DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

408M – Cascade Crusaders

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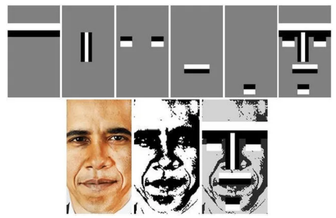
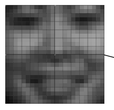
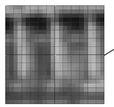
Problem Definition

- Develop an embedded face detector system which identifies images that contain **human faces.**
- Implement using the **Viola-Jones** algorithm, which makes use of **Haar-like Features**, which are easy to compute and at the same time indicative of facial features.
- Optimize for accuracy, speed, and power-consumption performance of the algorithm in separating face from non-face images.





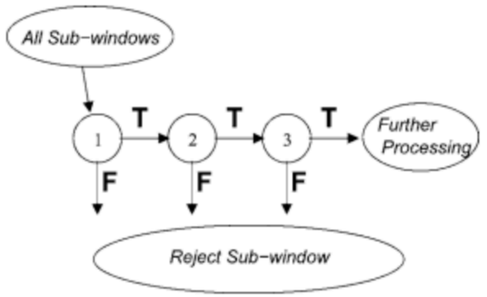


Design Calculations & Analysis

Training goes through ~136,800 features to determine the best features to detect/reject faces. We discovered that searching through all 136,000 is too costly even for a training program, and managed to get good results using only 1,000 of them.

Final Design

The final Viola-Jones algorithm uses **three** cascaded strong classifiers with **40** weak classifiers each.



Prototype & Test Results

One strong classifier with 100 weak classifiers already achieves good accuracy under testing.

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10 out of 493 positive samples were misclassfied
2.0284% false positive rate
2 out of 901 negative samples were misclassfied
0.221976% false negative rate
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Three strong cascaded classifiers with 40 weak classifiers each suffice to have 100% accuracy on training data.

```
Number of correctly classified positives after cascade: 495
Number of rejected positives after cascade: 899
Final testing accuracy after cascade: 100%
```

References

BenMauss. (2021, February 17). Haar-like Features: Seeing in Black and White. Medium. https://levelup.gitconnected.com/haar-like-features-seeing-in-black-and-white-1a240caaf1e3

Viola, P., & Jones, M. (2001). Rapid Object Detection using a Boosted Cascade of Simple Features. ACCEPTED CONFERENCE on COMPUTER VISION and PATTERN RECOGNITION. https://www.cs.cmu.edu/~efros/courses/LBMV07/Papers/viola-cvpr-01.pdf