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RESEARCH ARTICLE

COMPARATIVE ANALYSIS OF FACE RECOGNITION ALGORITHMS FOR HOME SURVEILLANCE USING OPENCV: AN ANALYTICAL REVIEW

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Abstract

Proposing a security system for surveillance of home alone children for safety purpose and send an alert to the register mobile number if some kind of intrusion is detected. I have used Viola-Jones algorithm to detect human face from the live camera and then frame is resized then resized image is processed by the Local Binary Pattern Histograms (LBPH) algorithm and save the model in a YML file and then it is implemented on live cam feed in which the algorithm will detect the face and if some unknown face has been identified it will trigger a notification to the registered mobile number using a python library named [Pywhatkit] so the user can perform security measures.

Keywords: Face recognition, Open-CV, HAAR cascade, face recognition.

Introduction

OpenCV – Open computer vision is a library which is used for this project due to its computational efficiency. OpenCV has a strong focus on real-time applications.

Main objective of this project is to keep an eye on our small child when he/she is alone at home,

for that purpose we need to train our model with the particular face and then in live video recognize the face and if some unknown face is detected in the camera then security alert is triggered by sending a message to the registered mobile number via a python library Pywhatkit, for recognizing a face in a live camera feed or in an image/a video is divided in two parts first of them is to detect a face and then our

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model will recognize it. For finding a better face detection technique (as faces cannot be recognized unless we detect them). I have studied various face detection techniques:

1. HAAR Cascade
2. Face detection using face_detection library
3. MTCN

1. HAAR Cascade – It is a cascade classifier whose approach is based upon the machine learning as it is trained with lots of positive and negative images and then we will extract features from it by subtracting a pixel which have no image from the pixel which have the image (edge and line detection), for selection of the best features Adaboost is used. After applying all the features on the training images. Threshold has been found for each feature which will classify positive and negative images.

Find the features which have minimum error rate, as because these are the features the most accurately for detection of face-images and non-face images.

Tried different versions, after this concluded that HAAR cascade is generally good for nearer faces, “haarcascade_frontalface_default.xml” can detect at a distances of >5m when subject is cooperating.

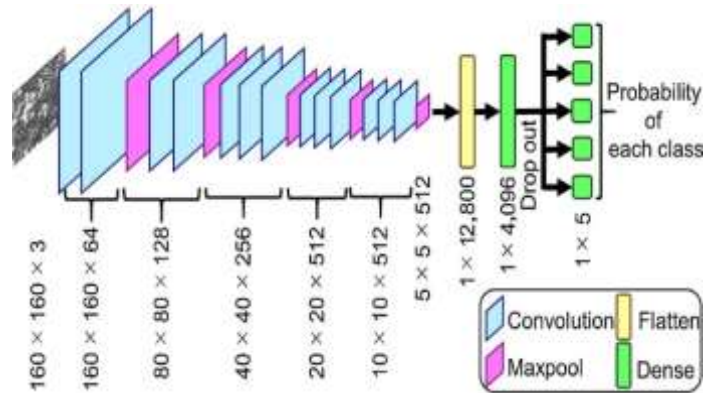
Face detection library

I – DSFD - Dual shot face detection is an open source face detection algorithm that offers higher accuracy than any other detection technique. It is able to detect faces at every angle (even the farthest, smallest, obstructed, side, partial) and distance. In 2018 it is ranked as first in WIDER FACE detection benchmark. There are three key areas of facial detection in this algorithm:

- 1) Feature learning
- 2) Progressive loss design
- 3) Anchor assign based Data augmentation

II – RetinaResNet50 – ResNet is an acronym for Residual Network introduced in 2015, It has many variants that runs in same concept but have different number of layers here ResNet50 is similar to the above described ResNet just the difference is about the number of network layers as it is described in the name itself it contains 50 network layers.

ResNet50 architecture is based upon the ResNet34 architecture. It has a 3 bottleneck block, this architecture provides higher accuracy and lesser training time than other variants of ResNet.



III – RetinaNetMobileNetV1 – This algorithm is also a variant of the RetinaNet. It can detect to a distance of 5-8 meter but it has a low detection on farther faces and I found this model to be most promising for my work as this algorithm provide an acceptable accuracy and it also provides the speed which is a must in this project.

MTCNN – (Multi Task Convolutional Neural Network)

Face alignment is one of the most common issue which is faced in face detection here MTCNN comes in and act as a solution to this problem. It is a three stage convolutional network:

In order to build an image pyramid, take images and resize them to different sizes which act as input of the below 3 staged cascade network.

Stage 1: (P-NET) the Proposal Network is used to obtain bounding box regression vectors and to obtain candidate windows. This stage is a FCN which is an

acronym of fully convolutional network. The difference between FCN and CNN is that a FCN doesn't use a dense layer as part of the architecture.

Stage 2: (R-NET) the Refine Network

Output from the P-Net fed to the R-Net. This is a CNN hence architecture contains a dense layer at the last stage. Calibration has been performed this network using bounding box regression, to merge overlapping candidates non-maximum suppression (NMS) has been employed, hence number of candidates has been further reduced by R-Net.

Stage 3 (O-NET) the Output Network

Aim of this network is describing the face details and show output, five main features of face like eye, nose and mouth, O-Net is similar to the R-Net but with an aim to give output.

Proposed Model

Main modules which have been used are:

1) Dataset Generation:

Creating the dataset is the very first step for this project; dataset creation involved collecting 30 images of each person and save them with unique id.

Attribute used here is a unique ID which is created by at the time of taking images. This ID is used later to identify the images in live camera feed.

2) Pre-processing:

Two main steps are involved in this step:

a) Face detection is used by using Viola – Jones algorithm.

b) After detection of the images, the size has been matched with a predefined size.

3) Extraction of features:

LBP histogram algorithm is used because it is accurate and it is less complex and it can process the data in real-time. Efficiency is also a reason due to which LBP is much efficient than other algorithms.



LBPH working (Local Binary Pattern Histogram):

The simple idea behind the Local Binary Patterns is, this idea can be stated as each pixel has been labeled via thresholding each neighborhood pixel and provide a binary number as a result. The main objective of LBP:

Take a pixel as center and threshold its neighbors against that center.

Division of the LBP image into local regions. We can get part of this image as a 3x3 pixels which containing intensity from 0~255 and then take a threshold value and change the intensity values to 1 if intensity value is greater than the threshold value or else 0.

A histogram has been extracted from each region.

- These are called Local Binary pattern Histogram.

- 1) Recognition:

Use of these histograms in detection as follows:

- Input a new face in the recognizer to get recognized.
- After recognition, recognizer generates a histogram for that image.
- New histogram is compared to the already created histograms.
- As a result the name of the person has been showed up with id of that person which is attached to that image.

2) Verification Step:

Instead of sending a message for every unknown face, we can send an image to the receiver and ask him/her to recognize the face:

- If; face is recognizable than add that to the database and train the model again.
- Else; if the person is unknown suggest the owner to take action.

Pywhatkit:

Pywhatkit is a python library which is used in this project to send an alert as a WhatsApp message to the register mobile number because no one can ignore the WhatsApp message now a days and it is also a convenient way to act in a case of emergency.

We can also use Twilio which is an online server used to send text messages to any number by having a twilio account.

Some Features of Pywhatkit:

- Sending Message to a group or person.
- Sending Image
- Play YouTube videos

Instead of sending a message for every unknown face, we can send an image to the receiver and ask him/her to recognize the face:

- If face is recognizable than add that to the database and train the model again.
- Else; the person is notified and suggested to

<u>Algorithm Name / Criteria-></u>	Speed of detection	Detection of faces at angles	Detect faces at distances
HAAR cascade	~1.15 fps	Top, Side	5 meter
Face detection-DSFD (Dual Shot face Detection)	[Unable to run on the CPU]	Detection at every angle	Detect all faces in frame
Face detection –RetinaResNet50	~0.4 fps to ~1.5 fps	Detection at every angle	8-10 meter
Face detection – RetinaNetMobileNetV1	~3.2 fps to ~5.3 fps	Detection at every angle	5-8 meter (low on farther faces)
MTCNN	~3.8 fps	Unable to detect side faces	Detect Front face in large distances.

take action.

Conclusion:

- After researching about various face detection techniques and trying most of them it has been concluded that:
- RetinaNetMobileNetV1 is the most suitable algorithm which can be used in our project. Dual Shot Face Detector gives maximum detection but it very slow and it needs high specifications computer.MTCNN gave good results but it lacks in top and side angles of face detection which is a must in our project. Due to lack of a good specifications laptop/system unable to implement them all but tried this algorithm with HAAR classifier and get the result as expected.

Comparison Table:

- Here is a comparison table of all the studied algorithms, comparison have been made on

some parameters which are described in the table.

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