Claims

What is claimed is:

1. A method for classifying a received signal, the method comprising:

determining a covariance matrix of signal values of the received signal;

determining an eigenvalue matrix of the covariance matrix, the eigenvalue matrix comprising the eigenvalues of the covariance matrix;

determine a first function from at least one eigenvalue of the eigenvalues of the covariance matrix;

determine a second function from at least one eigenvalue of the eigenvalues of the covariance matrix, wherein the second function is different from the first function; and

classifying the received signal into a signal comprising data or into a noise signal dependent from a comparison between a value of the first function and a value of the second function.

2. The method of claim 1, further comprising:

sampling the received signal.

3. The method of claim 1, further comprising:

filtering the received signal.

4. The method of claim 2, further comprising:

filtering the sampled received signal.

5. The method of claim 1,

wherein the covariance matrix $\underline{\mathbf{R}}(N_S)$ of signal values $\underline{\mathbf{x}}(n)$ of the received signal is determined according to the following equation:

$$\underline{\mathbf{R}}(N_S)=\frac{1}{N_S}\sum_{n=0}^{N_S-1}\underline{\mathbf{x}}(n)\underline{\mathbf{x}}^H(n),$$

wherein N_S denotes the number of signal values $\underline{\mathbf{x}}(n)$ in the covariance matrix.

6. The method of claim 1,

wherein the eigenvalue matrix is determined by transforming the covariance matrix to the eigenvalue matrix.

7. The method of claim 5 and 6,

wherein the eigenvalue matrix $\underline{\tilde{\mathbf{R}}}(N_S)$ is determined according to the following formula:

$$\underline{\tilde{\mathbf{R}}}(N_S)=\underline{\mathbf{Q}}^{-1}\underline{\mathbf{R}}(N_S)\underline{\mathbf{Q}}^{-H},$$

wherein $\underline{\mathbf{Q}}$ denotes a Hermitian matrix.

8. The method of claim 1,

wherein the first function is a combination of a plurality of the eigenvalues.

9. The method of claim 8,

wherein the first function is a linear combination of a plurality of the eigenvalues.

10. The method of claim 1,

wherein the first function comprises at least the maximum eigenvalue of the eigenvalue matrix.

11. The method of claim 10,

wherein the first function comprises a predetermined number of the largest eigenvalues of the eigenvalue matrix.

12. The method of claim 1,

wherein the determining the value of the first function comprises determining the trace of the eigenvalues of the eigenvalue matrix.

13. The method of claim 1,

wherein the second function is a combination of a plurality of the eigenvalues.

14. The method of claim 13,

wherein the second function is a linear combination of a plurality of the eigenvalues.

15. The method of claim 1,

wherein the second function comprises at least the minimum eigenvalue of the eigenvalue matrix.

16. The method of claim 15,

wherein the second function comprises a predetermined number of the smallest eigenvalues of the eigenvalue matrix.

17. The method of claim 1,

wherein a scaling factor is used in the comparison between the value of the first function and the value of the second function.

18. A classifier to classify a received signal, the classifier comprising:

a first determining circuit to determine a covariance matrix of signal values of the received signal;

a second determining circuit to determine an eigenvalue matrix of the covariance matrix, the eigenvalue matrix comprising the eigenvalues of the covariance matrix;

a third determining circuit to determine a first function from at least one eigenvalue of the eigenvalues of the covariance matrix;

a fourth determining circuit to determine a second function from at least one eigenvalue of the eigenvalues of the covariance matrix, wherein the second function is different from the first function; and

a classifier circuit to classify the received signal into a signal comprising data or into a noise signal dependent from a comparison between a value of the first function and a value of the second function.

19. The classifier of claim 18, further comprising:

a sampler to sample the received signal.

20. The classifier of claim 18, further comprising:

a filter to filter the received signal.

21. The classifier of claim 19, further comprising:

a filter to filter the sampled received signal.

22. The classifier of claim 18,

wherein the first determining circuit is configured to determine the covariance matrix $\underline{\mathbf{R}}(N_S)$ of signal values $\underline{\mathbf{x}}(n)$ of the received signal according to the following equation:

$$\underline{\mathbf{R}}(N_S)=\frac{1}{N_S}\sum_{n=0}^{N_S-1}\underline{\mathbf{x}}(n)\underline{\mathbf{x}}^H(n),$$

wherein N_S denotes the number of signal values $\underline{\mathbf{x}}(n)$ in the covariance matrix.

23. The classifier of claim 18,

wherein the second determining circuit is configured to determine the eigenvalue matrix by transforming the covariance matrix to the eigenvalue matrix.

24. The classifier of claim 22 and 23,

wherein the second determining circuit is configured to determine the eigenvalue matrix $\tilde{\underline{\mathbf{R}}}(N_S)$ according to the following formula:

$$\tilde{\underline{\mathbf{R}}}(N_S)=\underline{\mathbf{Q}}^{-1}\underline{\mathbf{R}}(N_S)\underline{\mathbf{Q}}^{-H},$$

wherein $\underline{\mathbf{Q}}$ denotes a Hermitian matrix.

25. The classifier of claim 18,

wherein the first function is a combination of a plurality of the eigenvalues.

26. The classifier of claim 25,

wherein the first function is a linear combination of a plurality of the eigenvalues.

27. The classifier of claim 18,

wherein the first function comprises at least the maximum eigenvalue of the eigenvalue matrix.

28. The classifier of claim 27,

wherein the first function comprises a predetermined number of the largest eigenvalues of the eigenvalue matrix.

29. The classifier of claim 18,

wherein the third determining circuit is configured to determine the value of the first function using the trace of the eigenvalues of the eigenvalue matrix.

30. The classifier of claim 18,

wherein the second function is a combination of a plurality of the eigenvalues.

31. The classifier of claim 30,

wherein the second function is a linear combination of a plurality of the eigenvalues.

32. The classifier of claim 18,

wherein the second function comprises at least the minimum eigenvalue of the eigenvalue matrix.

33. The classifier of claim 32,

wherein the second function comprises a predetermined number of the smallest eigenvalues of the eigenvalue matrix.

34. The classifier of claim 18,

wherein the classifier circuit is configured to use a scaling factor in the comparison between the value of the first function and the value of the second function.

35. An electronic device comprising the classifier of any of the claims 18 to 34.

36. The electronic device of claim 35, further comprising:

a receiver to receive a signal.

37. The electronic device of claim 35,

being configured as an electronic device selected from a group of electronic devices consisting of:

- communication terminal;
- medium player device configured to play at least one medium.

38. A computer program product for classifying a received signal configured to comprise the following steps when being executed by a processor:

determining a covariance matrix of signal values of the received signal;

determining an eigenvalue matrix of the covariance matrix, the eigenvalue matrix comprising the eigenvalues of the covariance matrix;

determine a first function from at least one eigenvalue of the eigenvalues of the covariance matrix;

determine a second function from at least one eigenvalue of the eigenvalues of the covariance matrix, wherein the second function is different from the first function; and

classifying the received signal into a signal comprising data or into a noise signal dependent from a comparison between a value of the first function and a value of the second function.

Claims

What is claimed is:

1. A method carried out by a classifier circuit for classifying a received signal, the method comprising:
determining a covariance matrix of signal values of the received signal;
determining an eigenvalue matrix of the covariance matrix, the eigenvalue matrix comprising the eigenvalues of the covariance matrix;
determine a first function from at least one eigenvalue of the eigenvalues of the covariance matrix wherein the first function comprises at least the maximum value of the eigenvalue matrix;
determine a second function from at least one eigenvalue of the eigenvalues of the covariance matrix, wherein the second function is different from the first function;
and classifying the received signal into a signal comprising data or into a noise signal dependent from a comparison between a value of the first function and a value of the second function.

2. The method of claim 1, wherein the covariance matrix $\underline{\mathbf{R}}(N_S)$ of signal values $\underline{\mathbf{x}}(n)$ of the received signal is determined according to the following equation:

$$\underline{\mathbf{R}}(N_S)=\frac{1}{N_S}\sum_{n=0}^{N_S-1}\underline{\mathbf{x}}(n)\underline{\mathbf{x}}^H(n),$$

wherein N_S denotes the number of signal values $\underline{\mathbf{x}}(n)$ in the covariance matrix.

3. The method of claim 2, wherein the eigenvalue matrix $\underline{\tilde{\mathbf{R}}}(N_S)$ is determined according to the following formula:

$$\underline{\tilde{\mathbf{R}}}(N_S)=\underline{\mathbf{Q}}^{-1}\underline{\mathbf{R}}(N_S)\underline{\mathbf{Q}}^{-H}$$

wherein $\underline{\mathbf{Q}}$ denotes a Hermitian matrix.

4. The method of claim 1, wherein the eigenvalue matrix is determined by transforming the covariance matrix to the eigenvalue matrix.

5. The method of claim 1, wherein the first function is a combination of a plurality of the eigenvalues.

6. The method of claim 5, wherein the first function is a linear combination of a plurality of the eigenvalues.

7. The method of claim 1, wherein the first function comprises a predetermined number of the largest eigenvalues of the eigenvalue matrix.

8. The method of claim 1, wherein the determining the value of the first function comprises determining the trace of the eigenvalues of the eigenvalue matrix.

9. The method of claim 1, wherein the second function is a combination of a plurality of the eigenvalues.

10. The method of claim 9, wherein the second function is a linear combination of a plurality of the eigenvalues.

11. The method of claim 1, wherein the second function comprises at least the minimum eigenvalue of the eigenvalue matrix.

12. The method of claim 11, wherein the second function comprises a predetermined number of the smallest eigenvalues of the eigenvalue matrix.

13. The method of claim 1, wherein a scaling factor is used in the comparison between the value of the first function and the value of the second function.

14. A classifier to classify a received signal, the classifier comprising:
a first determining circuit to determine a covariance matrix of signal values of the received signal;
a second determining circuit to determine an eigenvalue matrix of the covariance matrix, the eigenvalue matrix comprising the eigenvalues of the covariance matrix;
a third determining circuit to determine a first function from at least one eigenvalue of the eigenvalues of the covariance matrix wherein the first function comprises at least

the maximum eigenvalue of the eigenvalue matrix;

a fourth determining circuit to determine a second function from at least one eigenvalue of the eigenvalues of the covariance matrix, wherein the second function is different from the first function; and

a classifier circuit to classify the received signal into a signal comprising data or into a noise signal dependent from a comparison between a value of the first function and a value of the second function.

15. The classifier of claim 14, wherein the first determining circuit is configured to determine the covariance matrix $\underline{\mathbf{R}}(N_S)$ of signal values $\underline{\mathbf{x}}(n)$ of the received signal according to the following equation:

$$\underline{\mathbf{R}}(N_S)=\frac{1}{N_S}\sum_{n=0}^{N_S-1}\underline{\mathbf{x}}(n)\underline{\mathbf{x}}^H(n),$$

wherein N_S denotes the number of signal values $\underline{\mathbf{x}}(n)$ in the covariance matrix.

16. The classifier of claim 15, wherein the second determining circuit is configured to determine the eigenvalue matrix $\underline{\tilde{\mathbf{R}}}(N_S)$ according to the following formula:

$$\underline{\tilde{\mathbf{R}}}(N_S)=\underline{\mathbf{Q}}^{-1}\underline{\mathbf{R}}(N_S)\underline{\mathbf{Q}}^{-H},$$

wherein $\underline{\mathbf{Q}}$ denotes a Hermitian matrix.

17. The classifier of claim 14, wherein the second determining circuit is configured to determine the eigenvalue matrix by transforming the covariance matrix to the eigenvalue matrix.

18. The classifier of claim 14, wherein the first function is a combination of a plurality of the eigenvalues.

19. The classifier of claim 18, wherein the first function is a linear combination of a plurality of the eigenvalues.

20. The classifier of claim 14, wherein the first function comprises a predetermined number of the largest eigenvalues of the eigenvalue matrix.

21. The classifier of claim 14, wherein the third determining circuit is configured to determine the value of the first function using the trace of the eigenvalues of the eigenvalue matrix.

22. The classifier of claim 14, wherein the second function is a combination of a plurality of the eigenvalues.

23. The classifier of claim 22, wherein the second function is a linear combination of a plurality of the eigenvalues.

24. The classifier of claim 14, wherein the second function comprises at least the minimum eigenvalue of the eigenvalue matrix.

25. The classifier of claim 24, wherein the second function comprises a predetermined number of the smallest eigenvalues of the eigenvalue matrix.

26. The classifier of claim 14, wherein the classifier circuit is configured to use a scaling factor in the comparison between the value of the first function and the value of the second function.