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Attendance System Using Face Recognition

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Abstract

This project is a part of e-Yantra Summer Internship program, 2015. The project is undertaken by Syed Yousuff and Kunal Mehta under the guidance of Mr.Viral and Mr.Yamik Mangukia. The end goal of this project is to build an automatic logging system using image processing for face recognition. The cameras placed at the entrance and exit of the lab will capture the image of a person entering or leaving the lab. Facial recognition on the images will be applied and the identity of the person will be extracted from the images. Sensors to determine the height of the person are placed near the entry and the exit. The height data aids the facial recognition and improves the accuracy of the system. The recognition data will be automatically logged. The system will also include a GUI application that will monitor the system and also help in viewing the logs.

1 Getting Started

1.1 Introduction

This project involves the use of various tools of image processing to recognize faces and develop an efficient attendance recording system. Opencv library is used with Python to develop the project on Ubuntu platform.

1.2 Tools used

Opencv

Opencv is a powerful and platform independent library for Computer vision related applications spanning very basic tasks like pre-image processing, color conversions to high level algorithms like feature extraction, machine learning etc. It is a free software and provides a rich Application Programming Interface for C, C++ and Python.

Numpy

Numpy is a fundamental package for scientific computing with Python. Most important use of numpy for this project is that it contains a powerful N-dimensional array objects. We use 2 dimensional arrays provided by numpy to hold image data.

Python

Python is used to write all the programs and it uses the installed opencv and numpy packages.

Matplotlib

Matplotlib is a python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms.

IDLE

IDLE is an integrated development environment for Python.

Arduino

The Arduino IDE was used to program the Arduino Mega development kit. This kit was used to interface the ultrasonic distance measuring sensor in order to use the height of the subjects to aid the face recognition and to increase accuracy. Considerable improvements were noticed after adding height measurement to the system.

1.3 Installation and setup

Installing Opencv

- Download the opencv_latest·sh script file from the github repository. The link is given below
https://github.com/jayrambhia/Install-OpenCV/tree/master/Ubuntu
- Save the file as opencv·sh

- Navigate to the directory containing this file and change the permissions of the file and give it execution permission
  ```
  chmod +x opencv.sh
  ```

- Run the script file
  ```
  ./opencv.sh
  ```

Installing Numpy

- Run the command
  ```
  sudo apt-get install python-numpy
  ```

Installing Matplotlib

- Run the command
  ```
  sudo apt-get install python-matplotlib
  ```

Installing IDLE

- Run the command
  ```
  sudo apt-get install IDLE
  ```

Installing Arduino

- Arduino IDE can be most easily installed from the Ubuntu software centre or can also be installed using the following command.
  ```
  sudo apt-get install arduino
  ```

2 Basic image operations

2.1 Introduction

This section deals with basic image operations like reading an image from a file, performing different operations on images and saving back images to a file. Towards the end of this section, details are given as to how the inbuilt webcam or an external camera can be used to capture images and videos using Opencv and Python.

2.2 Bare Minimum

To perform almost any of the image operations discussed below, the *cv2* and the *numpy* libraries need to be imported.

- To use this function, the *cv2* and *numpy* libraries need to be imported.
  ```
  import cv2
  import numpy
  ```

2.3 Reading image from a file

- Images can be read into a numpy array using the following line of code
  ```
  Image_name = cv2.imread(’image_name_with_location’)
  ```
- The *Image_name* is a user defined variable that refers to the numpy array corresponding to the image.

2.4 Writing image to a file / Saving an image

- Images can be saved to a file using the following line of code
  ```
  cv2.imwrite(‘name_to_save_with’, image_name)
  ```
- *name_to_save_with* is the name of the image with the location at which the image needs to be stored.
- *image_name* is the name of the np array corresponding to the image.

2.5 Displaying an image to the screen

- Images can be displayed using the following line of code:
  ```
  cv2.imshow(“window_name”, image_name)
  ```
- A window is created with the name *window_name* and the image corresponding to the numpy array *image_name* is displayed on the window.

2.6 Converting between Color formats

- Images can be easily converted between one color format to the other using the following line of code.
  ```
  cv2.cvtcolor(image_name, color_format_1 2 color_format_2)
  ```
- *color_format_1* is the original color format of the image.
- *color_format_2* is the desired color format for the image.

- One example of the color format conversion that converts the image from BGR color format to the gray color format is given below
  ```
  cv2.cvtcolor(Image_name, BGR2GRAY)
  ```

2.7 Cropping images / Region of Interest

- Images can be easily cropped in opencv. Since images are represented as numpy arrays in opencv, selecting only a specific number of rows and columns from one numpy array and assigning it to a new array.
- To obtain the number of rows and columns in an image, the following function can be used.
  ```
  image_name·shape
  ```
- *image_name* is the name of the numpy array corresponding to the image.
- This function returns the shape of the image, i,e the number of rows and columns present in the image. It also returns the third dimension of the array in case of colored images.
- The specific rows and columns can be selected from this image and assigned to the new image. For example, if the top half of the image is to be cropped, then the following lines of code can be used.
  ```
  rows, colummns, colors = image_name·shape
  new_image = image_name[rows/2, columns, :]
  ```

2.8 Resizing images

- Images can be resized using the following line of code
  ```
  new_image = cv2.resize(image_name, (width, height), interpolation = cv2.INTER_CUBIC)
  ```
- Here, width is the desired width of the final_image and height is the desired height of the image.
- Interpolation refers to the technique that is employed to calculate the values of pixels that are newly added or to select the pixels that are to be removed.
- Different interpolation techniques can be used to resize images. More details can be found from the Opencv documentation.

2.9 Working with videos

- The webcam is used in most of the real time applications. To do so, the *VideoCapture* object can be used. Using this object, either a video file can be read frame by frame or a webcam can be opened and frames can be read into the program.
- The following line of code is used to create a VideoCapture object-
  ```
  object_name = cv2·VideoCapture(index)
  ```
- To open the inbuilt webcam, set index = 0.
- To use an external camera, use the index = 1, 2, 3 and so on in increasing order.
- To read from a video file, use the file location as the index.

- To capture a frame using the *VideoCapture* object, use the following line of code
  return, frame = object_name·read(0)

- The return value is true if the frame is successfully read. Else, it is 0.

- The frame is read in as a numpy array.

- The resuorce opened by the VideoCapture object has to be released once its use is over. The below line of code can be used.
  object_name·release()

3 Contours

3.1 Introduction

Contours are, in simple, curves joining all the continuous points (along the boundary), having same color or intensity. Contours are a useful tool for shape analysis and object detection and recognition. For better accuracy, use binary images. So before finding contours, apply threshold. FindContours function provided by the opencv library modifies the source image. So if you want source image even after finding contours, store it to some other variables. The following line of code illustrates the use of the findContours function provided by the opencv library

```
    output_image, contours, hierarchy = cv2·findContours(INPUT_IMAGE, cv2·RETR_TREE,
cv2·CHAIN_APPROX_SIMPLE)
```

Here, *output_image* is the final image, *contours* is a list of contours present in the *input_image*. *contour* is a numpy array of (x,y) coordinates of boundary points of the object. The first argument is the input image, the second argument is the contour retrieval mode and the third argument is the chain approximation method. The simple chain approximation is useful when the image contains rectangular contours. In such cases, only the endpoints or vertices of the rectangular are sufficient to denote the contour instead of storing all the points on the rectangle. This saves memory space.s

3.2 Drawing Contours

The list of contours returned by the function contains all the contours identified in the image by the function. The contours are labeled with 0 based indices. All contours can be drawn or a specific contour can be drawn based on the requirement.

To draw all the contours in an image:

```
image = cv2·drawContours(image, contours, -1, (0,255,0), 3)
```

To draw an individual contour, say 4th contour:

```
image = cv2·drawContours(image, contours, 3, (0,255,0), 3)
```

The fourth argument specifies the color to be used to draw the contours and the fifth argument specifies the thickness of the contour to be drawn.

3.3 Contour approximation method

This is the third argument to the function. As contours are the boundaries of a shape with same intensity, it stores the (x,y) coordinates of the boundary of a shape. But does it store all the coordinates ? That is specified by this contour approximation method.

If cv2·CHAIN_APPROX_NONE is passed, all the boundary points are stored. But actually do we need all the points? For egg, if contour is a straight line, then we do not need all the points on the line to represent that line. We need just two end points of that line.This is what cv2·CHAIN_APPROX_SIMPLE does. It removes all redundant points and compresses the contour, thereby saving memory.

Our project did not require the use of contours but still we studied contours as it is a versatile topic in image processing. It is recommended that more reading should be done on contours from the opencv documentation.

4 Detection of Different Objects using Open CV-Python

4.1 Introduction

Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class (such as humans, buildings, or cars) in digital images and videos. Well-researched domains of object detection include face detection and pedestrian detection. Object detection has applications in many areas of computer vision, including image retrieval and video surveillance. We basically started with detection of skin, face, eye and then moved towards detectign objects like cars and bottles. More details can be found here-
http://docs.opencv.org/modules/ocl/doc/object_detection.html

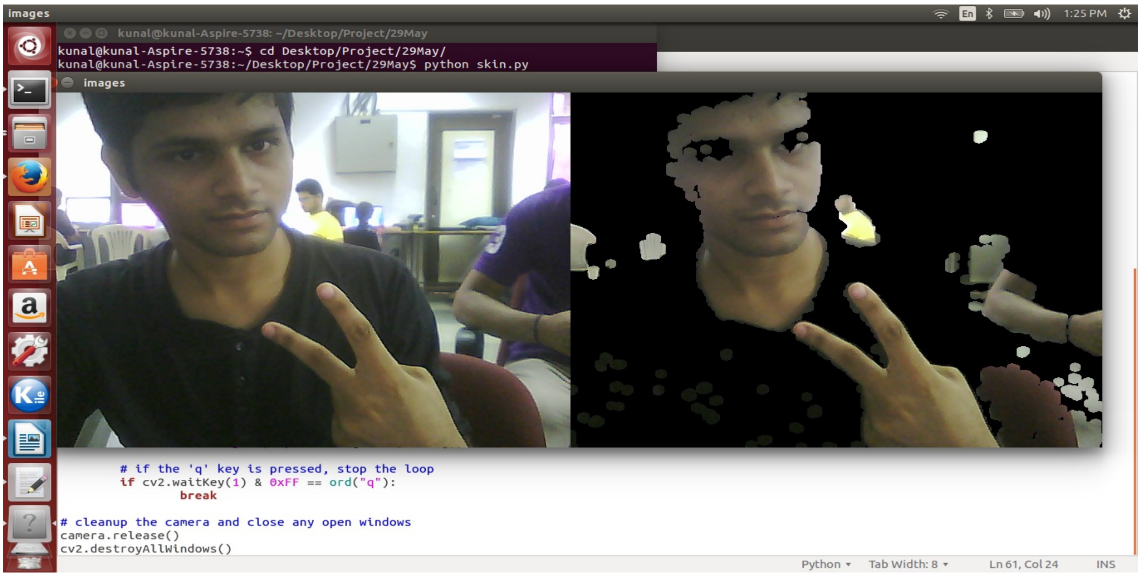
4.2 Skin Detection

Skin detection is the process of finding skin-colored pixels and regions in an image or a video. This process is typically used as a pre-processing step to find regions that potentially have human faces and limbs in images. Several computer vision approaches have been developed for skin detection. The skin detectors transform the given pixel into an appropriate color space and then use a skin classifier to label the pixel whether it is a skin or a non-skin pixel. A skin classifier defines a decision boundary of the skin color class in the color space based on a training database of skin-colored pixels.

Skin color and textures are important cues that people use consciously or unconsciously to infer variety of culture-related aspects about each other. Skin color and texture can be an indication of race, health, age, wealth, beauty, etc. However, such interpretations vary across cultures and across the history. In images and videos, skin color is an indication of the existence of humans in such media. Skin detection means detecting image pixels and regions that contain skin-tone color.

A Framework for Skin Detection Skin detection process has two phases: a training phase and a detection phase. Training a skin detector involves three basic steps:

- Collecting a database of skin patches from different images. Such a database typically contains skin-colored patches from a variety of people under different illumination conditions.
- Choosing a suitable color space.
- Learning the parameters of a skin classifier.Given a trained skin detector, identifying skin pixels in a given image or video frame involves:
  - Converting the image into the same color space that was used in the training phase.
  - Classifying each pixel using the skin classifier to either a skin or non-skin.
  - Typically post processing is needed using morphology to impose spatial homogeneity on the detected regions.



```
kunal@kunal-Aspire-5738:~$ cd Desktop/Project/29May/
kunal@kunal-Aspire-5738:~/Desktop/Project/29May$ python skin.py
```

```
        # if the 'q' key is pressed, stop the loop
        if cv2.waitKey(1) & 0xFF == ord("q"):
                break

# cleanup the camera and close any open windows
camera.release()
cv2.destroyAllWindows()
```

For More details, watch:
https://www.youtube.com/watch?v=HbqG1By2kas

4.3 Face & Eye Detection using Haar-based cascade classifiers

Object Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper, ”Rapid Object Detection, using a Boosted Cascade of Simple Features” in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. In this process, we basically need a lot of database of images. A database consisting if positive images (facial images) and another database of negative images (non-facial images). These databases are required specifically for training the classifier. The classification is a binary one (consist of two classes 1 (face) & 0 (non-face). After classifying it into two classes, we need to extract features from it. For this, Open CV provides lots of Haar features like edge, line, four-rectangle, etc. They basically go through the entire image, basically the matrix consisting of image pixels for the process of convolution. However, there are large numbers of features that are extracted. Using all the features will just eat up the processing time and memory. So, extra, unrequired features are eliminated using Adaboost technique.Now taking an image and applying all the necessary features on it to identify the facial position will just increase the time. To avoid this, features are applied one-by one after classifying them into groups of classifiers. This is called cascade classifying.OpenCV already contains many pre-trained classifiers for face, eyes, smile etc. Those XML files are stored in opencv/data/haarcascades/ folder. Let's create face and eye detector with OpenCV.

For more information:
http://docs.opencv.org/master/d7/d8b/tutorial_py_face_detection.html
https://realpython.com/blog/python/face-detection-in-python-using-a-webcam/

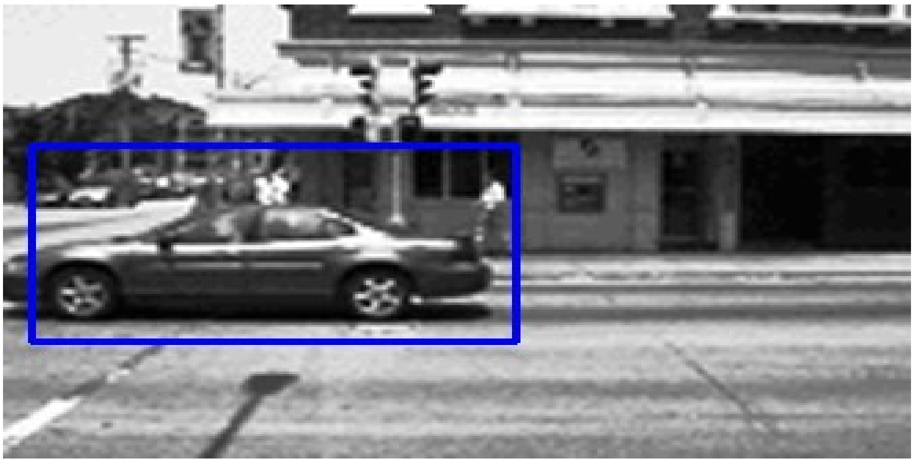
4.4 Car Detection (Training our own classifiers)

All the above based detection methods can be used for detecting different objects such as cars, etc. Here the same step follows except for the place where we were using already available cascade classifier file, here we will create our own cascade classifier. There are two applications in OpenCV to train cascade classifier:

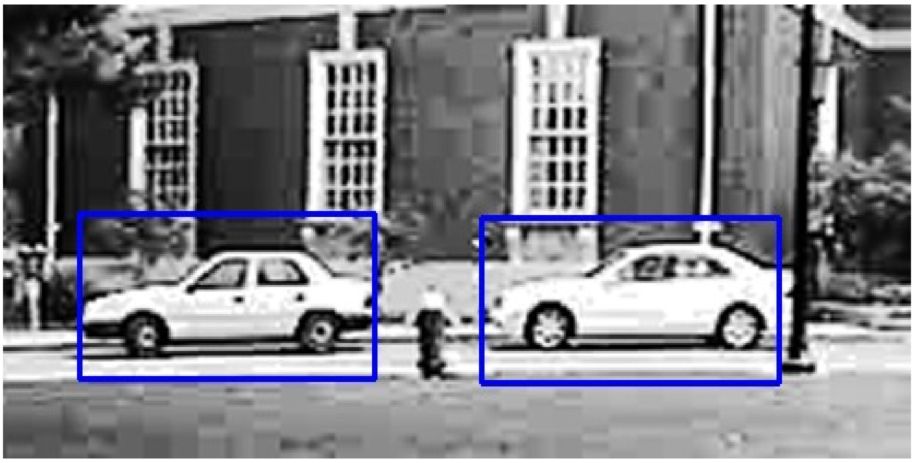
1. opencv_haartraining

2. opencv_traincascade.

The main difference between the two applications is that opencv_traincascade supports both Haar and LBP (Local Binary Patterns) features. LBP features are integer in contrast to Haar features, so both training and detection with LBP are several times faster than that with Haar features. Regarding the LBP and Haar detection quality, it depends on training: the quality of training dataset first of all and training parameters too. It's possible to train a LBP-based classifier that will provide almost the same quality as Haar-based one. Also there are some auxiliary utilities related to the training.opencv_createsamples is used to prepare a training dataset of positive and test samples. opencv_createsamples produces dataset of positive samples in a format that is supported by both opencv_haartraining and opencv_traincascade applications. The output is a file with *.vec extension, it is a binary format which contains images. opencv_performance may be used to evaluate the quality of classifiers, but for trained by opencv_haartraining only. It takes a collection of marked up images, runs the classifier and reports the performance, i.e. number of found objects, number of missed objects, number of false alarms and other information.

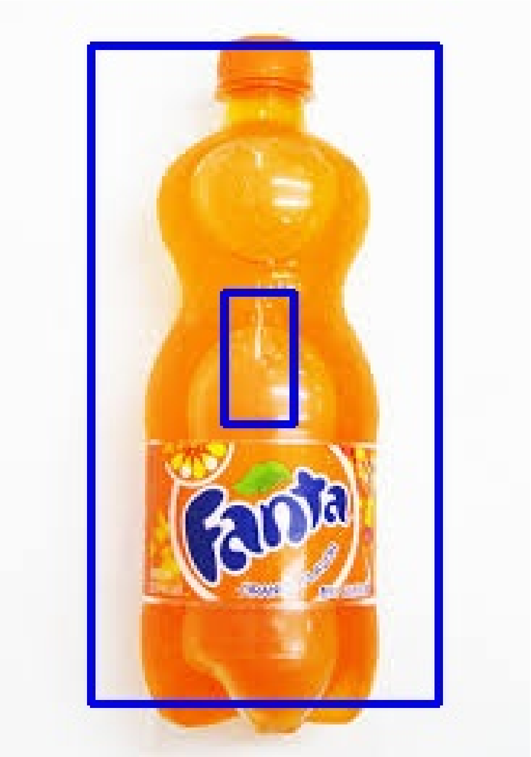


For car detection, we took almost 550 positive (car) images & 500 negative (non-car) images. The first step was to classify. It included creating an .info file containing information about the location, size, no. of cars in each of the positive image. We also created .txt file containing location of negative images. opencv_traincascade was used to train the samples. Initially, 6 stages were used (1 input, 1 output & 4 hidden layer). However the accuracy was less. Later, 18 stages were used (of course, with different weights). This increased the accuracy of the detection. The images used for training are called training data sets while that for checking the output are called testing data set.



4.5 Bottle Detection

The same process as that for car detection was used to detect soft drinks bottles like pepsi, coco-cola, Tupperware, mirinda, etc. However the accuracy was much less since we used only 20 positive images for training.



5 Face Recognition

5.1 Introduction

This particular task was performed as part of e-Yantra Summer Internship program, 2015. The task is to recognize a face. The complete program can be found at the git hub repository in the links given at the end of the document. The program takes the test image as a command line argument and returns the label corresponding to the given face and the level of confidence of detection. Note that the underlying theory and the working of the underlying algorithms involved in the face recognition process are not discussed. The functions provided by Opencv are directly used. For more details regarding the underlying algorithms, visit the links given in the reference section. The work of Bikramjot Singh Hanzra has been heavily used from his blog, "face recognition using python and opencv" thoughout the task.

The whole process can be divided in three major steps -

1. The first step is to find a good database of faces with multiple images for each induvidual.
2. The next step is to detect faces in the database images and use them to train the face recognizer.
3. The last step is to test the face recognizer to recognize faces it was trained for.

5.2 Face Database

We used Yale face database available for download from this link

http://vision.ucsd.edu/content/yale-face-database

It contains 165 grayscale images of 15 individuals in gif format, There are 11 images for each individual. In each image, the individual has a different facial expression like happy, sad, normal, surprised, sleepy etc. Indeed, there are 166 images with 12 images for the first individual.

We used this database by using 10 images of the total 11 images of each individual in training our face recognizer and the remaining single image of each individual to test our face recognition algorithm. The images corresponding to each individual are named like subject number. facial_expression where number ranges from 01, 02, 03. . . , 14, 15 and facial_expression is the expression that the individual has in the image. We did not use the image with .sad extension for training and used it for testing.

5.3 Detecting faces and training the recognizer

The first step is to detect the face in each image. Once, we get the region of interest containing the face in the image, we will use it for training the recognizer. For the purpose of face detection, we will use the Haar Cascade provided by OpenCV. The haar cascades that come with OpenCV are located in the /data/haarcascades¿ directory of your OpenCV installation. We will use haarcascade_frontalface_default.xml for detecting the face. So, we load the cascade using the cv2.CascadeClassifier function which takes the path to the cascade xml file.

```
face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')
```

Once the face detector is ready, we will use it to detect the faces from the database. These faces were added to a list and labels corresponding the face were added in a separate list. All faces of an indivisual were assigned the same label. To do this, a function is written get_training_set, which does the following:

1. Take input, the path of the folder containing the images.
2. Detect the faces from the database and add them to the list as separate images. Here, all faces but the ones with ·sad extension are added. .sad extension images are used as a testing set. So, it is not included in the training set.
3. Extract the label from the image name and add it to a separate list
4. Return both the lists to the calling program

```
def get_training_set(path):
    image_paths = [ os.path.join(path, f) for f in os.listdir(path) if not f.endswith(’
    images = [ ]
    labels = [ ]
    for image_path in image_paths:
    image_pil = Image.open(image_path).convert(’L’)
    image = np.array(image_pil, ’uint8’)
    label = int(os.path.split(image_path)[1].split(".")[0].replace("subject", ""))
    faces = face_cascade.detectMultiScale(image)
    for (x, y, w, h) in faces:
    images.append(image[ y: y + h, x: x + w] )
    labels.append(label)
    return images, labels
```

Once the training set (the list of images and the list of labels) was ready, the recognizer was trained. Opencv provides 3 face recognizers:

1. Eigenface face recognizer : createEigenFaceRecognizer()
2. Fisherface face recognizer : createFisherFaceRecoginzer()
3. Local Binary Pattern Histogram face recognizer : createLBPHFaceRecoginzer()

We used LBPH face recognizer for the task of face recognition.

face_recognizer = cv2.createLBPHFaceRecognizer()

The next task is to train the recognizer with the training set. We use the above defined function get_training_set to get the training set from the database.

images, labels = get_training_set(’./yalefaces/yalefaces’)

Then, by using this training set, we train the recognizer.

face_recognizer.train(images, np.array(labels))

5.4 Testing the recognizer to recognize faces

The trained recognizer is now tested using the test images. (images with .sad extension).

```
labelDetected, confidence = face_recognizer.predict(input_image)
```

labelDetected is the label corresponding to the detected image in the database. Confidence is the parameter specifying the accuracy level of the recognizer. A confidence level of 0 indicates that the face is recognized with 100

The input_image corresponds to only the face region of the image. This region can be extracted using the face_cascade declared earlier.

5.5 Personal notes

The above method was applied to a different database. 16 Images of Amir Khan were collected from the internet and a recognizer was trained to identify Amir khan's face. While testing the recognizer, the results were far less satisfactory since in most of the images in the database, the person was not looking into the camera and the alignment of the face and the position of eyes and mouth in all the images were not uniform. Also, the training set of images did not contain a wide range of emotions and majority of the images were of uniform emotions. (you can guess it! His old smiling face). So, the confidence level of detection was always above 150.

6 Integrating Height of a Person with LBPH based Facial Recognition.

6.1 Introduction

now, we have a handful experience with face recognition in OpenCV Python environment.We observed that accuracy of face detection is not highly reliable and it might make mistakes in detection and recognition of faces. This problem can be solved by integrating the height concept with the face recognition algorithm. We used Arduino and an Ultrasonic distance sensor to measure the height of the person and used this data to improve the accuracy of the system.

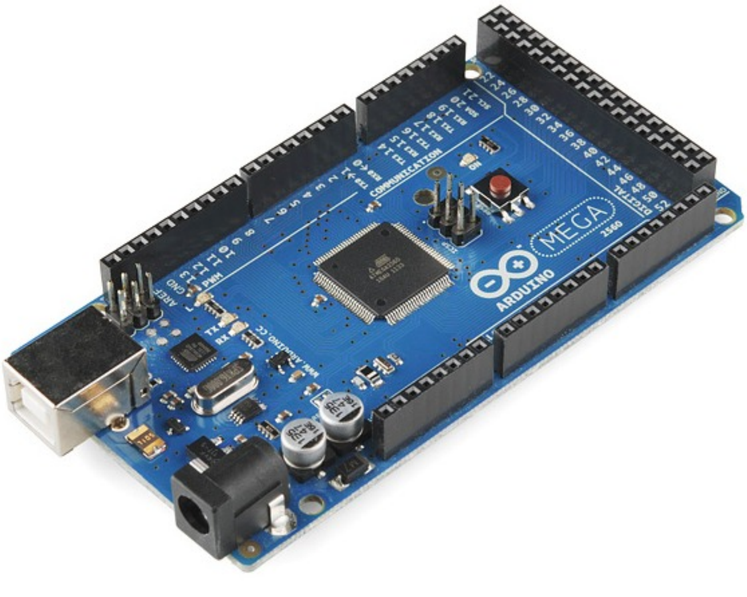
6.2 Arduino:

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

6.3 Arduino Mega (Atmega2560)

There is variety of Ardrinos available in the market. We finalised on using Aurdino Mega.



The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a DC source to get started. It even has an onboard voltage regulator. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

The Mega 2560 R3 also adds SDA and SCL pins next to the AREF. In addition, there are two new pins placed near the RESET pin. One is the IOREF that allow the shields to adapt to the voltage provided from the board. The other is a not connected and is reserved for future purposes. The Mega 2560 R3 works with all existing shields but can adapt to new shields which use these additional pins.

Features

1. ATmega2560 microcontroller
2. Input voltage - 7-12V
3. 54 Digital I/O Pins (14 PWM outputs)
4. 16 Analog Inputs
5. 256k Flash Memory
6. Clock Speed 16 MHz

Setup

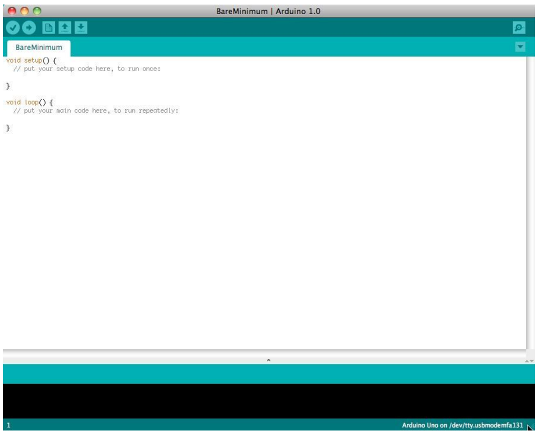
We will walk you through downloading, installing, and testing the Arduino software (also known as the Arduino IDE - short for Integrated Development Environment).

All our work was done on a Linux machine running the Ubuntu flavor. If you are a Linux user, you probably know that there are many different distribution 'flavors' of Linux out there. Unsurprisingly, installing Arduino is slightly different for many of these distributions. Luckily, the Arduino community has done an excellent job of providing instructions for most of the popular versions. Use the link below to learn more about installation of Arduino IDE on your system.
http://playground.arduino.cc/Learning/Linux

Writing your first application

After following the appropriate steps for your software install, we are now ready to test your first program with your Arduino board!

1. Launch the Arduino application. This is what You will see:


BareMinimum | Arduino 1.0
BareMinimum
1
Arduino Uno on /dev/tty.usbmodemfa131

```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

2. If you disconnected your board, plug it back in.

3. open the Blink example sketch by going to: File > Examples > 1.Basics > Blink

4. Select the type of Arduino board you're using: Tools > Board > your board type

5. Select the serial port that your Arduino is attached to: Tools > Port > xxxxxx (it'll probably look something like "/dev/tty.usbmodemfd131" or "/dev/tty.usbserial-131" but probably with a different number)

6. If you're not sure which serial device is your Arduino, take a look at the available ports, then unplug your Arduino and look again. The one that disappeared is your Arduino

7. With your Arduino board connected and the Blink sketch open, press the 'Upload' button

8. After a second, you should see some LEDs flashing on your Arduino(these are the RX and the TX LED's), followed by the message 'Done Uploading' in the status bar of the Blink sketch.

9. If everything worked, the on board LED on your Arduino should now be blinking! You just programmed your first Arduino!

Troubleshooting

Arduino Playground Linux section is a great resource for figuring out any problems with your Arduino installation. It is common that you may face some problems while uploading the code. Make sure that the USB cable is good. (We had problem uploading the code and we tried a hundred different things to get it working but finally found that the problem was with the USB cable). Select the right port and the board from the tools menu. Make sure that the port selected is not in use by any other application.

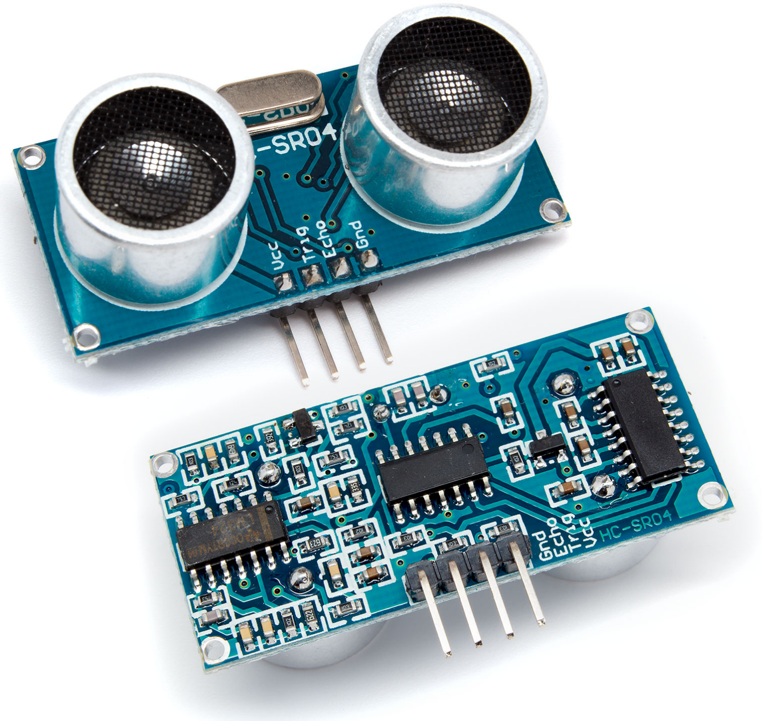
6.4 Ultrasonic Sensor

Introduction

HC-SR04 Ultrasonic Sensor is a very affordable proximity/distance sensor that has been used mainly for object avoidance in various robotics projects . It essentially gives your Arduino eyes / spacial awareness and can prevent your robot from crashing or falling off a table. It has also been used in turret applications, water level sensing, and even as a parking sensor. This simple project will use the HC-SR04 sensor with an Arduino and a Processing sketch to provide a neat little interactive display on your computer screen.

We used HC SR04 Ultrasonic module for height calculation. One can download the documentation from the official site:

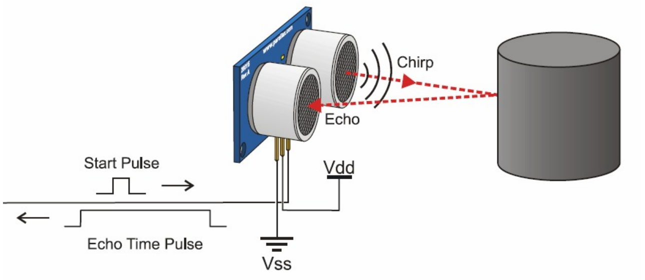
http://www.micropik.com/PDF/HCSR04.pdf



Working of the sensor

ULTRASONIC pulse travels with the speed of sound that is, 340·29 m/s. An ultrasonic sensor like the one we used in our project consists of an emitter and a receiver of ultrasonic sound waves. (Ultrasonic sound waves have a high frequency that humans cannot hear). The emitter emits ultrasonic sound waves. These sound waves travel in air, hit the object and reflect from its surface. The reflected waves are received by the receiver after some time. This time corresponds to the time the waves take to travel from the emitter to the object and from the object to the emitter after being reflected.

The microcontroller (in our case, the Arduino) keeps track of this time, i, e, the time it takes for the receiver to receive after the emitter has sent out the waves. Knowing this time, the microcontroller is programmed to calculate the distance of the object since the speed of the waves is known. (340·29 m/s). The simple formule distance = speed * time is used.



Interfacing the sensor with the Arduino

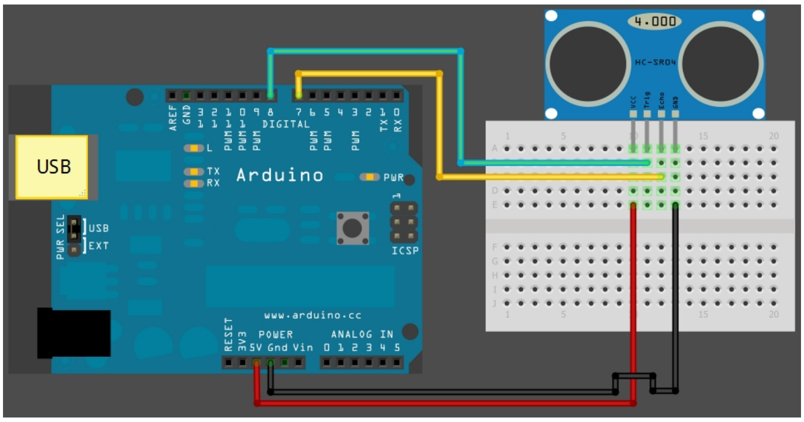
The sensor consists of 4 pins. The connections are listed below:

1. Vcc————————connect to 5V dc

2. Trigger——————pulse input that triggers the emitter.

3. Echo————————this pin indicates the reception of the echo.
4. Gnd————————–ground

The trigger pin and the echo pin can be connected to any of the GPIO pins of the Arduino. In our case, we conneced the trigger pin to pin 8 and the echo pin to pin 7 of the Arduino. If you are using the code provided below, then make the same connections. Or you can also redefine the trigPin and the echoPin according to the connections you make.



Arduino code

```
#define trigPin 13
#define echoPin 12

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  pinMode(trigPin, INPUT);
  pinMode(echoPin, OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
}

int getDistance()
{
  long duration;
  int distance;

  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  duration = pulseIn(echoPin, HIGH);
  distance = (duration/2)/29.1;

  return distance;
}

void serialEvent() {
  if (Serial.available()) {
    char temp = Serial.read();
    if(temp == ’s’)
    {
        Serial.println(getDistance());
    }
  }
}
```

7 GUI and the final system assembly

After Developing code for face detection and recognition and also an arduino code for height calculation, we moved to develop a final gui which can provide an easy interface and help view the results of recognition and the logs in an easy graphical wasy.

Python Supports variety of libraries to design a GUI. After some research, we found the following best for designing GUI for our application

7.1 Different options for creating GUI

Kivy

One of the more interesting projects, the liberal MIT-licensed Kivy is based on OPENGL CS 2 and includes native multi-touch for each platform and Android/iOS. It's an event-driven framework based around a main loop, and is thus very suitable for game development Your application adds callbacks from the main loop at a scheduled frequency, or by one-off trigger. The Kivy framework is very powerful for handling everything from widgets to animation, and includes its own language for describing user interface and interactions. If you want to create cross-platform graphical applications, or just need a very powerful cross-platform GUI, Kivy is highly recommended.

PyQt

Qt is a multi-licensed cross-platform framework written in C++. If your application is completely open source, you can use Qt for free under the community license; otherwise you'll need a commercial license. Qt has been around for a long time and was owned by Nokia for a while; it's a very comprehensive library of tools and APIs, widely used in many industries, and covers many platforms including mobile. If a gadget such as a SatNav has a GUI, there's a good chance it'll be Qt based.
We have used PyQt framework to run the GUI in our system.

PyGUI

Compared to Kivy and PyQt, PyGUI is considerably simpler and just for Unix, Macintosh and Windows platforms. Developed by Dr. Greg Ewing at the University of Canterbury in New Zealand, the MVC framework focuses on fitting into the Python ecosystem as easily as possible. One of the platform's aims is to interpose as little code as possible between the Python application and the platform's underlying GUI so the application's display always reflects the native GUI of the platform. If you're after a simple and quick way to learn GUI, start with this one.

libavg

This is another third-party library, written in C++ and scripted from Python, with properties of display elements as Python variables, a full-featured event handling system, timers (setTimeout, setInterval), support for logging and more. Like Kivy, libavg uses OpenGL and makes use of hardware acceleration. Libavg runs on Linux, Mac OS X and Windows, and is open source and licensed under the LGPL. It's been used extensively for artistic exhibitions and has a wide range of features such as a layout engine that can deal with thousands of objects (images, text, videos and camera output), fast video output, and a markup system for displaying text, as well as GPU shader effects such as blur, Chromakery and more. Plugins written in C++ have access to all libavg internals. If you ever see many people playing a multi-touch game on a large flat display, you might be looking at a good example of libavg in action.

wxPython

There have already been two books written about wxPython, making it worth a mention even if it isn't quite ready for Python 3. WxPython is based on wxWidgets, a cross-platform GUI library written in C++. In addition to the standard dialogs, it includes a 2D path drawing API, dockable windows, support for many file formats and both text-editing and word-processing widgets. There's a great set of demos provided with wxPython, along with several sets of tutorials to help get you started. Given that wxWidgets has a 22-year development pedigree, this is one of the most popular frameworks. Make sure you read the wikipedia. This is a great set of frameworks that should cover most needs. However, we selected PyQt4, the latest version of PyQt for developing GUI for attendance System.

7.2 Using PyQt

Creating an application in PyQT4 may be done in a few ways. The most common one is to use QTDesigner, which we get with QT. QTDesigner is a drag and drop tool that lets us design the GUI which is very handy for complicated interfaces. We can place widgets on the window, add names etc. To create an application in PyQT4, the following steps need to be followed.

1. Download the PyQt4 package. Use the following command:
   sudo apt-get install pyqt4-dev-tools

2. Download QTDesigner. This can be found on the Ubuntu software centre.

3. Create the GUI in QTDesigner. This is just a drag and drop job.

4. Set proper names for each widget in the property editor.This is important to code easily.

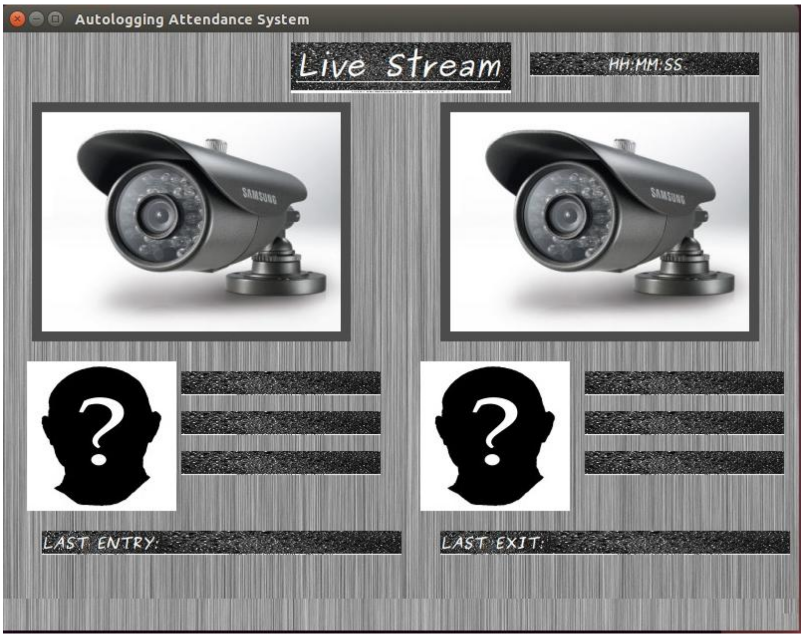
5. Save the design. The file will be saved as .ui file. If you open this file in an editor, you'll notice that is is just an xml file.

6. Using pyuic4 create the python GUI class. Use the following command to do this:
   pyuic4 filename·ui >outputFileName·py

7. Instanciate this GUI class and call the application from within this class.

8. You will need to use a timer to update the GUI continuously as the application runs.

The GUI we created looks like the one shown below.



7.3 The System assembled

The application creates three different recognizers, each recognizer trained on a different set of database. The database is divided into three sets based on the heights of the indivisiuals. First set consists of indivisuals whose height is less than 125 cm. Second set consists of indivisuals whose height is between 125 and 135 cm and the third set consists of indivisuals whose height is greater than 135 cm. The heights are as measured by the ultrasonic sensor.
The Gui displays continuous video stream taken from the Entrance and Exit. The stream is a live stream. The application runs face detection on the frames captured from the stream. If a face is detected, the application requests the Arduino to send the height value via the serial terminal. Depending on the height reading returned by the arduino, the correspoding face recognizer is called and the detected face is given as an input to that face recognizer. The image of the recognized person is displayed below the stream along with the name, entry/exit time and an ID. The same information is also logged in the excel workbook. This book consists of a sheet for each day, with the name of the sheet being the date.
If an unknown person is recognized, then the image of the person is captured and stored in a separate folder along with the time stamp so that the authorized person can know about it later.
The initial implementation was without the use of thread. In this case, the livestream was slow and somewhat non continuous. This is because the sequence of events were as follows:

- Capture a frames
- Display it on the GUI
- Run the face detection algorithm on the frames
- If face is found, then run the face recognition algorithm on the detected face
- Capture the next frame and repeat the cycle

The processing between the capturing of two different frames took enough time to make the video look slow. So, threads were created to do the backend work, while in the front end, continuous frames were being captured and displayed. The sequence of events with the use of threads is as follows:

- Capture a frame
- Display it on the screen
- If a thead is already running in the background, do not use this frame for processing and capture the next frame
- If there is no thread running in the background, create a thread and run the detection and recognition algorithm on this frame in the background.

We maintained only a single thread at a time. Once the thread finished processing on the frame, then that thread died and the next thread was created. You can maintain more than one thread to achieve speed but you will have to be careful about the global variables accessed by the threads. Proper data locking mechanisms should be used in that case to protect shared data.

8 Challanges faced

1. The database must be highly accurate and the expressions must be of same amenity for different person. Eg all the person must wink their left or right eye only. Mixture of both will not be considered accurate.

2. The training of the database involves lots of mathematics and deep understanding of wide variety of algorithms ranging from principal component analysis through machine learning upto neural networks and wavelet designs. Understanding algorithms and deciding which one to use is a challenging task.

3. The training of database involves training them through various layers called hidden layers with different weights. We trained upto 38 stages which took almost 7 to 8 hours. Still the accuracy was not as high as expected.

4. The accuracy with just image processing was not as high as expected and the results were with some error. However this error was reduced greatly using height integration. It can be further reduced by integrating weight.

5. Designing GUI from a wide range of available Python libraries was challenging since none of the library supported direct video streaming. So we started saving images with 30fps and then reading them into the GUI. Thus using persistence of vision concept to make those images being viewed as a continuous video.

9 Future scope for improvements

1. We can add the data of newly joined employee in the database with the click of a button without having to make any changes in the code.

2. An android app can be created so as to ensure all the employees to check whether their attendance is marked or not.

3. We can even add an LCD display below the camera were a person can see his/her name or ID when detected and recognized.

4. We can even make a sophisticated system where the door of the room automatically opens or closes on detection of the person, making it smart room or smart office.

10 Potential applications

1. As we said, this kind of Image processing for facial recognition can be used for auto logging attendance system in colleges. Since Our colleges have lectures of 1hr of which quarter time is wasted in taking attendance

2. Not only in the case of human, this concept can be expanded to detect different objects and perform processing operations on them. For example, one can use this for auto car parking by detecting cars and classifying empty slots. This can even be used to find the traffic on the sides of highways or roads and clear them by giving larger waiting times to path with lesser commuters.

3. The human face recognition system can be used at public places like railway stations to detect criminals and locate their path. This can be useful for surveillance purpose.

11 References

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