SLT Term Project Presentation

Car Detection Using Cascaded AdaBoost

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- Project Goal

  Visual-aided outdoor guidance for the blind

  => Narrow environment down to NTHU campus, daytime, with good sunlight.

  => Narrow functionality down to car detection, possibly to “coming” car detection.

  => Ideal input: Videos, USB cameras, to simulate visual-aid devices.

Problem motivations

- For car and human detection, intensity-based features and gradient-based features have been widely used.
- [Viola & Jones, CVPR'01]: Rectangle features + boosted cascade => Fast human detection.

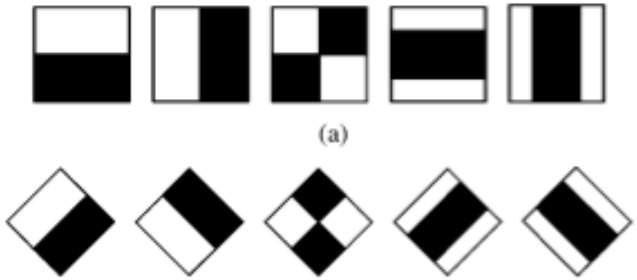
  Drawback: REC features are *not accurate* enough.
- [Dalal & Triggs, CVPR'05]: Histogram of Oriented gradients (HOG) + SVM => High detection accuracy.

  Drawback: Feature dimensions are too high (thousands), *slow* for sliding windows or video applications
- **A combination?** [Chen & Chen (陳昱廷 & 陳祝嵩), 2008]:

  "*Fast human detection using a novel boosted cascading structure with meta stages*"

Combined Feature Pool (1)

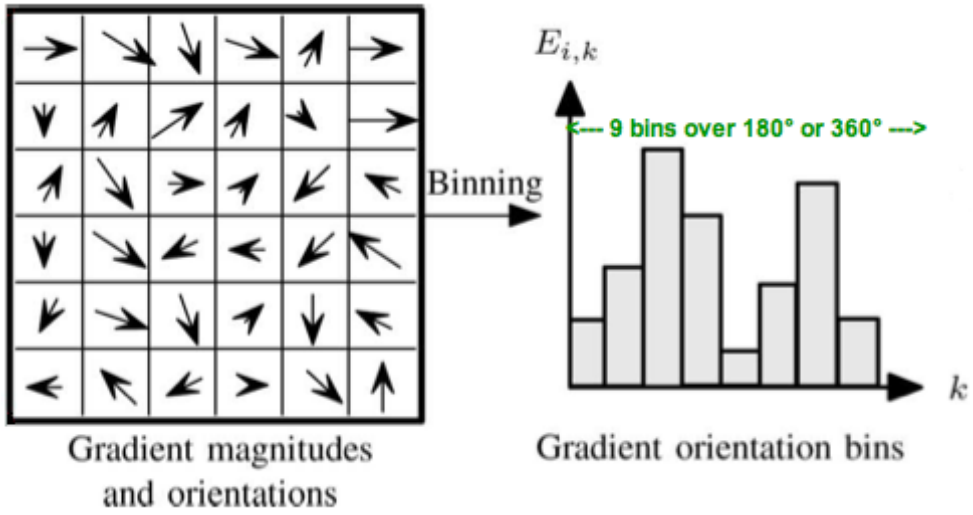
- For all possible block B_i of different sizes and positions:
- Rectangle features (REC) x 10 (r = 1 ~ 10)



$$F_{i,r}^{REC} = \text{White sum} - \text{Black sum}$$

1. 45°-tilted version proposed by Lienhart & Maydt.
2. Computations can be sped up using *integral image* techniques.

- Edge Orientation Histogram (EOH) x 9 (K = 9)

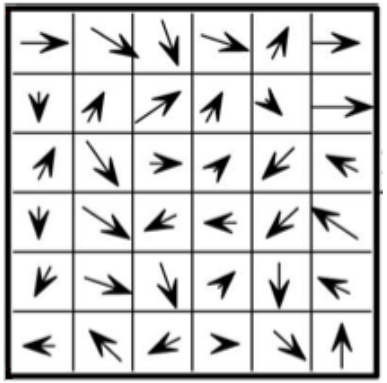


$$F_{i,k}^{EOH} = \frac{E_{i,k}}{\sum_{j=1}^{K} E_{i,j} + \epsilon}$$

The ratio of one *orientation* histogram bin over all K bins.

Combined Feature Pool (2)

- Edge Density (ED) x 1


Gradient magnitudes

$$F_i^{ED} = \frac{\sum_{(x,y)} m(x,y)}{area(B_i)}$$

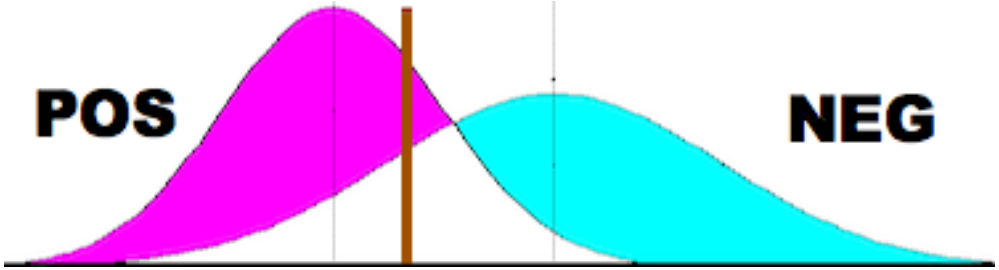
Again, use integral image techniques to speed up.

The average gradient *magnitude* (m) over this block. Ignore the gradient orientations.

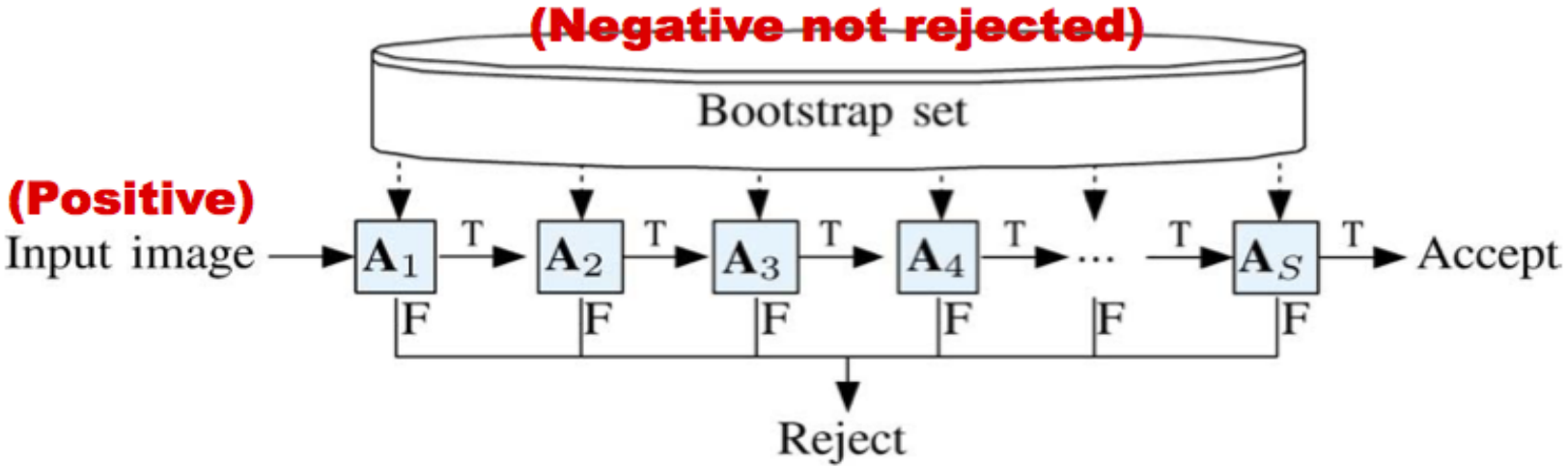
- e.g. 6,948 blocks * 20 features = 138,960 features in one image.

  However, use only *one (1-D) feature at a time* in training.

  That is, a *weak classif er* only performs 1-D classif cation.



Cascaded AdaBoost (1)



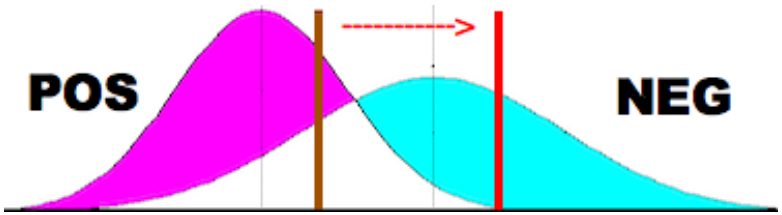
- Goal: Reject negative *quickly* in sliding window situations.
- Each A_i is an AdaBoost *strong* classif er.

$$H_i(x) = sign\left(\sum_{t=1}^{T} \alpha_{i,t} h_{i,t}(x) - theshold_i\right)$$

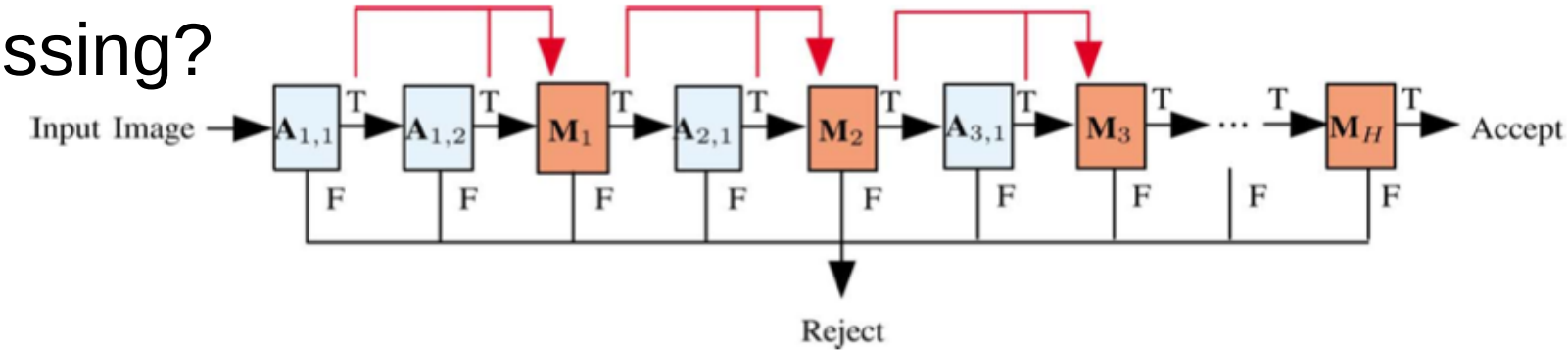
- Negative (N2) are many times more than positive (N1).
- At each stage, N1 positive data remain the same, but N1 negative data are randomly selected from those *not rejected* by previous stages. (Focus on harder examples.)

Cascaded AdaBoost (2)

```
Parameters: F_target = 1e-6, d_minA = 0.995, f_maxA = 0.5;
while (F_current > F_target) do {
    (1) Learn AdaBoost stage A(i) {
        Randomly select N1 non-rejected negative from bootstrap set;
        Set f_local = 1.0;
        while (f_local > f_maxA) do {
            [1] Add the weak classifier to A(i) that minimizes error;
            [2] Modify the threshold(i) to fulfill d_minA;
            [3] Update f_local of A(i);
        }
        F_current = F_current * f_local;
    }
    (2) Learn Meta stage M(i) ... skipped
}
```



- What's missing?



Experiment Results

- The project source code is hosted on Google code:

  http://code.google.com/p/candy2009/
- Environment: C/C++ with OpenCV 2.0 library, Mac OS X 10.6 with Xcode, Intel Core 2 Duo CPU with 3GB RAM.
- Previously: C with no library at all => 3,000 lines now abandoned.
- NTHU campus Data set:

  107 positive images & 9,355 negative images generated from 199 large ones => All are of size 128 x 128.
- Training: Later stages require more weak classif ers.
- Online *detection* system is not yet completed.

Future Work

- Get the system *work* with video and camera inputs.
- Add in missing elements in the Chen & Chen paper, e.g. tilted REC features, real AdaBoost, Confidence Values, Meta stages.
- Enlarge the NTHU campus data set.
- Detect for *coming* cars, not just any cars.
- NSC(國科會) project report.
- Misc: Port to Windows and Linux. Edit project website and documentations. Convert the data set into MATLAB .mat format.
- Again, visit http://code.google.com/p/candy2009/