Optimizing color information processing inside an SVM network

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Outline

1. Motivations
   - Problem
   - Used features
   - The SVM Network
2. How taking into account color information
   - Color space
   - Design proposal for SVM Network
3. Experimental results

Urban Object Detection In Aerial Images

Urban object definition :

- The appearance of the objects varies : color, size, orientation...
- Multiple distortions and occlusions due to shadows, vegetation..
- Multiple-object detection

About the databases of aerial images :

- 19 images for the training database
- 3 images for the validation database
- 2 images for the testing database

Features Extraction

Extraction of multiple Histograms of Oriented Gradients

- Calculate HOG within cells and blocks
- Accumulate features to construct HOG descriptor of different sizes

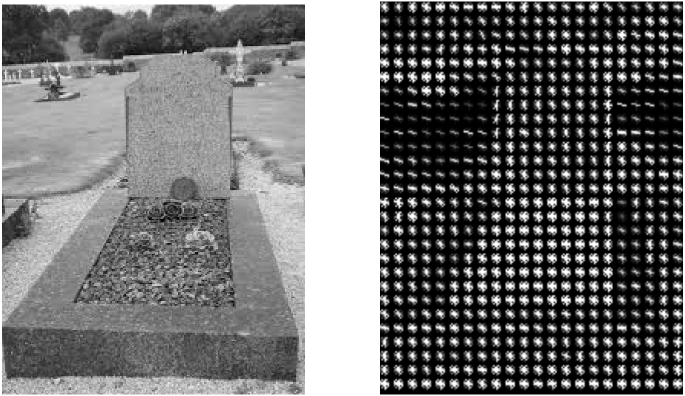

Figure : HOG representation for 9x9 cells size.

Color Features Extraction

How can we extract the best descriptor based on the HOG descriptor when there are 3 channels (color image)?

1. Transform the color image input into grey level
2. Extract HOG descriptor on each channel and concatenate them
3. Only take into account the highest gradient
4. Reduce the dimension (PCA...)

HOG and SVM Network

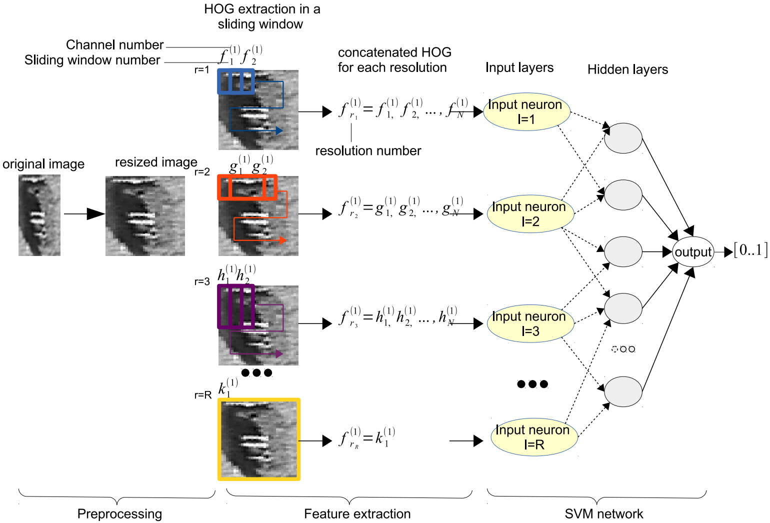

Figure : SVM Network works on grey level images.

HOG and SVM Network

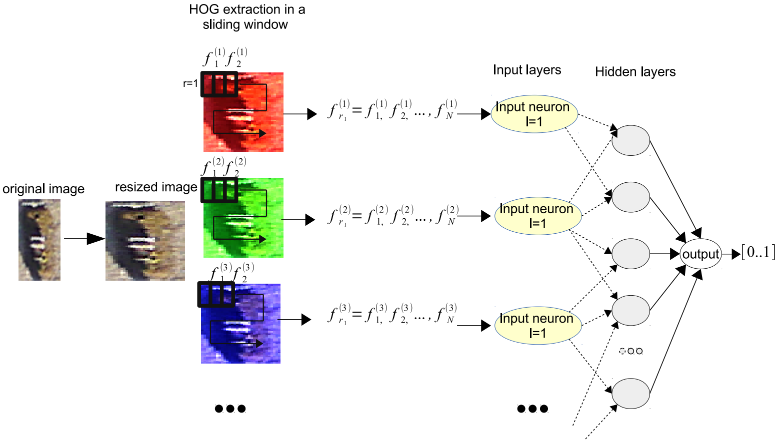

Figure : SVM Network works on color images called *separate architecture*.

Color space

What is the best discriminant color space?

- RGB
- $Y = 0.21R + 0.71G + 0.07B$
- $CIE - LAB$ and $CIE - LUV$ (based on human perception)
- HSV (cylindrical-coordinate representations of RGB)
- Use a PCA transformation

Experimental results

SVM Network vs SVM Single :

- SVM Network always improves the precision
- The performance from different color spaces are very closed.
- HSV and RGB : the 2 bests

=> But the colors are threaten separately in the SVM Network...

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Design the network

1- Fusion of channels per resolution

Concatenate the different channels from the same resolution.

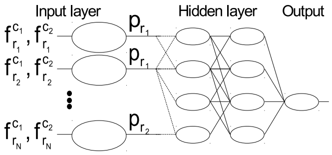

Figure : Representation of the Fusion Network

Different channels are not necessarily in the same feature space, e.g. : HSV.

=> Normalisation problem

Design the network

2- A specific function to merge the channels per resolution

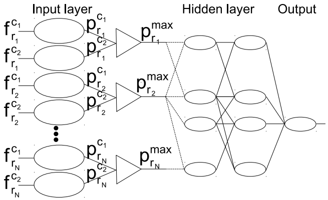

Figure : Representation of the Maximum Network

Connect all input neurons with the same resolution *r* to a specific function :

- No focus on the low variations (Maximum function)
- Linear quantification (Product function)
- The first principal component (PCA transformation)

=> The quantification may lose important information.

Design the network

3- Stacking of channels per resolution

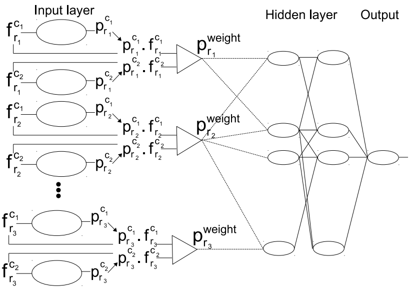

Figure : Representation of the Stack Network

- Features from different channels are scaled and used in the same neuron
- Each weight is learned by using an SVM

Results

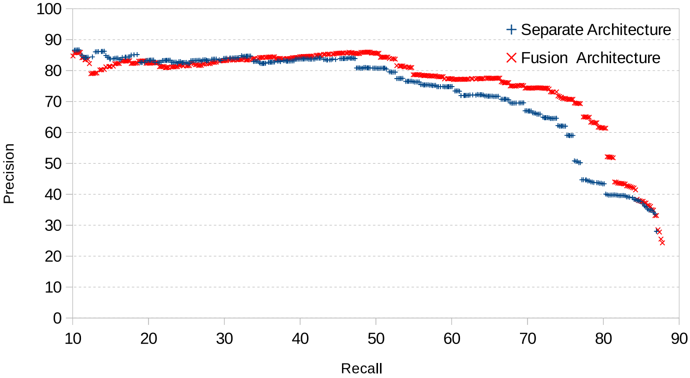

Figure : ROC curves for the separate and fusion architectures

Results

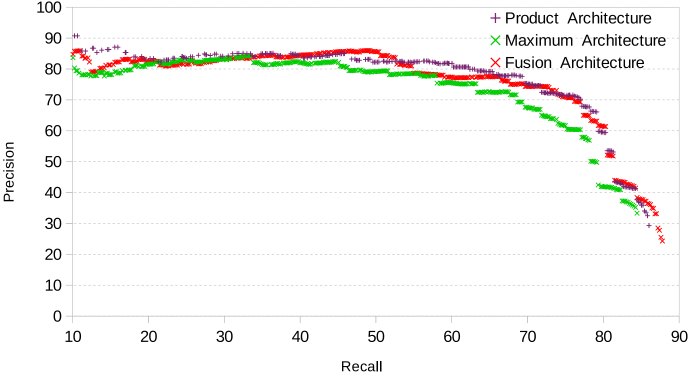

Figure : ROC curves for the fusion, product and maximum architectures

Results

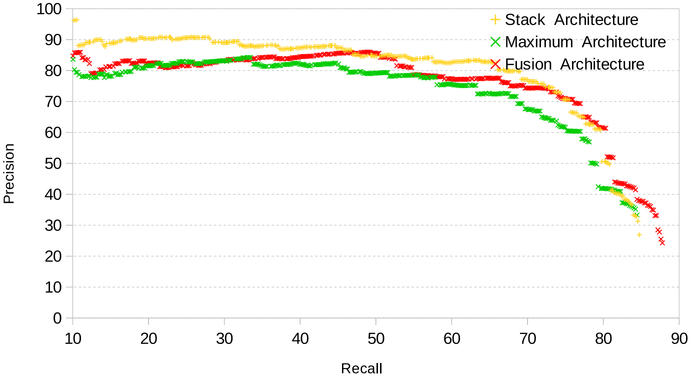

Figure : ROC curves for the fusion, maximum and stack architectures

Overview of the Network performance

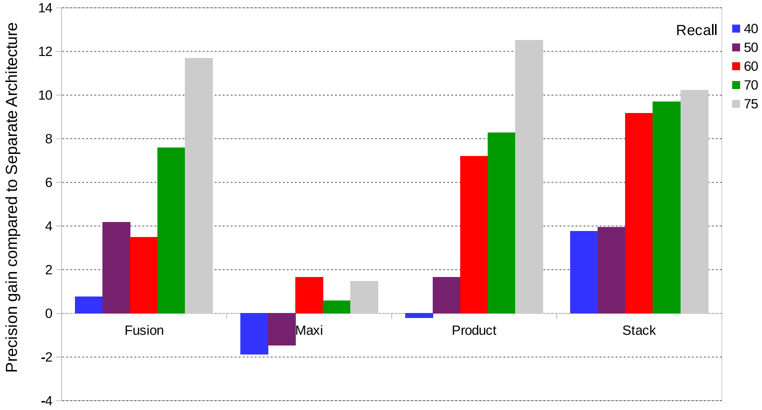

Figure : Precision gain is compared to the separate architecture.

Summary

Conclusions

- SVM Network outperforms SVM by an average precision gain ranging from 1.5% to 6%.
- SVM Network design (e.g. Stack Design) would improve to 10% the precision.

Future works

- Design an SVM Network to combine several feature types : SURF, SIFT...
- Design a CNN input neurons.

Thanks!

The best Parameters for SVM Network

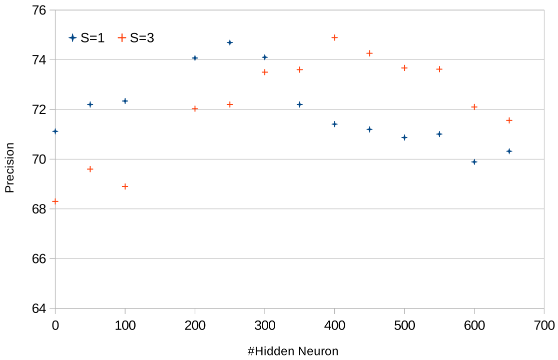

Figure : Tuning of the SVM Network on a validation database

Before each experiment the SVM network used a validation database to fix the best number of hidden and random neurons.