



Survey of Robust Object Detection

Munther Abualkibash, Ahmed El-Sayed, Ausif Mahmood
Department of Computer Science and Engineering
University of Bridgeport, Bridgeport, CT
{mabualki, aelsayed, mahmood}@bridgeport.edu

Abstract

This poster presents a well known object detection technique, which has been used for long time.

Viola-Jones approach, is a real time object detection algorithm, which is mostly used for face detection.

In Viola-Jones algorithm there are three main contributions:

First, inventing a new technique for features computation, which is called Integral Image.

Second, using Adaboost learning algorithm to build complex classifier from simple ones.

Third, design complex classifier from a strong classifiers, produced from the learning algorithms, by using cascade structure in order.

The main goal of our work, is to implement Viola-Jones approach using Matlab and C# programming language, then enhance it by using parallel programming techniques which are supported by .NET framework under this name:

Task Parallel Library (TPL).

Features

The following figure represents the feature types used by Viola-Jones technique.

To get the value of each feature, subtract the sum of pixels in the white area of the rectangle from the black area of the same rectangle.

The total no. of features over 24X24 image is 160,000 feature, which is much greater than the total number of pixels.

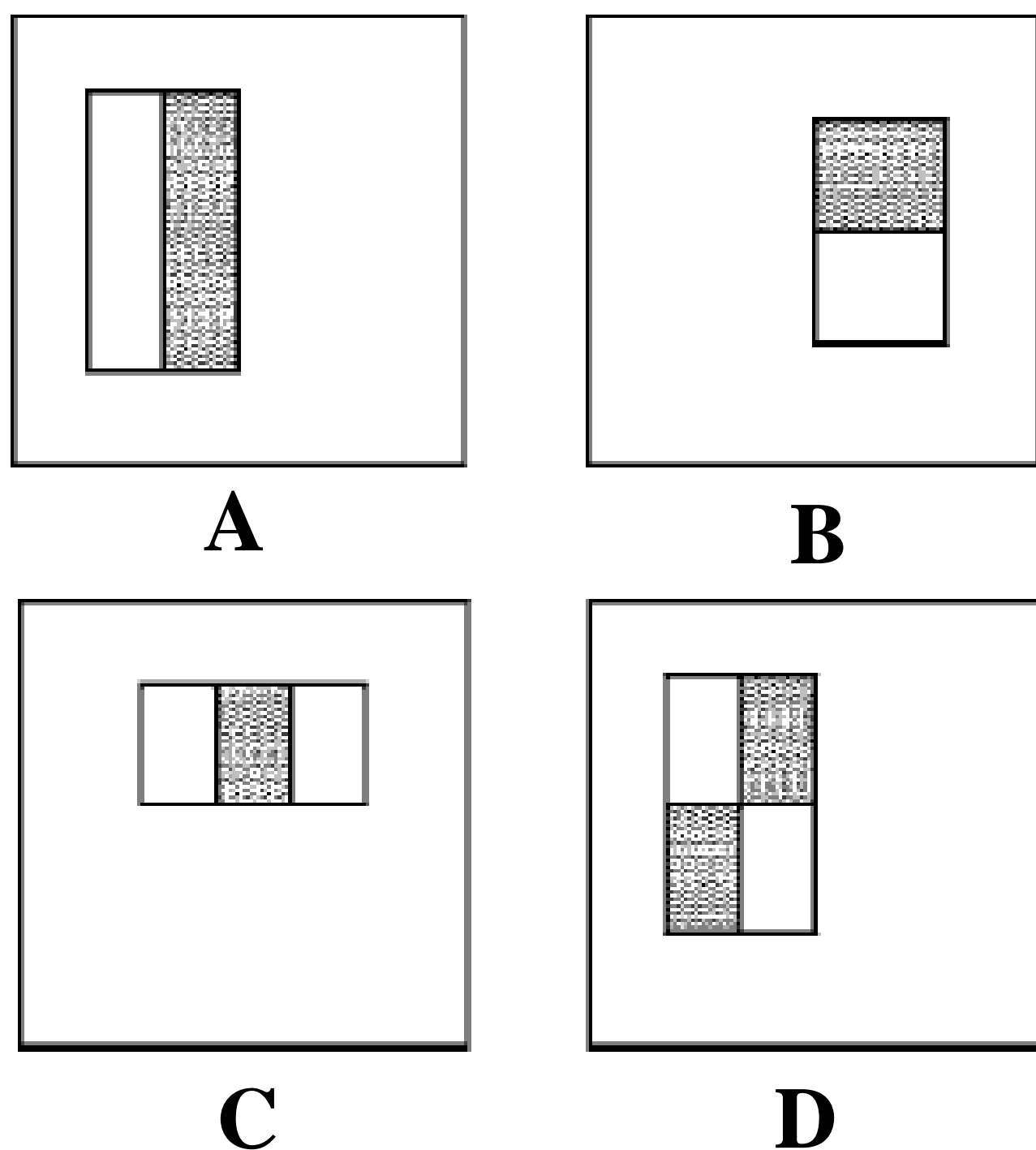


Figure 1. Feature types used by Viola-Jones

Integral Image

The value of the integral image at point (x, y) is the sum of all the pixels above and to the left.

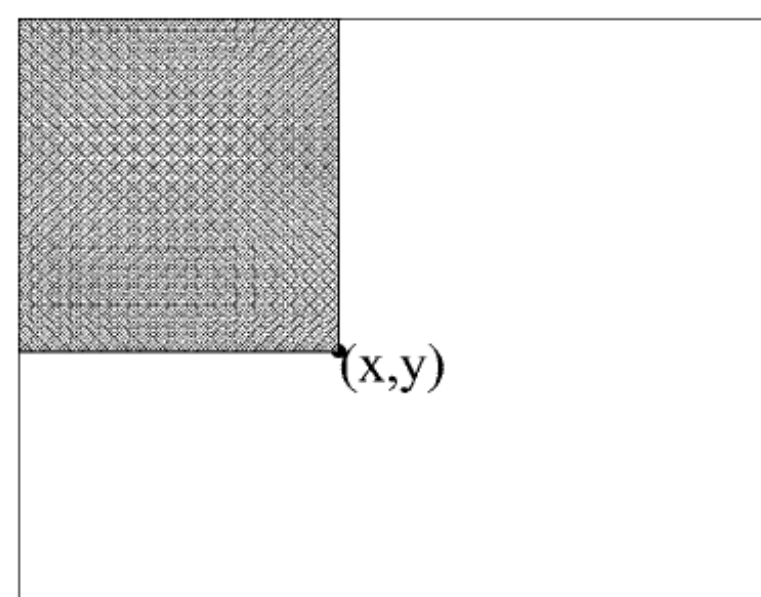


Figure 2. Example of the value of (x,y) pixels

The following figure explains how to calculate integral image at each location:

1 = sum of the pixels in rectangle A.

2 = A + B.

3 = A + C.

4 = A + B + C + D.

As a result, D can be computed as $4 + 1 - (2 + 3)$.

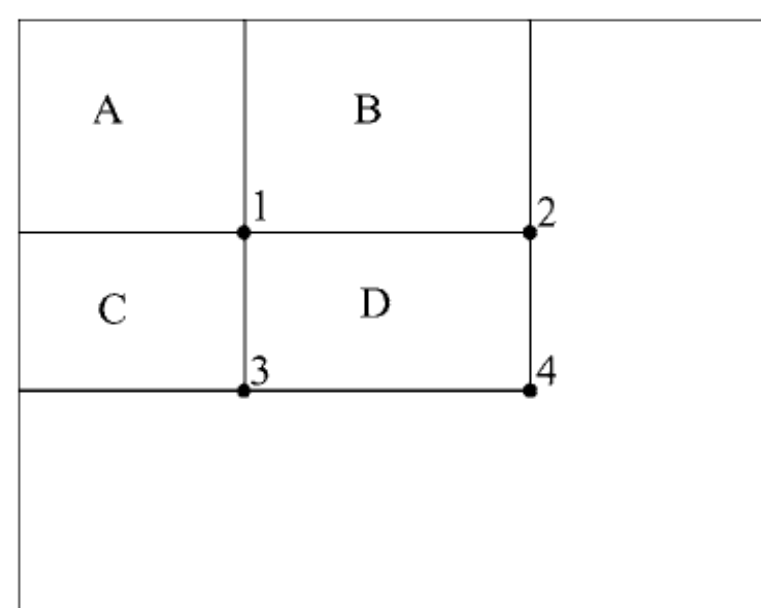


Figure 3. Example of how to calculate integral image.

Adaboost learning algorithm

By having a feature and training set of positive and negative images, there will be a huge number of features which is going to be a big challenge for Adaboost algorithm to select the best features with the minimum error percentage.

A Cascade of Classifiers

Combining successively more complex classifiers in a cascade structure, will lead to a classifier more accurate than a single one.

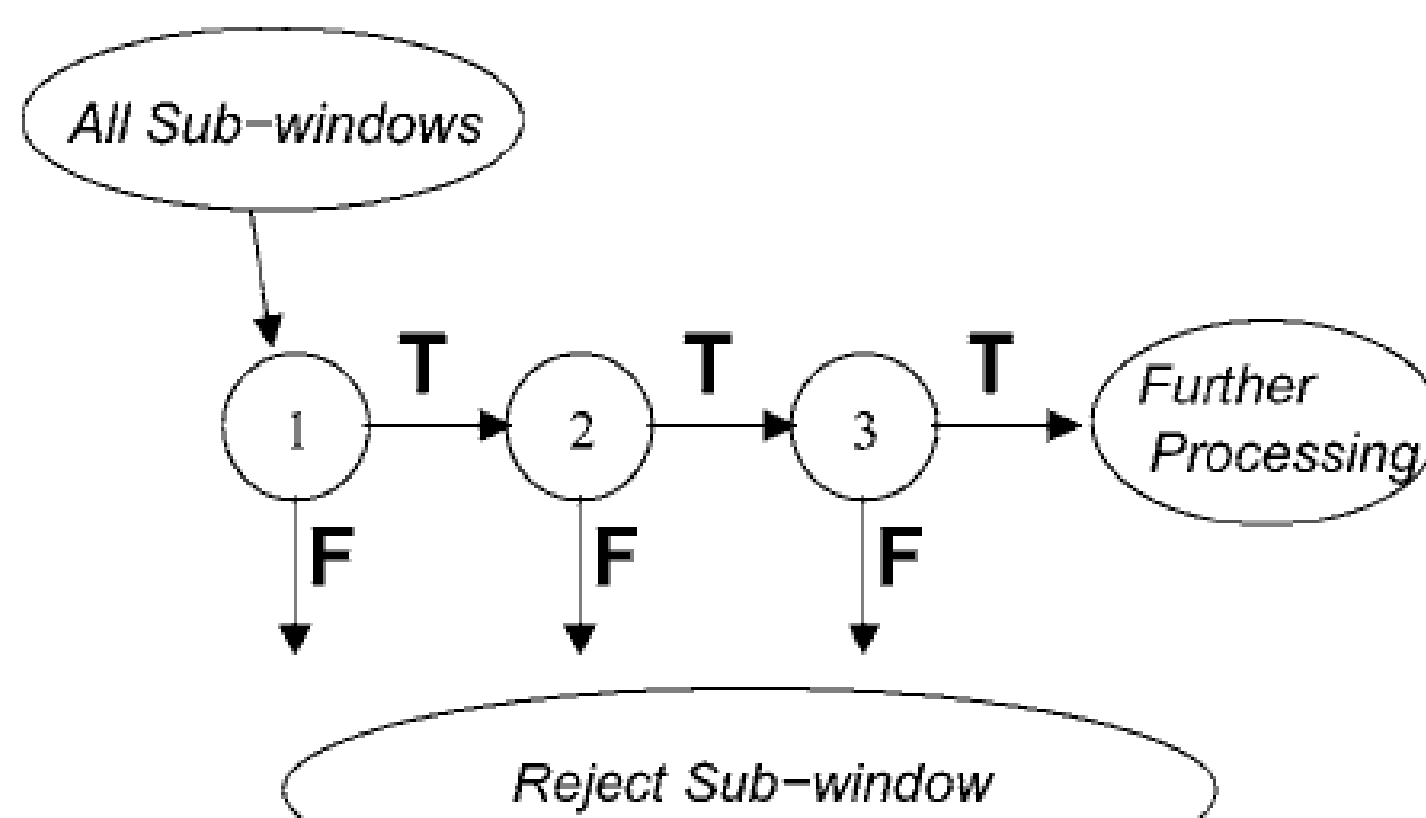


Figure 4. Cascade structure

Previous figure shows that:

- boosted classifiers can reject many of negative sub-windows while detecting all positive instances.
- Series of such simple classifiers can achieve good detection performance while eliminating the need for further processing of negative sub-windows.

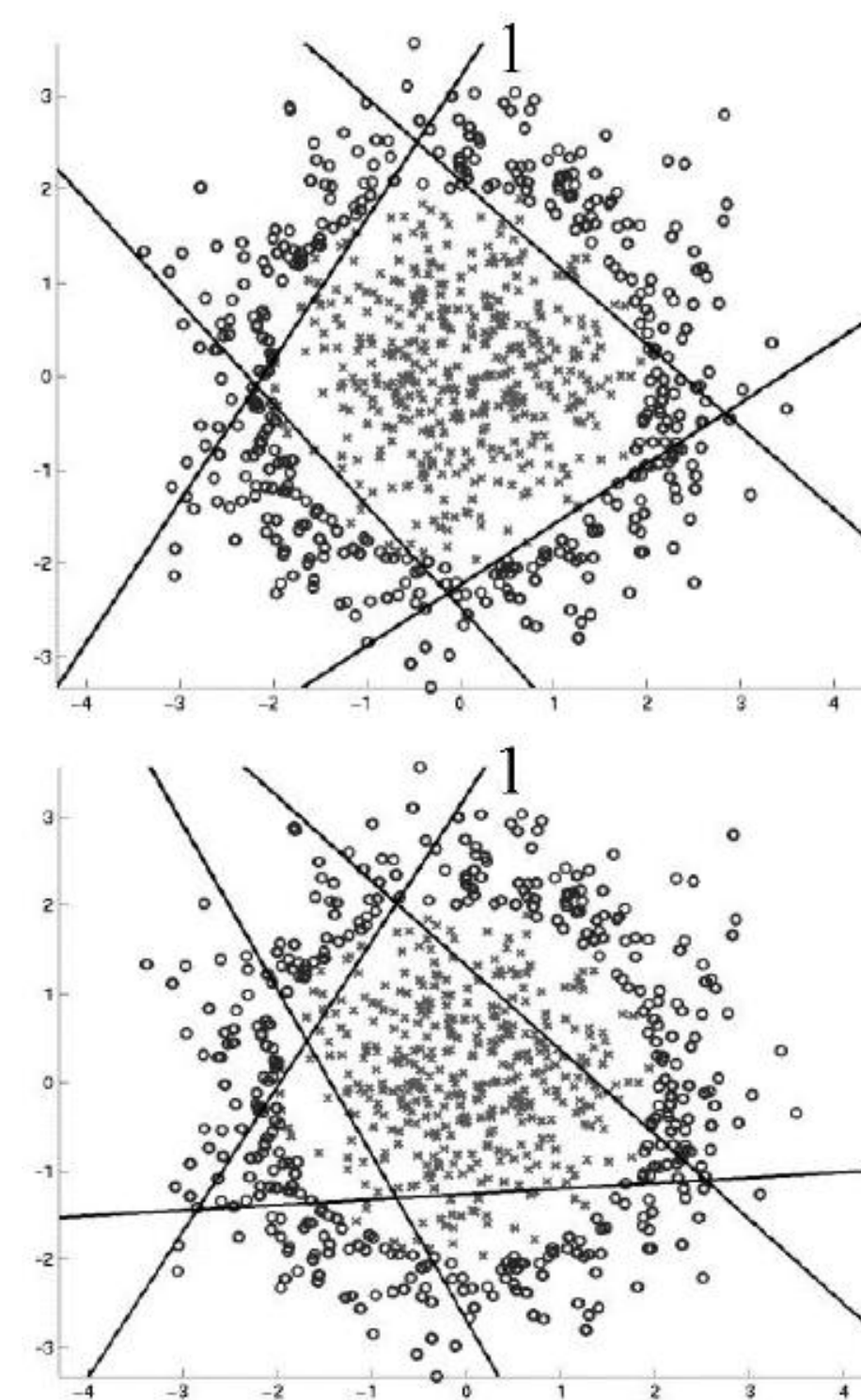


Figure 5. Two simple examples: positive examples are 'x', negative 'o'

Results



The final detector is a 38 layer cascade of classifiers which included a total of 6060 features. The first classifier in the cascade is constructed using two features and rejects about 50% of non-faces while correctly detecting close to 100% of faces. The next classifier has ten features and rejects 80% of non-faces while detecting almost 100% of faces. The next two layers are 25-feature classifiers followed by three 50-feature classifiers followed by classifiers with a Robust Real-Time Face Detection 149 variety of different numbers of features chosen according to the cascading algorithm.

CONCLUSION

In this poster we show, one of the powerful algorithms used for face detection in gray scale images.

This algorithm required 0.067 sec. to detect faces in 384X288 image on processor Pentium III 700 MHz, which is 15 times faster than the neural network approach for face detection. (was the fastest algorithm for face detection before this algorithm comes out).