Project Proposal

Thermal sensing face recognizing camera for COVID 19

By

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This report is submitted to the Department of Electrical and Computer Engineering in partial fulfillment for LE401 Electrical Engineering Project I
2020

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(*Advisor's signature*)

1. Problem Statement

Since our world was introduced to the existence of potentially the most contagious virus of all time COVID-19 that put most of the business into a halt and the public were not allowed to leave their home without an acceptable reason,many experts in the related field have been trying to come up with an idea to fight against such a pandemic in order to be able to handle the situation after the reopening phase of the business, One of solution is the thermal camera which detects human body temperature.

Detection of the person who possesses a symptom of the COVID-19 is not the only main concern but also to prevent the virus from spreading from person to another is a goal that needs to be achieved. Because COVID-19 is known to be less-lethal but highly contagious meaning although it is not being very harmful to a person who does not have any health issues it is very easy to be spread from person to person by direct physical contact. With that being said the risk of one person who conducted the virus to spread it to the other is high, Hence the ability to quickly measure temperature of body, identify and pinpoint the location that the person went or stayed without requiring any human interaction is very important.

However, with today's technology, it is in fact possible to comes up with a device that is fast and precise enough that also does not require any human interaction to make the device work properly for measuring multiple human body temperature at once but because the cost of the whole system is very high and that is what makes it inaccessible to many communities.

2. Objectives *The writing in this section should include but not limited to the following topics*

1. To allow a quick analysis of the person temperature who enters the property
2. To enable the camera to recognize the person face and be able to describe the person identity based on the existing database
3. Does not require human interaction to complete the task
4. Reduce the total cost of the system

3. Project Scopes *The writing in this section should include but not limited to the following topics*

1. Understand the working principle of a thermal imaging camera
2. Selection of software and hardware during the designing process
3. Program the system to be able to detect the human face and be able to gather the essential data such as the picture of the person face automatically
4. Understand the algorithm of face recognition model and be able to choose the one that is suitable for this project the most

4. Theory and Related Concepts *The writing in this section should include but not limited to the following topics*

4.1. ***Thermal temperature measurement*** *(ยังไม่ได้เติมกล้อง)*

Temperature measurement of the human body can be achieved through a Thermal sensor which can detect the infrared spectrum radiating from an object as long as the object is not at the absolute temperature.

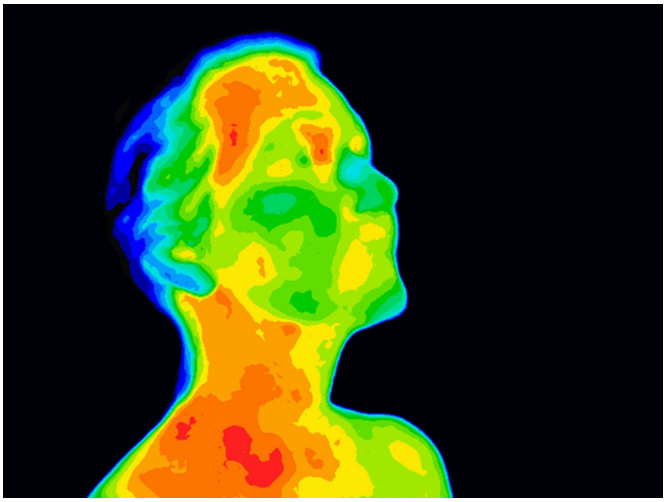
Thermopiles

Thermopiles are designed to measure temperature from a distance by detecting an object's infrared (IR) energy. The higher the temperature, the more IR energy is emitted. The thermopile sensing element, composed of small thermocouples on a silicon chip, absorbs the energy and produces an output signal.

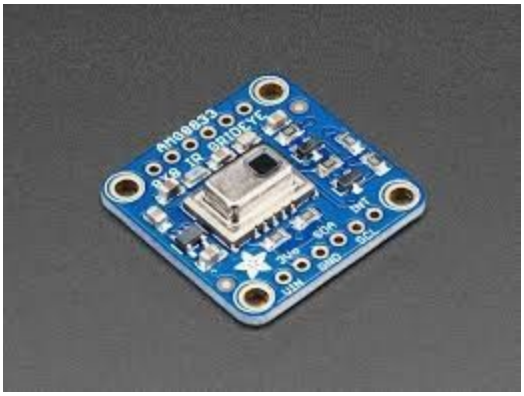
Temperature measurement of human body is the first approach of identifying the person who has conducted the COVID-19 virus, The most reliable location to measure the temperature of the human body with a contactless thermometer is on the forehead since it has the largest surface area

The lists below are thermal imaging camera modules, like thermopiles these modules work in the same principle which is detecting the intensity of the infrared radiating by the object or human body in this case. However, These modules will also generate thermal images which can then be measured from

each pixel that is inside the range of the camera. In a more simple word the thermal camera is consisted of many thermopiles combined which can then generate an image through the monitor



4.1.1.AMG8833(ใส่ข้อมูล)



This sensor is from an 8×8 array of IR Thermal sensors. When connected to a microcontroller (or raspberry Pi), it returns an array of 64 individual infrared temperature values over I2C. It's like those Unusual thermal cameras, but compact and simple enough for easy integration.

This part measures the temperature from 0 ° C to 80 ° C (32 ° F to 176 ° F) With an accuracy of + -2.5 ° C (4.5 ° F). He can detect a person from a distance of 7 m (23) feet. With a maximum frame rate of 10 Hz, it is ideal for creating your own human detector or mini thermal camera. We have the code to use this breakthrough on Arduino or compatible (the sensor binds more than I2C) or to the raspberry pi from the python. On Pi, with a little image processing help from the pythpy python library, we were able to

interpolate the 8×8 Grid and get pretty good results!

The AMG8833 is the next generation of 8×8 thermal infrared sensors and offers better performance than the predecessor. The sensor only supports I2C, and has a configurable interrupt pin that can fire when any single pixel goes above or below the threshold that you set.

To be easy to use, we select and place it on a section board with a 3.3V regulator and a switching level. So, you can use it with any 3 V or 5 V microcontroller or computer.

Even better, adafruit has done all the hard work here, with code examples and support for software libraries, to get you up and running in a few lines of code! Read our guide for how to get started.

Features:

1. The AMG8833 infrared camera sensor is an 8x8 infrared thermal sensor array. When connected to your microcontroller (or Raspberry Pi), it will return a set of 64 individual infrared temperature readings via I2C. It's like those fancy thermal cameras, but it's compact and simple and easy to integrate. The AMG8833 offers higher performance than the previous AMG8831. The sensor only supports I2C and has a configurable interrupt pin that can be triggered when any single pixel is above or below your set threshold.

2. It can detect humans from a distance of up to 7 meters (23) feet. It is a perfect fit for creating your own human detector or mini camera. We use this breakthrough code on Arduino or compatible (sensor communicates via I2C) or on Python's Raspberry Pi. On the Pi, thanks to the image processing help of the SciPy python library, we can insert an 8x8 grid and get some very good results.

Specification:

Accuracy: + - 2.5°C (4.5°F).

Maximum frame rate: 10Hz,

Power supply: 3~5V

Temperature Measurement Range: 0°C to 80°C (32°F to 176°F)

Dimensions: 1.7x1.8cm/0.67x0.71inch

4.1.2. MLX90640(ใส่ข้อมูล)

***Overview**:*

This is a 32×24 pixels, 55° field of view, IR array thermal imaging camera, communicating via I2C interface. It is compatible with 3.3V/5V operating voltage, supports host platforms such as Raspberry Pi/Arduino(ESP32)/STM32, etc.

By utilizing the MLX90640 far-infrared thermal sensor array, this module can detect the IR distribution of objects in the field of view, turn the data into surface temperature of the objects by calculation, and then generate thermal images. Due to the small form factor, it can be easily integrated into miscellaneous industrial or intelligent control applications.

***Features**:*

- *Adopts MLX90640 far-infrared thermal sensor array, 32×24 pixels*
- *Communicating via I2C interface, configurable to fast mode (up to 1MHz data rate)*
- *Noise Equivalent Temperature Difference (NETD) 0.1K RMS @1Hz refresh rate*
- *Onboard voltage translator, compatible with 3.3V/5V operating voltage*
- *Comes with development resources and manual (examples for Raspberry Pi/ Arduino (ESP32)/STM32)*

***Specifications**:*

- *Operating voltage: 3.3V/5V*
- *Operating current: < 23mA*

- *Communication interface: I2C (address 0x33)*
- *Field of view (Horizontal×Vertical):*
    - *MLX90640-D55 Thermal Camera: 55°×35° (narrow angle FOV, suit for long range measuring)*
    - *MLX90640-D110 Thermal Camera: 110°×75° (wide angle FOV, suit for short range measuring)*
- *Operating temperature: -40℃ - 85℃*
- *Target temperature: -40℃ - 300℃*
- *Resolution: ±1℃*
- *Refresh rate: 0.5Hz - 64Hz (programmable)*
- *Dimensions: 28mm × 16 mm*
- *Mounting hole size: 2.0mm*

***Applications**:*

- *High precision non-contact temperature measurements*
- *IR thermal imaging devices, IR thermometers*
- *Smart home, intelligent building, intelligent lighting*
- *Industrial temperature control, security monitoring, intrude/movement detection*

(4.1.3.FLIR Lepton)(ใส่ข้อมูล)

(4.1.4.HT102)(ใส่ข้อมูล)

(4.1.5.OpenMV4)(ใส่ข้อมูล)ไม่มั่นใจ

*4.2.**Face detection***

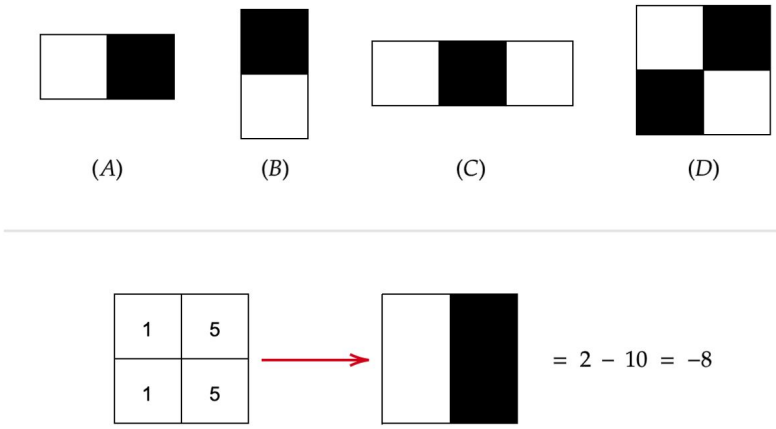
is an image processing technique to allow the computer to recognize the face of a human from an image or video (anything that has an image as an output). This will not only enable the computer to detect and draw a boundary around the face detected for analysis purposes but in this case, it will be scripted to gather the data which is the cropped picture of the face of the person who walks passed the camera automatically.

4.2.1.Haar Classifier

4.2.1.1.Haar-like Features(ยังไม่ได้แก้คำ)

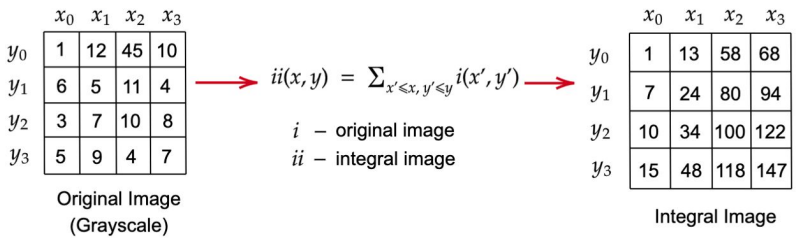
A Haar-like feature consists of dark regions and light regions. It produces a single value by taking the sum of the intensities of the light regions and subtracting that by the sum of the intensities of dark regions. There are many different types of Haar-like features but the Viola-Jones Object Detection Framework

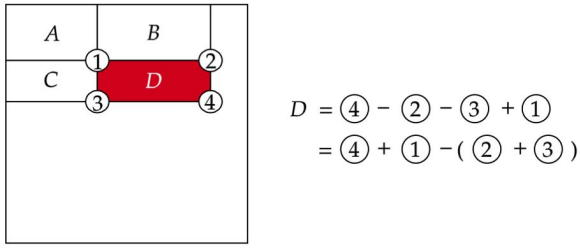
only uses the ones in Figure. The different types of Haar-like features let us extract useful information from an image such as edges, straight lines, and diagonal lines that we can use to identify an object.



4.2.1.2.Integral Images Integral Image(ยังไม่ได้แก้คำ)

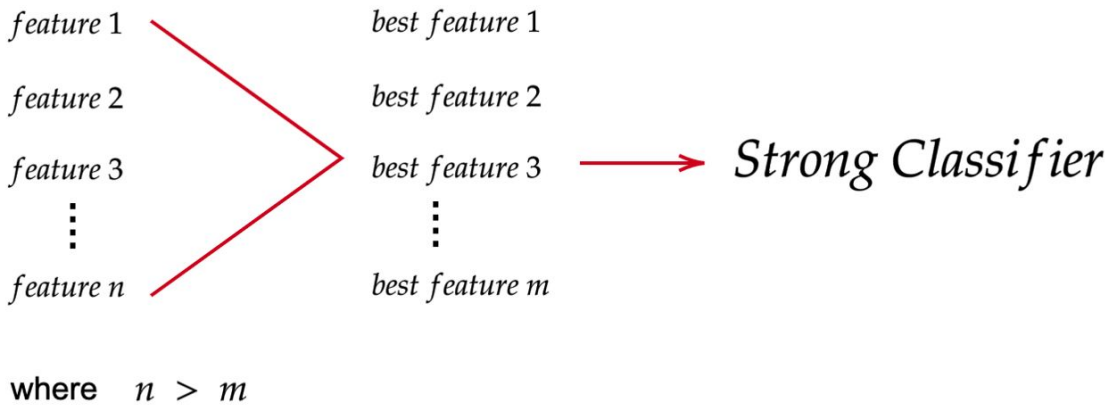
An Integral Image is an intermediate representation of an image where the value for location (x, y) on the integral image equals the sum of the pixels above and to the left (inclusive) of the (x, y) location on the original image (Viola & Jones, 2001). This intermediate representation is essential because it allows for fast calculation of the rectangular region. To illustrate, the Figure shows that the sum of the red region D can be calculated in constant time instead of having to loop through all the pixels in that region. Since the process of extracting Haar-like features involves calculating the sum of dark/light rectangular regions, the introduction of Integral Images greatly cuts down the time needed to complete this task.





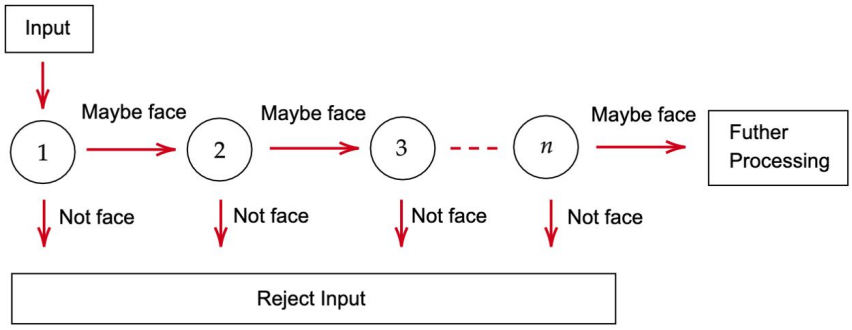
4.2.1.3.The AdaBoost Algorithm(ยังไม่ได้แก้คำ)

The AdaBoost (Adaptive Boosting) Algorithm is a machine learning algorithm for selecting the best subset of features among all available features. The output of the algorithm is a classifier (a.k.a Prediction Function, Hypothesis Function) called a *"Strong Classifier"*. A Strong Classifier is made up of a linear combinations of *"Weak Classifiers"* (best features). From a high level, in order to find these weak classifiers the algorithm runs for *T* iterations where *T* is the number of weak classifiers to find and it is set by you. In each iteration, the algorithm finds the error rate for all features and then choose the feature with the lowest error rate for that iteration.



4.2.1.4.The Cascade Classifier*(ยังไม่ได้แก้คำ)*

A Cascade Classifier is a multi-stage classifier that can perform detection quickly and accurately. Each stage consists of a strong classifier produced by the AdaBoost Algorithm. From one stage to another, the number of weak classifiers in a strong classifier increases. An input is evaluated on a sequential (stage by stage) basis. If a classifier for a specific stage outputs a negative result, the input is discarded immediately. In case the output is positive, the input is forwarded onto the next stage. According to Viola & Jones (2001), this multi-stage approach allows for the construction of simpler classifiers which can then be used to reject most negative (non face) input quickly while spending more time on positive (face) input.

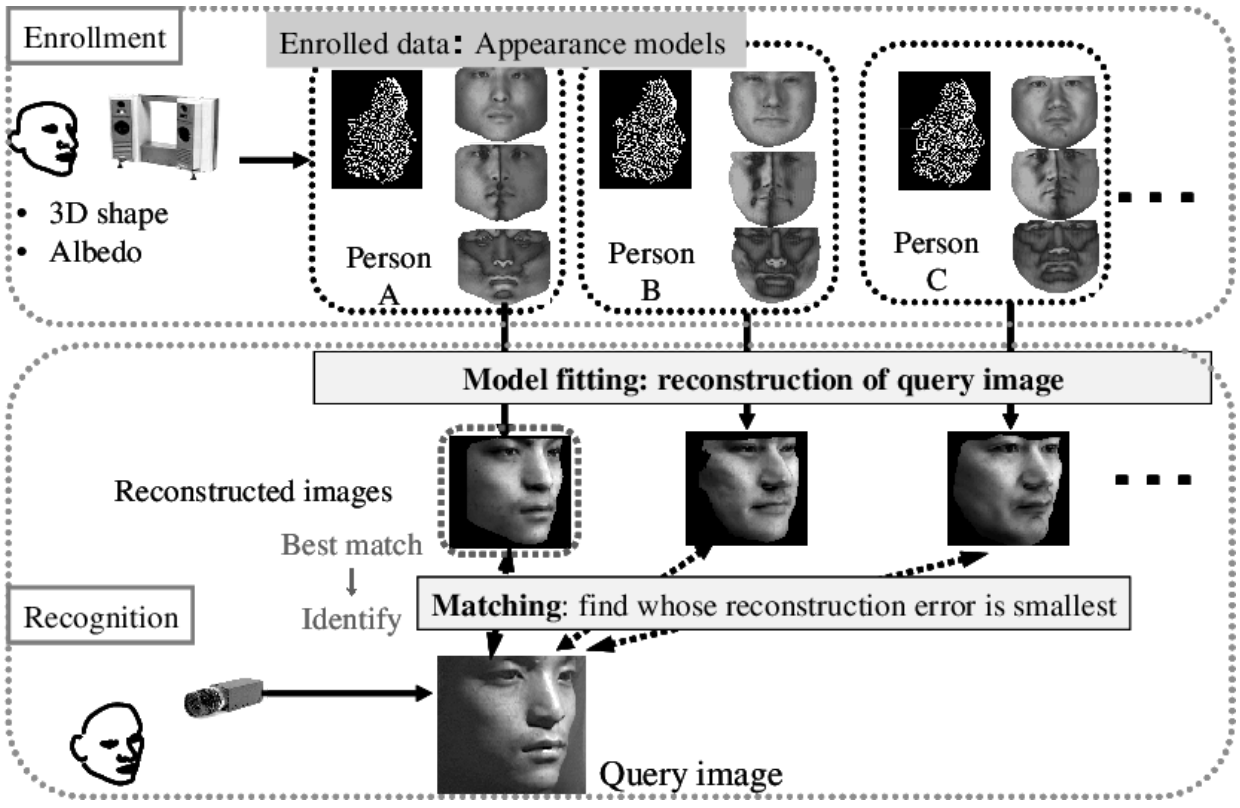

Input
Maybe face
Maybe face
Maybe face
1
2
3
n
Futher Processing
Not face
Not face
Not face
Not face
Reject Input

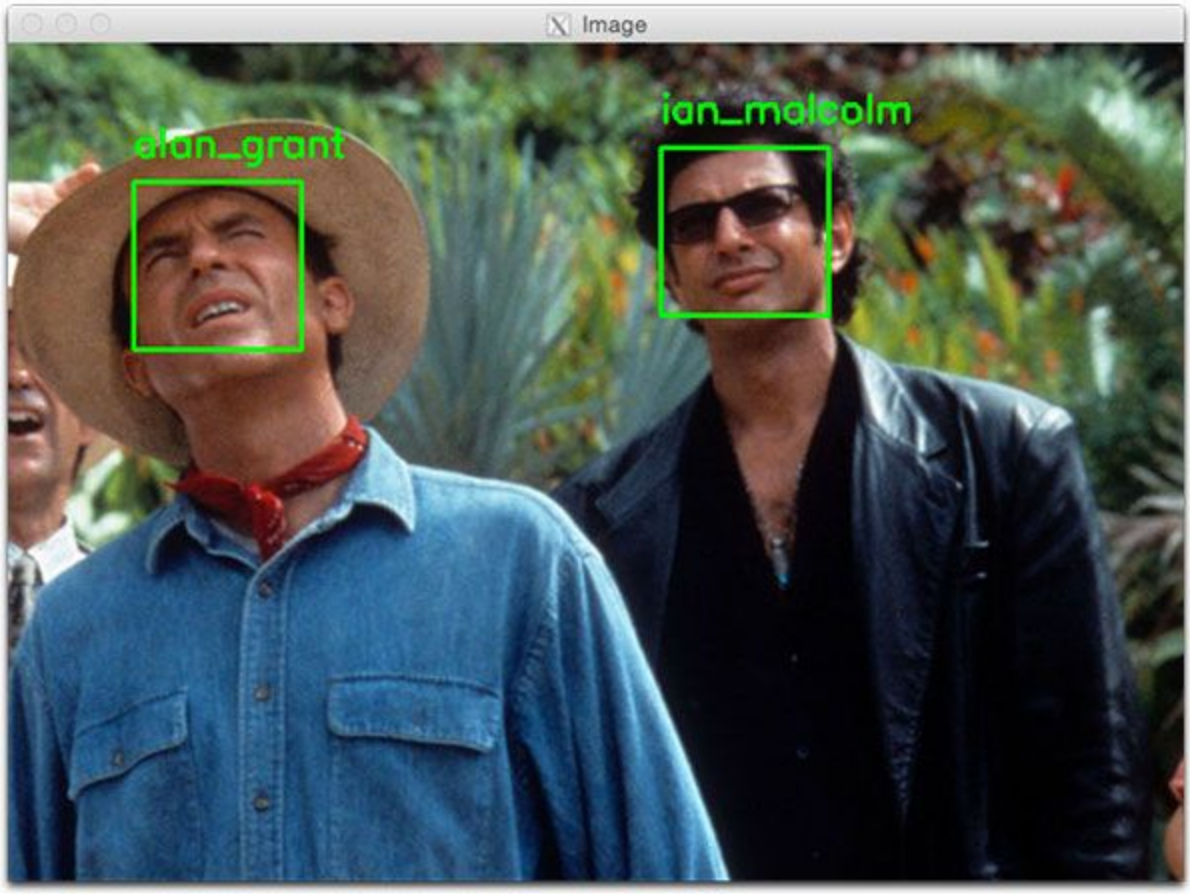
*4.3.**Face recognition***

Face recognition is a machine learning technology that helps to remember the person based on their faces using a complex computer algorithm. In a more simple word, face recognition is related to how humans remember each other when they look at their faces. As humans we remember the features of our face such as jawline, mouth shape, hairstyle. Eyes shape, etc. Computers similarly use biometrics to map facial features from a photograph or video. It compares the information with a database of known faces to find a match.

The procedure of recognizing the people of the computer :

1. *Obtain the dataset, usually the cropped picture of the person face*
2. *Label the name to all of the pictures gathered*
3. *Compare the face detected on the camera with the existing database*
4. *Determine the name of the person*





*4.4.**Hard and Software***

4.4.1.Microcontroller board

4.4.1.1.esp32

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process.[2] It is a successor to the ESP8266 microcontroller.

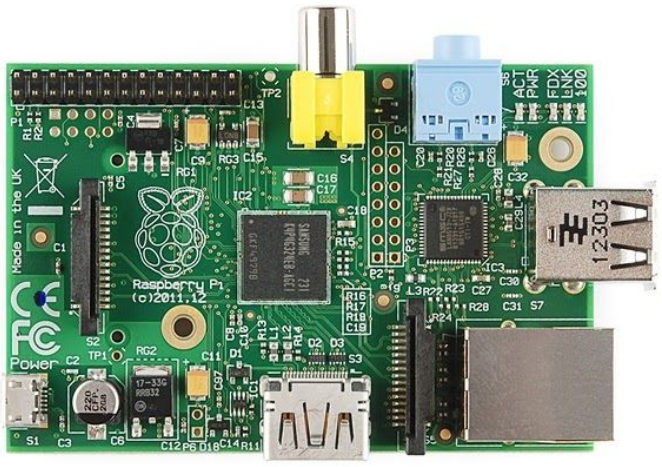
4.4.1.2.raspberry pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

4.4.1.3. Different between esp32 and raspberry pi

Raspberry Pi is the most powerful and versatile platform. For education purposes, it has the most resources, and it's perfect for projects requiring a powerful Linux computer or gateway. It's also the easiest platform to get started by far.

Arduino is the best choice for real-time I/O control, battery-powered projects, and it also comes with good materials for STEM education. You may not even have to choose between Raspberry Pi and Arduino, as both can be combined with an Arduino board being connected to a Raspberry Pi board over a UART (serial) connection.About adding WiFI or Bluetooth connectivity to a project, ESP8266 or ESP32 boards are the obvious, cost-effective choice. The downside is that the platform may be better suited for people with a higher knowledge of electronics and programming.



4.4.2.Python

4.4.2.1.Opencv

OpenCV (Open source Computer Vision) is a library of programming functions (Library of Programming Functions), mainly bent to real-time computer vision (Real-Time Computer Vision) .It was originally developed by Intel, but Originally backed by Willow Garage, followed by Itseez (which was later bought by Intel) OpenCV is the opposite of the library. (Cross-Platform) and is free to use under the license of BSD Open Source (Open-Source BSD License).

OpenCV continues to cycle deep learning frameworks (TensorFlow, Torch / PyTorch and Caffe).

Application

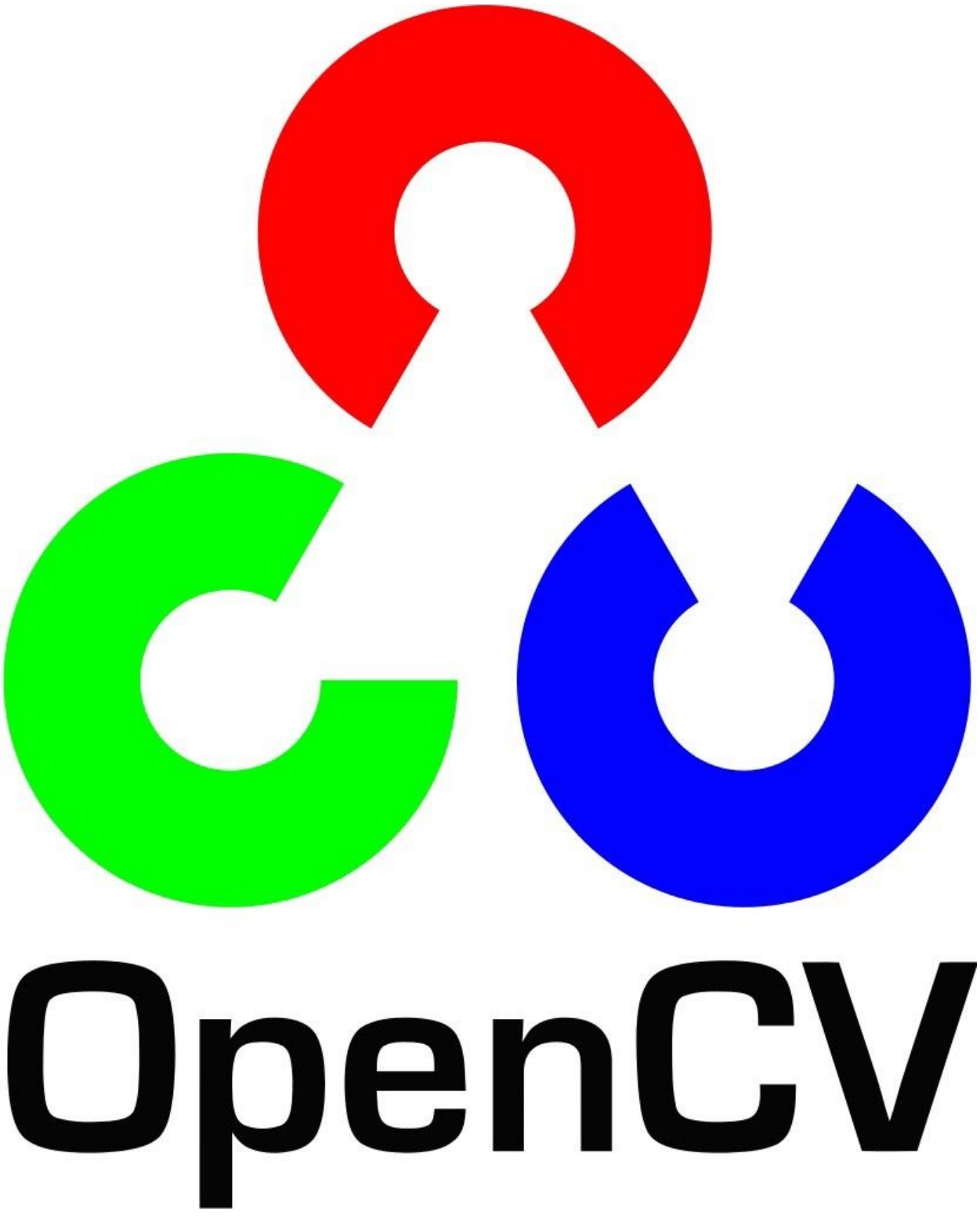
-2D and 3D feature toolkits

- Egomotion Estimation

- Facial recognition system

- Gesture recognition

- Human-Computer interaction


OpenCV

5. Work Plan

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Propose the topic										
Working on Program										
Design human body thermal measuring device										
Specs selection										
First progress presentation										
Test and improvement										
Write thesis										
Final presentation										

6. Bibliography

6.1. *[1] Voila-Jones algorithm*
https://en.wikipedia.org/wiki/Viola%E2%80%93Jones_object_detection_framework

6.2. *[2]https://docs.opencv.org/3.4/df/d25/classcv_1_1face_1_1LBPHFaceRecognizer.html*

6.3. *[3] dlib library http://dlib.net/*

6.4. *[4] face_recognition library (python) https://pypi.org/project/face-recognition/*