Carpet Wear Classification based o Support Vector Machine Pattern Recognition Approach

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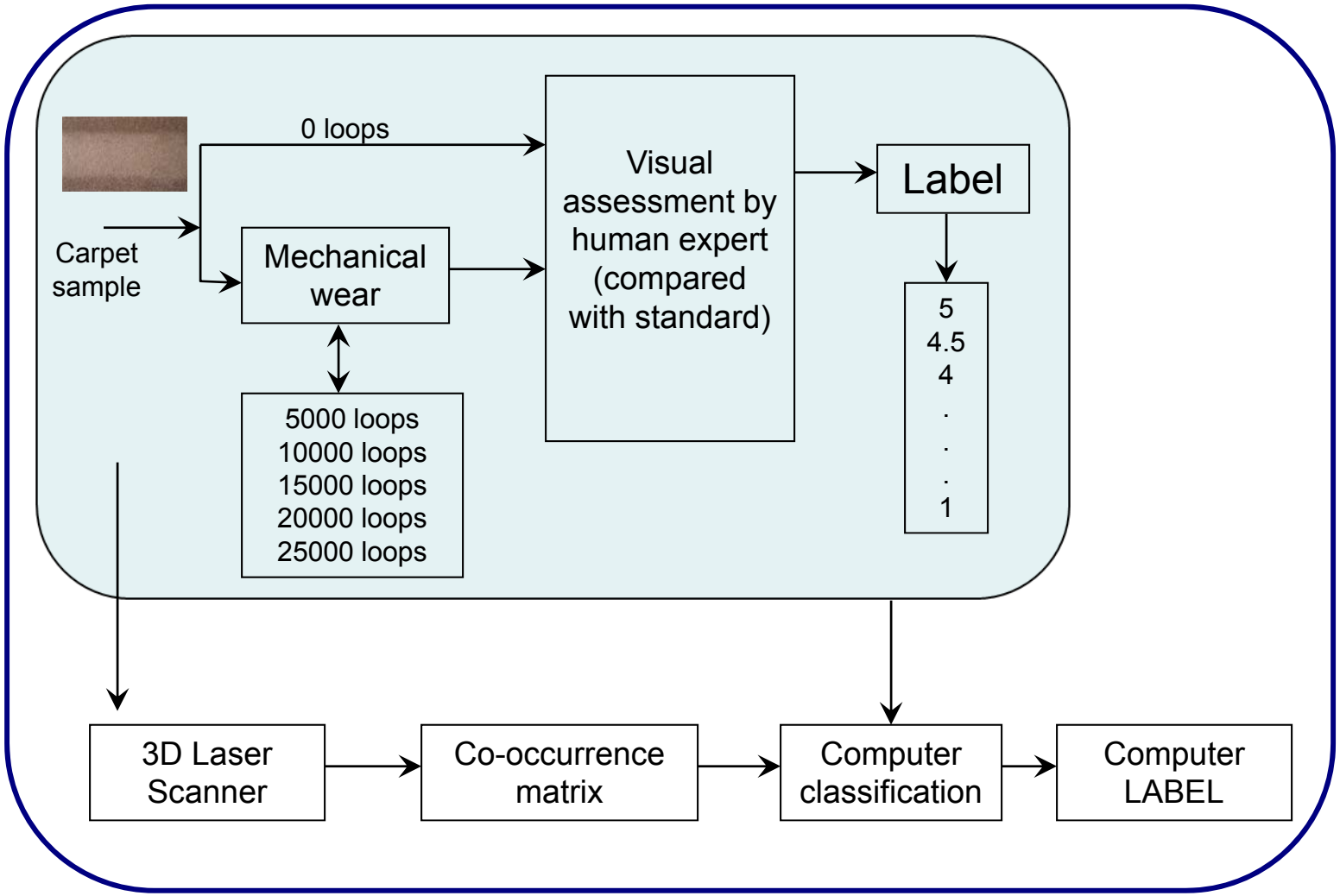
Outline

- Introduction
- Features extraction
- PCA (Principal Component Analysis)
- Features classification
- Results
- Conclusion

Objective


0 loops
Carpet sample
Mechanical wear
5000 loops
10000 loops
15000 loops
20000 loops
25000 loops
Visual assessment by human expert (compared with standard)
Label
5
4.5
4
.
.
.
1
3D Laser Scanner
Co-occurrence matrix
Computer classification
Computer LABEL
Automated classifier

Data Acquisition

Fig 1. Digital image

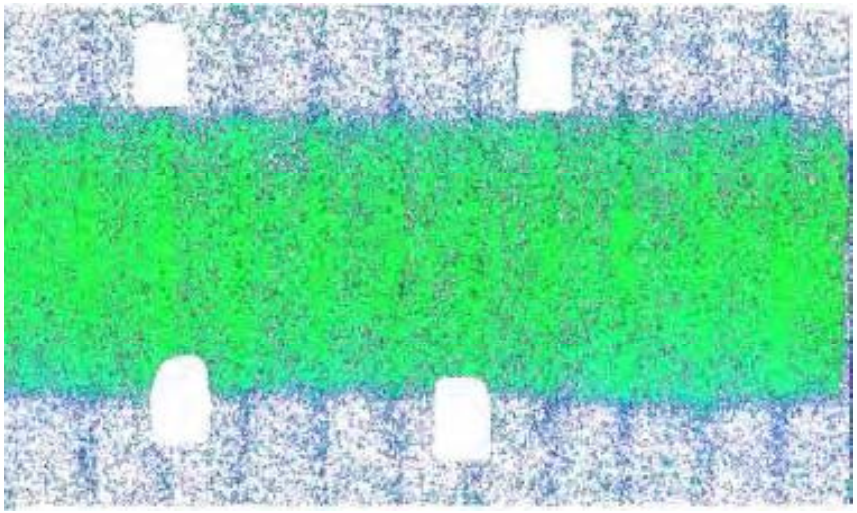


Fig 2. Laser image

Co-occurrence matrix

- Co-occurrence matrix composed

1	3	4	2	7
1	1	2	5	6
3	6	7	1	2
1	1	2	7	5

Gray-scale matrix

	1	2	3	4	5	6	7
1	2	3	1	0	0	0	0
2	0	0	0	0	1	0	2
3	0	0	0	1	0	1	0
4	0	1	0	0	0	0	0
5	0	0	0	0	0	1	0
6	0	0	0	0	0	0	1
7	1	0	0	0	1	0	0

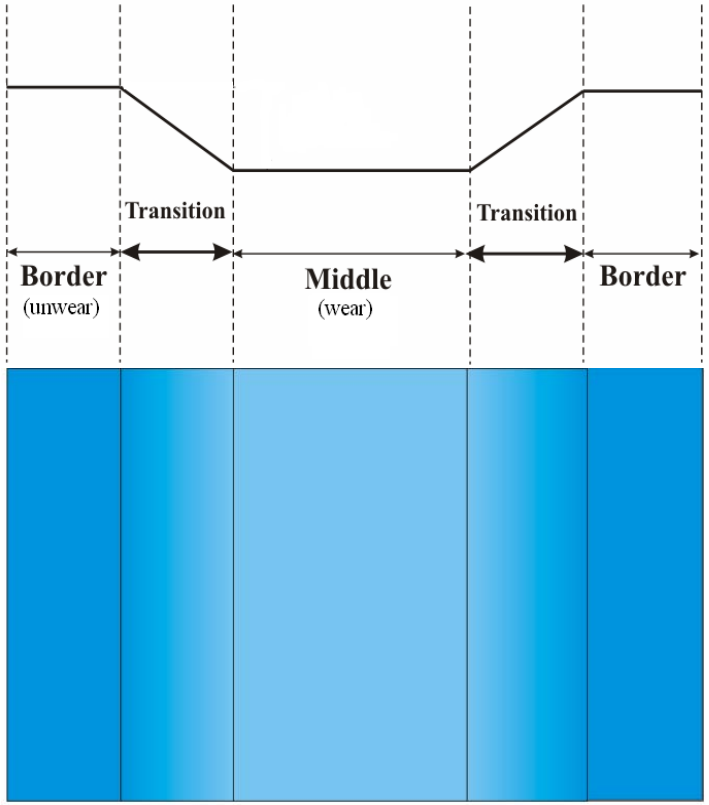
Co-occurrence matrix $(0^o \ \& \ d = 1)$

$$C_d(g(i,j), g(i+k, j+l)) = C_d(g(i,j), g(i+k, j+l)) + 1$$

Where: $d = \sqrt{k^2 + l^2}$

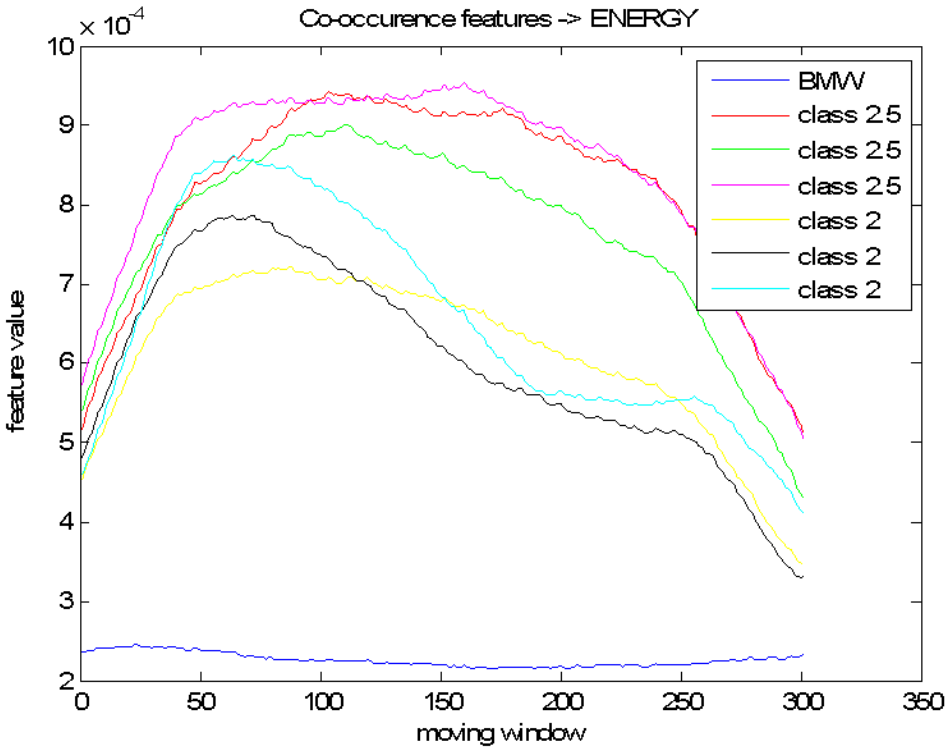
Haralick's Features

- ✓ *Energy*
- ✓ *Sum Entropy*
- ✓ *Entropy*
- ✓ *Sum Variance*
- ✓ *Inertia*
- ✓ *Difference Variance*
- ✓ *Homogeneity*
- ✓ *Difference Entropy*
- ✓ *Contrast*
- ✓ *Informational Measures of Correlation*
- ✓ *Correlation*
- ✓ *Maximal Correlation Coefficient*
- ✓ *Sum Average*



Theoretical representation

Features Validation



Haralick feature - Energy

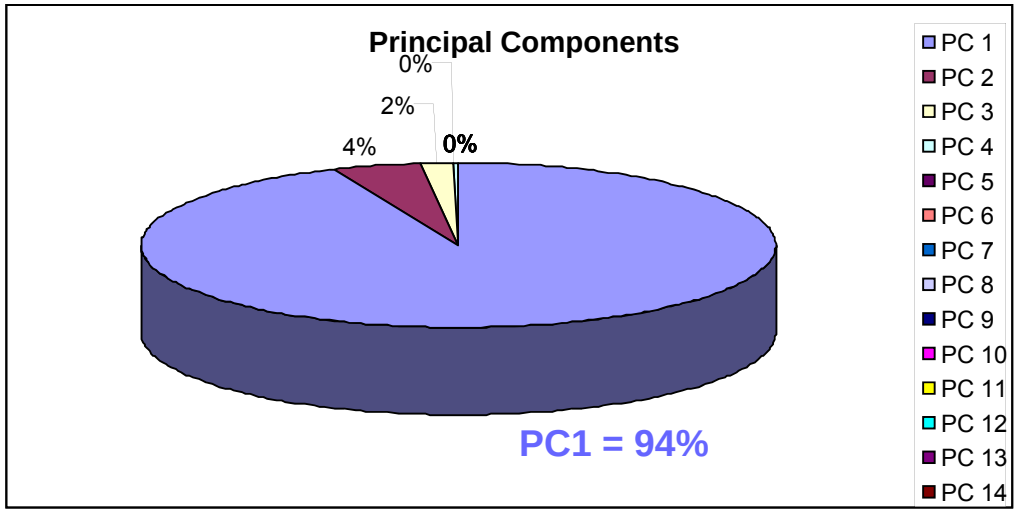
Name of carpet	Human expert classification
20 kl 517	BMW
20 kl 517 – 2	2.5
20 kl 517 – 4	2.5
20 kl 517 – 6	2.5
20 kl 517 – 8	2
20 kl 517 – 10	2
20 kl 517 – 12	2

Table of human expert

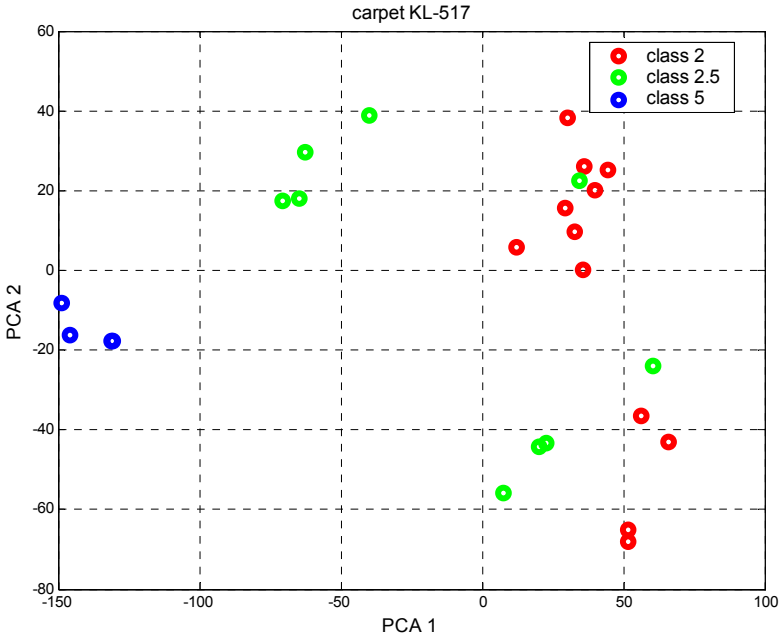
What and why PCA?

- Principal Component Analysis is a useful technique used to reduce the dimensionality of large data sets, such as those from micro array analysis;

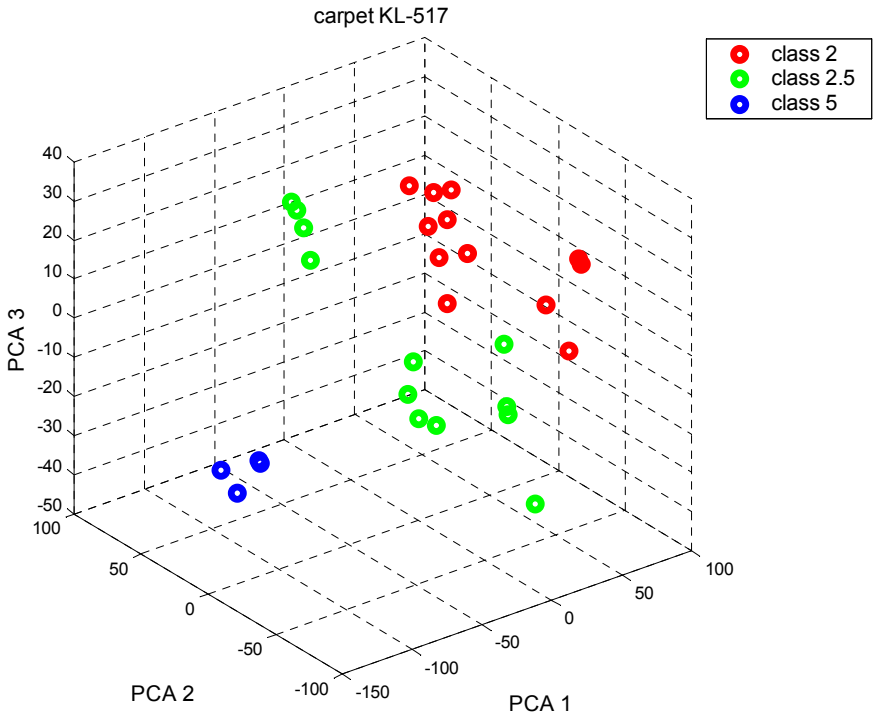
- When there are more than three variables, it is more difficult to visualize graphically their relationships.



PCA Results

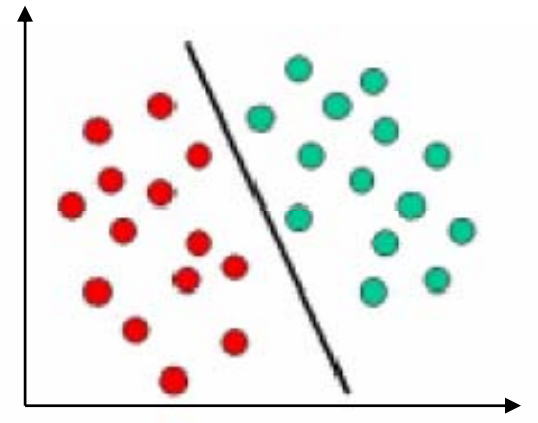


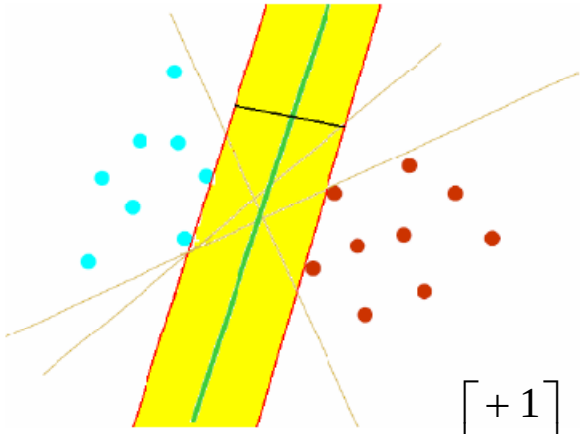
2D Plotting of first tow PC



3D Plotting of first third PC

Binary SVM





$$w^T x + b = \begin{bmatrix} +1 \\ 0 \\ -1 \end{bmatrix}$$

- A separated hyperplane:

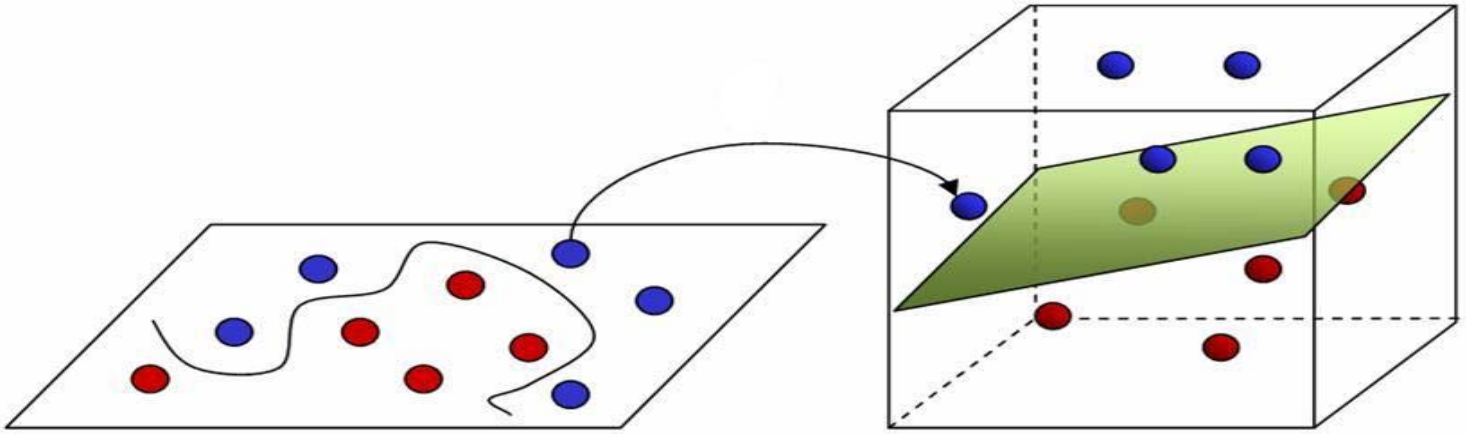
$$w^T x + b = 0$$

$$w^T x + b > 0 \quad \text{if} \quad y = 1$$

$$w^T x + b < 0 \quad \text{if} \quad y = -1$$

Where - x is training data
- y is indicator vector

Nonlinear - SVM



Input space *Feature space*

$k(x_i, x_j) = (x_i x_j + 1)^p$ - polynomial kernel

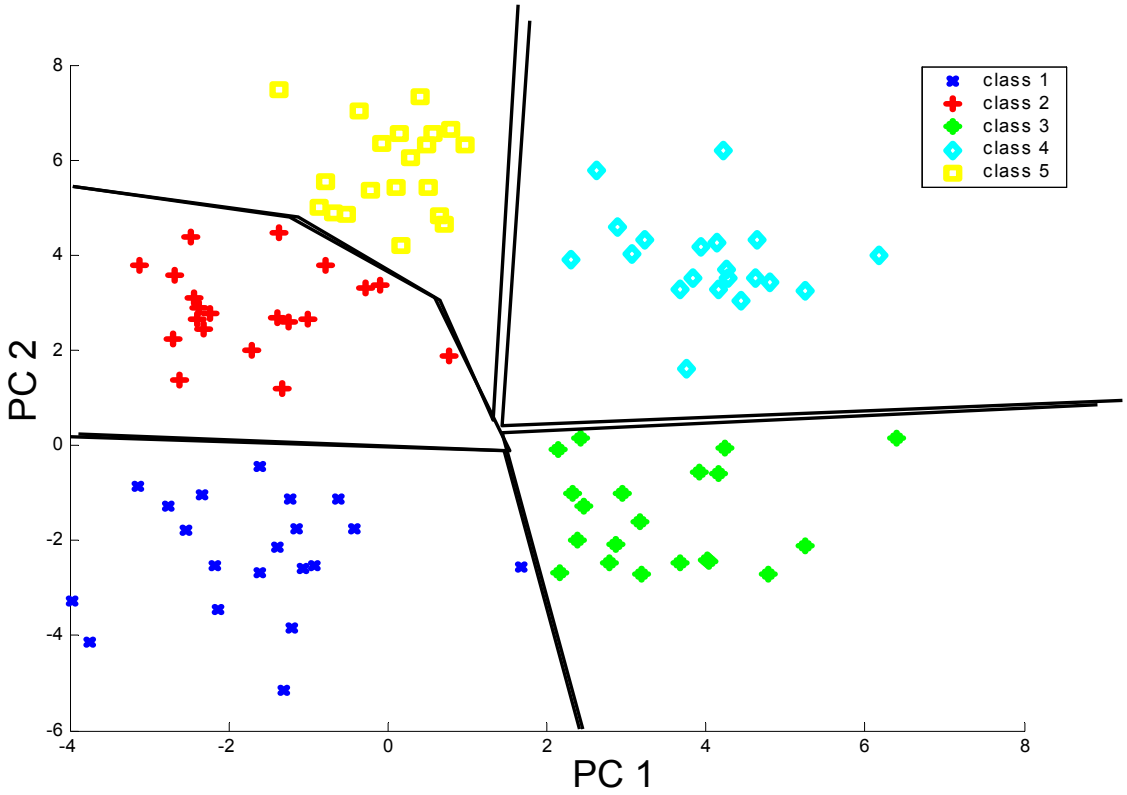
$k(x_i, x_j) = e^{-\|x-y\|/2\sigma^2}$ - Gaussian kernel

The separable plane will be:

$$k(x_i, x_j)w^T + b = 0$$

Multi – class SVM

- One - Against - All decomposition



Testing Results

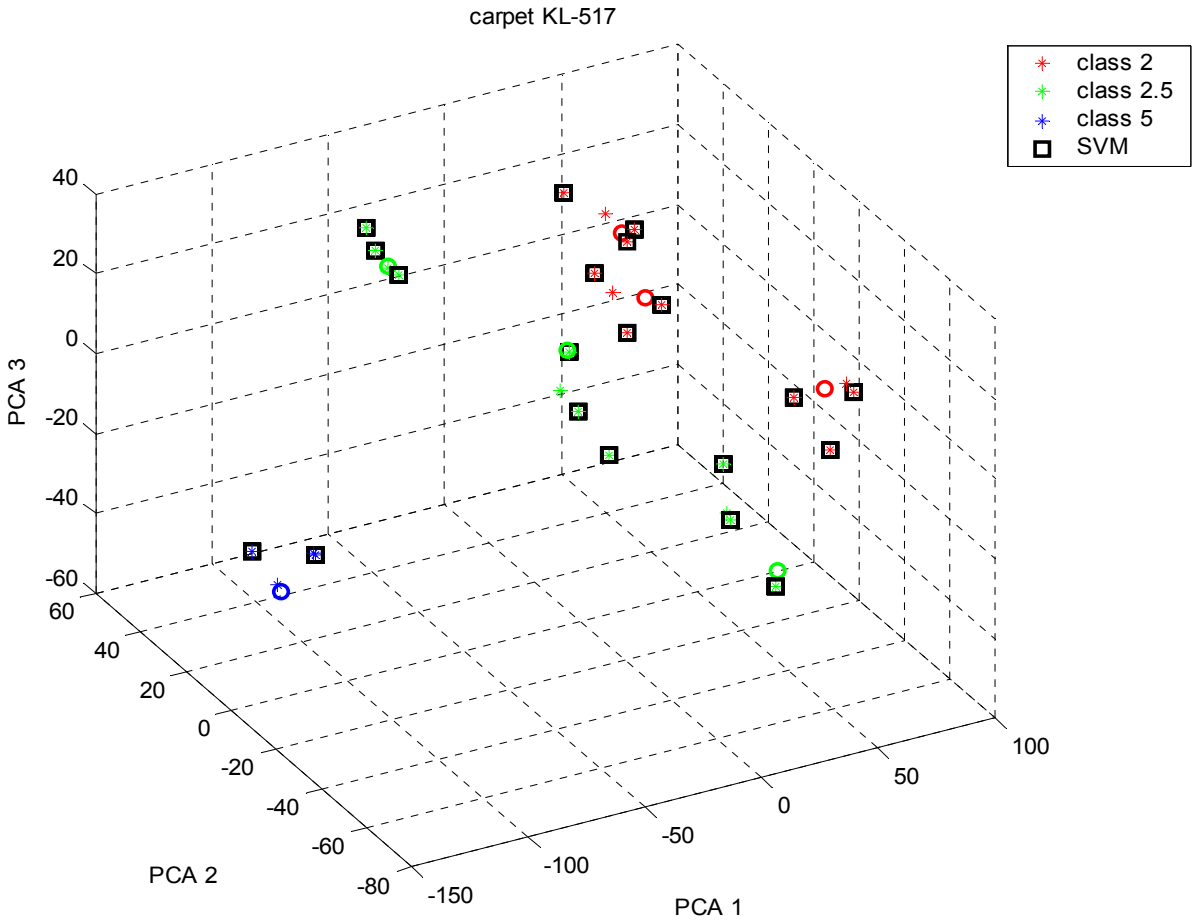
- For every carpet are used:

  - 4 points for training
  - 1 point for testing

Type of carpet	Polynomial kernel %	Gaussian kernel %
A8 – 501	84,4	84,4
A8 – 701	84,4	100
Big 4	100	100
20 KL 803 beige	84,4	84,4
LA 7	84,4	100
Pr 84	100	100
20 KL 517	100	100
Big 8	86	86
LA 9	72	100
20 KL 803	100	100
Over all	89,56	95,48

Table of percentage classification

SVM Classification



Classification for carpet KL-517

Conclusion

- Automated carpet classification can be achieved using co-occurrence matrix, PCA and SVM
- Polynomial kernel gives 88,32% over all classification
- Gaussian kernel gives 94,24% over all classification

THANK YOU!