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Real Time Face Detection using Haar Cascade Classifier Algorithm

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***Abstract* - In biometrics research, face detection and recognition from an image or video is a hot topic. Due to the enormous market potential and application value of face recognition technology, such as in real-time video surveillance systems, it has garnered a lot of attention. Face recognition has a significant impact on surveillance systems, it is widely acknowledged, because it doesn't require object cooperation. Using Python and OpenCV programming, we create a real-time face recognition system based on IP cameras and an image set algorithm. The system is composed of three modules: detection, training, and recognition.**

Keywords: OpenCV, Machine Learning.

I. INTRODUCTION

Machine learning is a growing area of computational algorithms that seek to pretend human intelligence by learning from their surroundings. A person can be recognised from a video or photo source using face detection and recognition technology. Using what is known as a RAND tablet, which allowed users to input horizontal and vertical coordinates on a grid using a stylus that produced electromagnetic pulses, Bledsoe created a device that could manually classify photographs of faces. Since that time, the recognition system has undergone continuous improvement and optimization, and as technology matures, it is increasingly utilised in everyday life. Law enforcement and military personnel have increasingly used it for forensics.

In fact a facial recognition system was employed to help confirm his identity. For device security, the face recognition system is also being used more frequently in mobile devices. In this paper, we propose a Python-based OpenCV-based face detection and recognition system the three modules that make up this system are detection, training, and recognition. In essence, the detection module recognises a face that enters the camera's field of view and saves it as an image in JPG format. The system is then trained using the Haar cascade algorithm, which Paul Viola and Michael-Jones proposed in there paper. There are four steps in this process.

II. IMPLEMENTATION

Paul Viola and Michael Jones in their 2001 paper "Rapid Object Detection using a Boosted Cascade of Simple Features" proposed an efficient object detection technique that uses Haar feature-based cascade classifiers. Using machine learning, a cascade function is trained using a large number of both positive and negative images. The next step is to use it to find objects in other pictures.

In this case, face detection will be used. The algorithm initially needs a lot of both positive and negative examples to train the classifier. Then we need to extract features from it. This makes use of the har features from the image below. They precisely resemble our convolutional kernel. The sum of the pixels under the white and black rectangles is subtracted to yield a single value for each feature.

III. HAAR CASCADE

In the 2001 paper "Rapid Object Detection using a Boosted Cascade of Simple Features," Paul Viola and Michael Jones proposed the concept of features that the Haar Cascade body object detection algorithm is based on. The algorithm is used to identify objects in an image or video.

Using ML, a cascade function is a trained using a large number of both +ve and -ve images.

The next step is to use it to find objects in other pictures. There are four phases to the algorithm: Haar Feature Selection

1. Creating Integral pictures
2. Adaboost Instruction
3. Cascades the Classifier

Although it is best way for its ability to recognize faces and body-parts in pictures, it can be trained to recognise the objects.

Take face detection as an illustration. To train the classifier, the algorithm initially requires a large number of positive images of faces and negative images without faces. After that, we must draw features from it.

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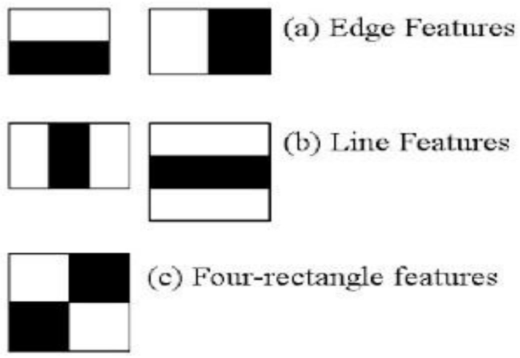
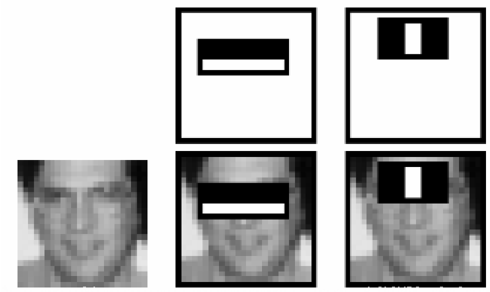
The Haar Features must be gathered in the first step. An adjacent rectangular region in a detection window is taken into account by a Haar feature, which then calculates the difference between the sums of the pixel intensities in each region.



This is made possible by the use of Integral Images.

However, the majority of the features we calculated are irrelevant considering the illustration below. The top row includes two noteworthy features. The first characteristic seems to emphasise how frequently the area around the eyes is darker than the region around the nose and cheeks. The eyes' darker hue than the nose's bridge was chosen as the second distinguishing characteristic. However, using the same windows on the cheeks or any other part of the body is pointless.



How then do we choose the best features from the 160000+ features available? Adaboost, a theory that both chooses the best features and trains the classifiers that use them, is used to achieve this. By linearly combining weighted, straightforward "weak" classifiers, this algorithm creates a "strong" classifier. Here is how it works.

During the detection stage, a window with the target size is moved over the input image, and Haar features are computed for each section of the image. In the video down below, you can see this in action. Then, this difference is contrasted with a learned threshold that distinguishes between objects and non-objects. Since each Haar feature is only a "weak classifier" (its detection quality is barely better than random guessing), many Haar features must be combined into cascade classifiers in order to create a strong classifier that can accurately describe objects.

Haar Feature Selection

The Haar Features must be gathered in the first step. An adjacent rectangular region in a detection window is taken into account by a Haar feature, which then calculates the difference between the sums of the pixel intensities in each region.

Creating Integral Images

This process is made quick by using integral images. The vast majority of the calculated features are useless.

Adaboost Training

Adaboost is a theory that both chooses the best features and trains the classifiers. By linearly combining weighted simple weak classifiers, this algorithm creates a strong classifier.

Cascading Classifiers

The cascade classifier has several stages, each of which consists of a collection of weak learners. Decision stumps are straightforward classifiers that are weak learners. The technique known as boosting is used to train each stage. By using the weight and average of the decisions made by the weak learners, boosting enables the training of a highly accurate classifier.

The principal components of the face from the new videos lastly unzipped in the recognition module. The features with the match are then found and the name of the thing being recognised is displayed after they have been compared to the list of elements stored during training. This monitoring the system satisfies the fundamental requirements of a face detection and recognition system while also taking into account costs to make the pervasive mode as affordable as possible. It can also be used in conjunction with real-time analysis algorithms.

IV. EXISTING SYSTEMS

A. Linear Discriminative Analysis

Finding a linear combination of features that distinguish or characterize two or more classes of objects or events is done using the LDA method. The resulting can be used to produce a linear classifier. In computerized face recognition, a large number of pixels are used to represent the face. Earlier than classification In order to simplify and reduce the number of features, linear discriminant analysis is used. A template for

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new dimensions is created by a linear combination of pixel values.

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A mathematical technique called PCA is used to reduce the number of potentially correlated variables into a greater number of uncorrelated variables called principal components. The first principal components, explain the variability in the data, and subsequent principal components explain additional variability. PCA is the most popular tool for making predicted models and conducting explaratory data-analysis. PCA is used to calculate the one value decompositions of a data matrix. PCA facilitates the eigenvector-based multivariate analysis. By exposing the data's internal structure, which is thought to be one of the key operations, the variance in the data can be best explained. A lower-dimensional image is provided if a multi-variations dataset is represented as a set of coordinates the data space (one- axis / variable).

Advantages:

- Easy to built& Low cost.
- Can travel in any direction.
- Full duplex communication between controller & robotic module.
- Range measurement helps in accurate firing on targets.

Disadvantages:

- The target may miss if the timing between detection and firing is improper.

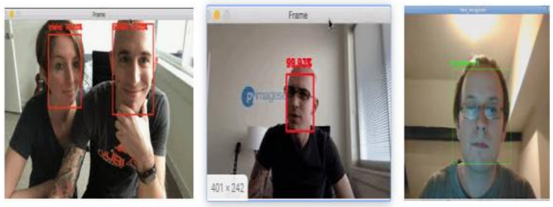
V. SCOPE

This could eventually extend to products. We need to make this project cost-effective and compact in order to make it as durable and user-friendly as possible. Further, with advancements in technology, the majority of the units can be embedded alongside the controller on a single board, shrinking the system's overall size.

VI. CONCLUSION

In this study, we use opencv to create a system for face-detection and recognisation. It is utilised to find and identify human faces. The datasets that are defined and trained prior to recognition are images of people.

For detection, the Haar cascade algorithm is used.



Small features can be improved to enable better face detection and recognition. As technology develops, more sophisticated features will be added to the system in the future.

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