SOUTH CHINA UNIVERSITY OF TECHNOLOGY

MULTI-ANTENNA AND SIGNAL PROCESSING & MIMO COMMUNICATION

HANN WEIGHTING

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SPECTRAL WEIGHTING METHOD

Hann Weighting

Beam pattern of desired shape can be obtained by changing the weight of each sensor output. Using this technique a beam pattern with desirable output can be obtained.

Hann Weighting is given by the following expression:

$w(m) = c_2 * \cos^2(\frac{\pi m}{M})$ ……………………………………………………………………………………………… Eq.1

where $m = \frac{-M-1}{2}, \ldots \ldots, \frac{M-1}{2}$

C_2 is used to normalize the beam pattern and its value is calculated by equating the beam pattern to unity.

For a linear array, Beam pattern is given by:

$$B(f, \phi, \theta) = \Sigma_m\, w_m^* \exp\left(\frac{j2\pi m\Delta sin\theta}{\lambda}\right)$$

where, $m = \frac{-M-1}{2}, \ldots \ldots, \frac{M-1}{2}$
Δ = spacing between the sensors.
λ = wavelength of the signal.

Using Eq.1, we get
$B(f, \phi, \theta) = C_2\, \Sigma_m \cos^2\left(\frac{\pi m}{M}\right) * \exp\left(\frac{j2\pi m\Delta sin\theta}{\lambda}\right)$ …………………………………………...Eq.2
where, $m = \frac{-M-1}{2}, \ldots \ldots, \frac{M-1}{2}$

Now calculate the value of C_2.

Using Eq.2,

$B(f, \phi, \theta) = 1\ and\ \theta = 0°$.

$1 = C_2\, \Sigma_m \cos^2\left(\frac{\pi m}{M}\right)$

$C_2 = \frac{1}{\Sigma_m \cos^2\left(\frac{\pi m}{M}\right)}$ where, $m = \frac{-M-1}{2}, \ldots \ldots, \frac{M-1}{2}$

Finally, the beam pattern of linear array is given by

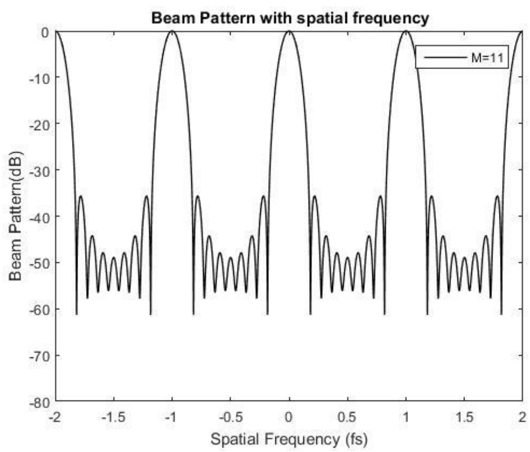
$B(f, \phi, \theta) = \frac{1}{\Sigma_m \cos^2\left(\frac{\pi m}{M}\right)} * \Sigma_m[\cos^2\left(\frac{\pi m}{M}\right) exp\left(\frac{j2\pi m\Delta sin\theta}{\lambda}\right)]$ ……………………………… Eq.3

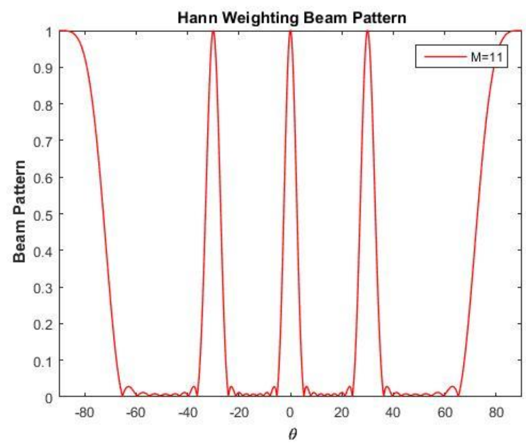
Eq.3 is the equation of beam pattern of Linear Array for Hann Weighting.

The analysis of the beam pattern can be done using Matlab. Eq.3 is used to analyze the beam pattern.

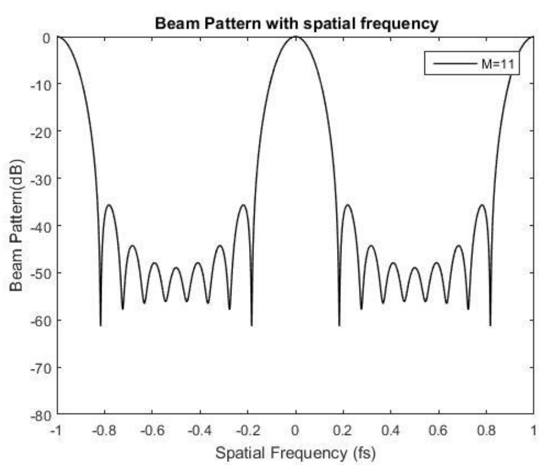
In Matlab, *plot* command can be used to draw the beam pattern.
The *Plot* command will draw the pattern in 2D in Cartesian coordinates.

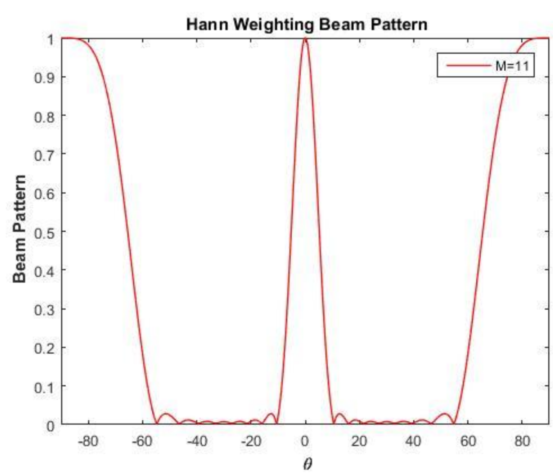
Beam Pattern for M = 11, $\Delta = 2\lambda$:



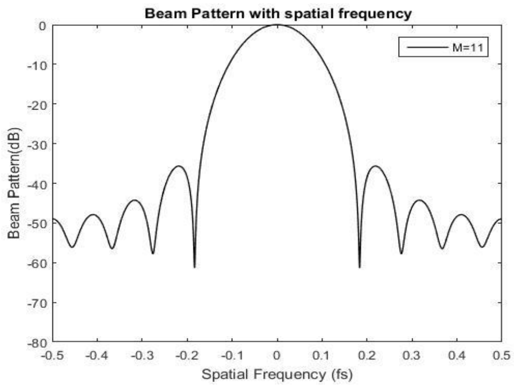


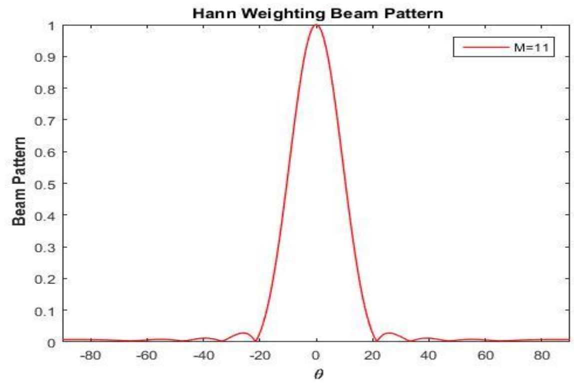
Beam Pattern for M = 11, $\Delta = \lambda$:



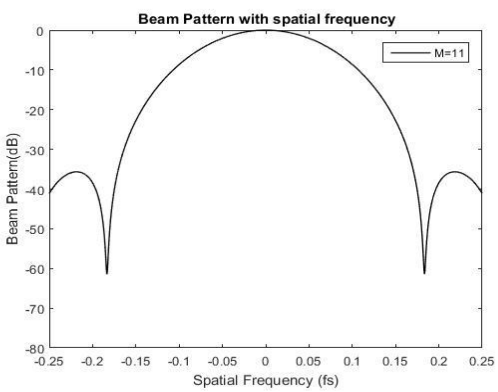


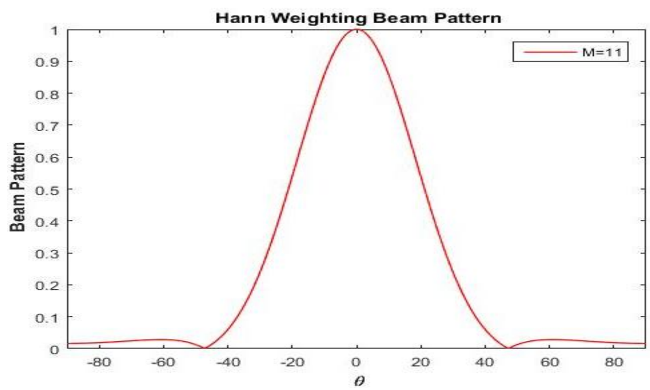
Beam Pattern for M = 11, $\Delta = \boldsymbol{\lambda}\backslash\mathbf{2}$:



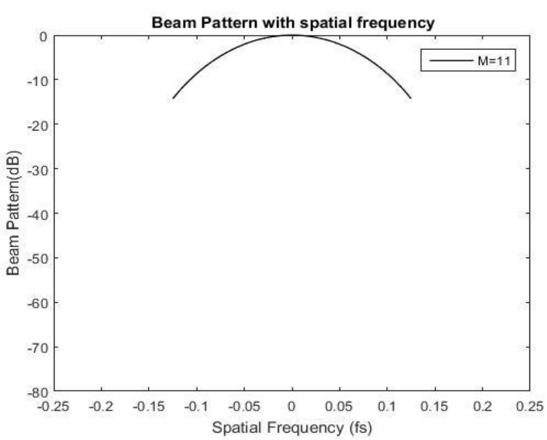


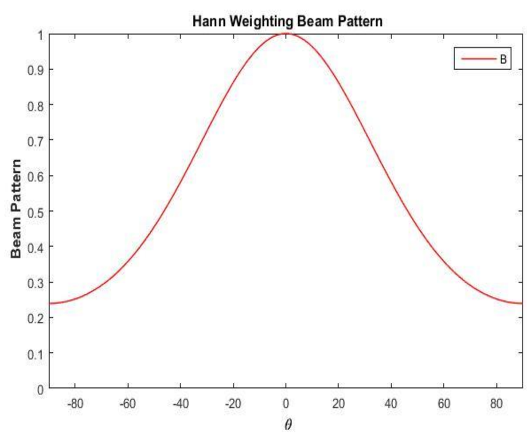
Beam Pattern for M = 11, $\Delta = \boldsymbol{\lambda}\backslash\mathbf{4}$:



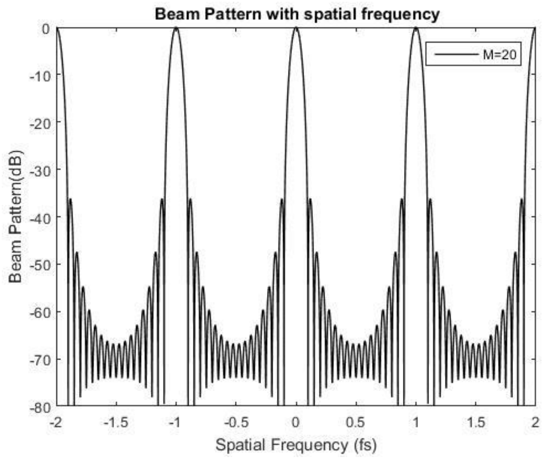


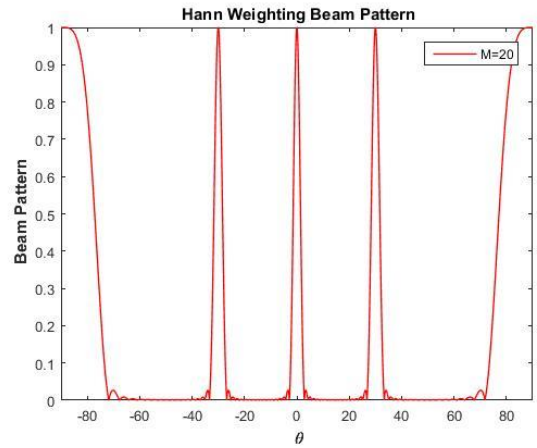
Beam Pattern for M = 11, $\Delta = \boldsymbol{\lambda}\backslash\mathbf{8}$:



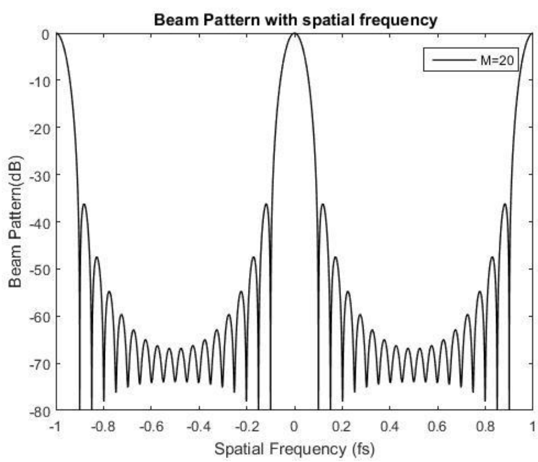


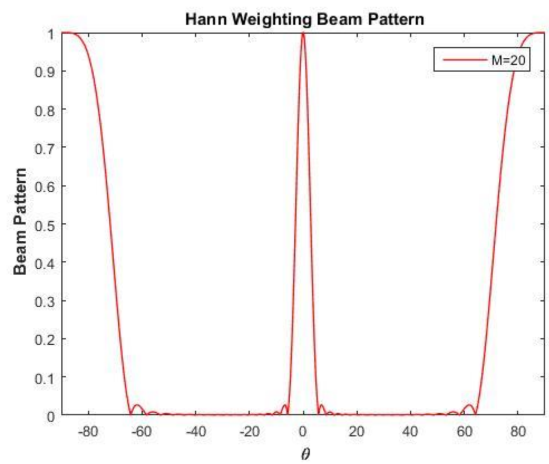
Beam Pattern for M = 20, $\Delta = 2\lambda$:



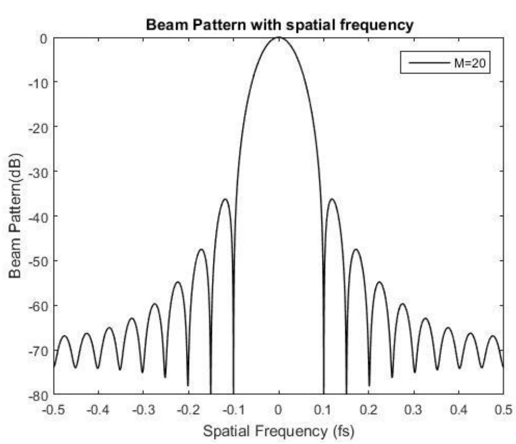


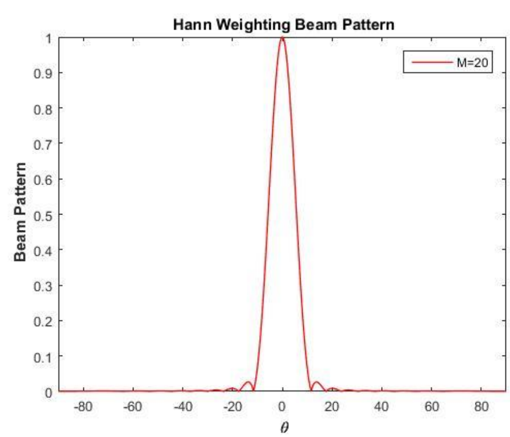
Beam Pattern for M = 20, $\Delta = \lambda$:





Beam Pattern for M = 20, $\Delta = \lambda/2$:





It can be seen from the above patterns that the side lobes in Hann weighting are decreasing more rapidly than the uniform weighting. Side lobes energy in Hann Weighting is very less. The main lobe width is less than the uniform weighting. It shows that the resolution capability has been increased from the uniform weighting.