1 Eigenvectors of a Continuous Filter

If $Av = \lambda v = s$, then $v$ is an eigenvector of $A$ and $\lambda$ is an associated eigenvalue

$$\mathbb{T}\{x(m_x, m_y)\} = y(m_x, m_y) = \beta x(m_x, m_y),$$

where $\beta$ is a scalar.

$$y(m_x, m_y) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} h(\lambda_x, \lambda_y) e^{2j\pi f_x(m_x - \lambda_x)} e^{2j\pi f_y(m_y - \lambda_y)} d\lambda_x d\lambda_y$$

$$= e^{2j\pi f_x m_x} e^{2j\pi f_y m_y} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} h(\lambda_x, \lambda_y) e^{-2j\pi f_x \lambda_x} e^{-2j\pi f_y \lambda_y} d\lambda_x d\lambda_y$$

$$H(f_x, f_y) = \beta$$

Therefore

$$y(m_x, m_y) = H(f_x, f_y) e^{2j\pi f_x m_x} e^{2j\pi f_y m_y}$$

$$= \beta x(m_x, m_y)$$

We notice that $\mathbb{T}$ is then shift operator $S_{\alpha, \beta}$.

*http://www.ece.uprm.edu/~domingo*
1.0.1 Object Domain Representation

Obtain the impulse of $S_{\alpha,\beta}$; that is

$$S_{\alpha,\beta}\{\delta(m_x, m_y)\} = h(m_x, m_y)$$

where

$$h(m_x, m_y) = \delta(m_x - \alpha, m_y - \beta).$$

To obtain

$$y(m_x, m_y) = S_{\alpha,\beta}\{x(m_x, m_y)\}$$
for \( x(m_x,m_y) \) an arbitrary signal, we proceed as follows:

\[
y = x * * h = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} x(\lambda_x,\lambda_y) h(m_x - \lambda_x, m_y - \lambda_y) \, d\lambda_x d\lambda_y
\]

\[
= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} x(\lambda_x,\lambda_y) \delta(m_x - \alpha - \lambda_x, m_y - \beta - \lambda_y) \, d\lambda_x d\lambda_y
\]

\[
= x(m_x - \alpha, m_y - \beta).
\]

**Theorem 1  Object Domain Convolution**

The Fourier transform of the linear convolution of two arbitrary signals, say \( x \) and \( h \) is equal to the product of the Fourier transform of each of the individual signals.

If

\[
y = x * * h \implies Y(f_x, f_y) = X(f_x, f_y) \cdot H(f_x, f_y).
\]

**Theorem 2  Spectral Domain Convolution**

The Fourier transform of the product of two arbitrary signals is equal to the linear convolution of the Fourier transform of each of the individual signals.

If

\[
x_v = x \cdot v \implies X_v(f_x, f_y) = X(f_x, f_y) * * V(f_x, f_y).
\]

1.1  **ODCT: Object Domain Convolution theorem**

The Fourier transform of the impulse response function is called the frequency response or spectral response of the system.

1.2  **Multi–input/Multi-output LSI systems**

for \( m_0, m_1, ..., m_{N-1} \in \mathbb{R} \).
1.3 Modeling of multidimensional systems through filters

1.3.1 Direct method: Type I

We substitute the input delta function by Gaussian white noise.
1.4 System Identification

Objective: Minimize $\varepsilon$

$$\varepsilon = y_n - y_m$$

Example 3 Ideal filter are filters that assume values of zero or one only is prescribed spectral bands We the have

$$H_L = \begin{cases} 
1, & |f_x| \leq f_{M_x} , |f_y| \leq f_{M_y} , \\
0, & \text{otherwise.} 
\end{cases}$$

Figure 6: System identification.

Figure 7: .

Figure 8: .
1.5 Objective in multidimensional signal processing

A main objective of multidimensional signal processing is the processing of multidimensional using discrete samples techniques.

Figure 9:

where CSD: Changed coupled deviles; SAW filter: Surfase Acoustic wave filter; DSP: Digital Signal Processor.