To detect unauthorised persons)
Action type: Select "Send Emails"
Min duration btw trig(s): 5 (Allow some gaps for smtp server to response)
Server address: smtp.gmail.com (Using google smtp service)
Server port: 587
Email password: abcd1234
Sender address: departmentA@gmail.com
Receiver addresses: hr_manager@company.com
Subject: Unauthorised person detection alert.
Body: Unauthorised person detection at department A. Please see attachment.
Check "Attach Image"
Max send per period: 20
Period duration(s): 600 (Every 10 minutes only allow maximum 20 emails.

Step 4) Creating program (following instructions from section 3.3.3)

Name: Door Security System (Department A)
Description: Manage door unlock and unauthorised persons detection.
Scripts: Select scripts
"Unlock door (Department A)",
" Sound buzzer (Department A)" and
" Send email (Department A)"

Step 5) Upload program to PiFaceCam edge device.

a) Search the device in all network devices list, click on the device to open the control panel.
b) The default name is "CAM001" and we would like to rename it to "CAM_DEPT_A".
c) Since this is for door entrance and we would like to reduce the chances of wrong identification as much as possible, we set detection confidence level to 99.9%.
d) By default, the PiFaceCam edge device is not passkey protected, we will on the passkey protection and provide a "New passkey".
(Note: Once ON, the passkey will be automatically stored in this PiFaceCam app. In event if the passkey was erased, you can key-in the password manually at the "PassKey" edit box.)
e) We are using Pi Camera, so we choose MONO_PICAM for camera setup.
f) Click on the pencil icon next to program and select "Door Security System (Department A)".
g) Click the green upload button at the bottom right to upload the setting and program to the connected PiFaceCam edge. The PiFaceCam edge will start executing the instructions in the program.

4.2 Case 2: Remote controlling and displaying of ids through JSON server.

Expanding from case 1, we would like to have our security office to be alerted whenever the camera detects a person. If it is an authorized person, green LED should light up and red LED if it is an unauthorized person. We also want the id of all the persons in the camera to be displayed.

ESP8266 JSON server

We will use a ESP8266 module (ESP07) as a JSON server which will receive information from PiFaceCam edge. It will control 2 LEDs and display ids on a 20x4 hd44780 LCD (with I2C). The Arduino sketch for this can be found at github "ESP8266_JSON_server_V02/ESP8266_JSON_server_V02.ino".

This sketch uses

- "ArduinoJson" library by Benoit Blanchon for handling of JSON.
- "hd44780" library by Bill Perry to control LCD via I2C.
- "WiFiManager" library by Tzapu to manage network credentials (SSID and password).
- "TimeLib" library by Paul Stoffregen to convert Unix epoch time to standard format.

PiFaceCam edge

As in case 1, we will create 2 scripts for this. One to send a key-value 1 to JSON server when detect authorized personnels and the other to send a key-value 2 when detect unauthorized personnels. ESP8266 server will receive a JSON packet with all these information and turn ON/OFF the corresponding LED as per the key_value. It will also display all (max 4) ids on the 20 x 4 matrix LCD.

```
{       "device_id": device_id,
        "num_of_faces": num_of_faces,
        "faceID_list": faceID_list,
        "key_value": key_value,
        "time_stamp": time_stamp    }
```

i) Script 1:

Name: JSON key-value 1 (Department A)
Description: Send key-value 1 to JSON server when detect authorised personnels.
Faces: Select face ids from group "department A"
Trigger type: Select "When detect"
Action type: Select "Upload JSON"
Min duration btw trig(s): 0.1 (A small value as response of ESP8266 server is relatively fast).
Server address: IP address of the ESP8266 server.
Server port: Port number of the ESP8266 server.
Max send per period: 100 (A largevalue as response of ESP8266 server is relatively fast).
Period duration(s):1
Key value: 1

ii) Script 2:

Name: JSON key-value 2 (Department A)
Description: Send key-value 2 to JSON server when detect unauthorised personnels.
Faces: Select face ids from group "department A"
Trigger type: Select "When detect others" (To detect unauthorised persons)
Action type: Select "Upload JSON"
Min duration btw trig(s): 0.1
Server address: IP address of the ESP8266 server.
Server port: Port number of the ESP8266 server.
Max send per period: 100
Period duration(s):1
Key value: 2

Append these 2 new scripts to the program in case 1, upload the program to PiFaceCam edge, it will start sending JSON packets to the ESP8266 server.