Sidelobe Reduction of LFM Signal Using Convolutional Windows

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Pulse compression

- In a pulse radar system the transmitted pulse width should be as long as possible to increase the sensitivity of the system and as small as possible at the receiver for better range resolution.

- In pulse compression technique a long coded pulse is transmitted and the received echo is processed to obtain a relatively narrow pulse.

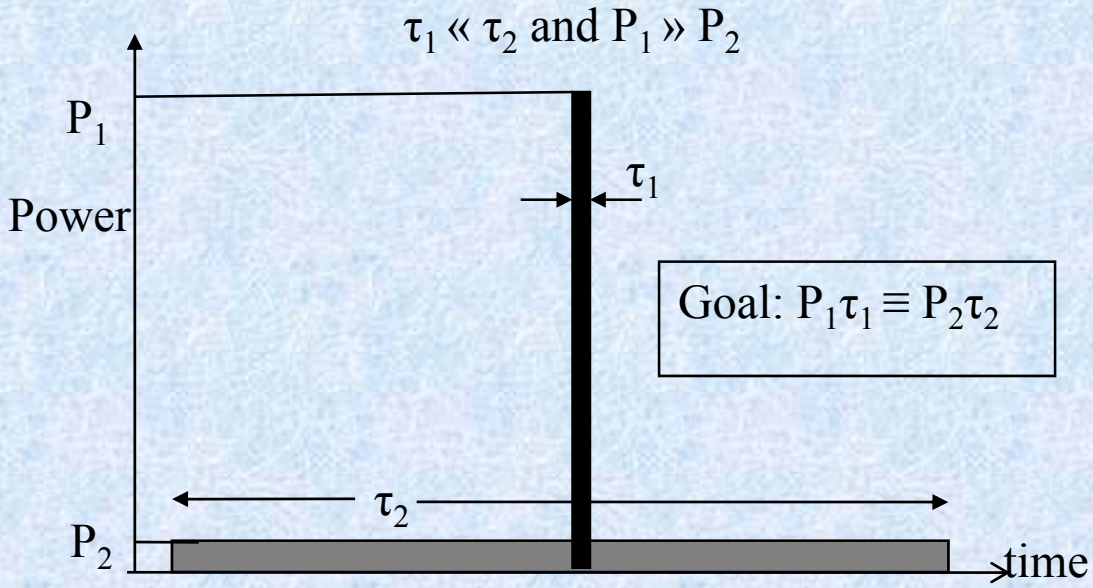
- Pulse compression technique avoids the transmission of a signal having small pulse width and high peak power for better range resolution.

- The performance of range resolution radar would be optimal, if the coded waveform has impulsive autocorrelation.

- Wide bandwidth, which is necessary for good range resolution, is obtained by modulating phase or frequency of the signal, while maintaining constant pulse amplitude.

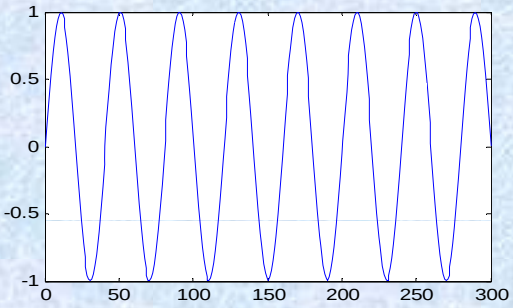
Pulse compression Contd…

Energy content of long-duration, low-power pulse will be comparable to that of the short-duration, high-power pulse

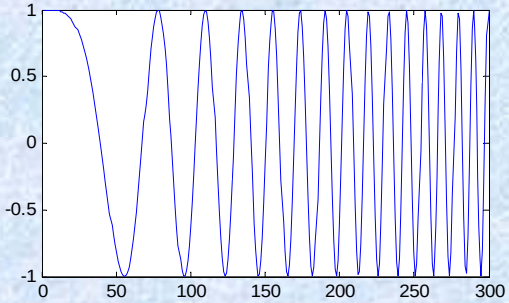


LFM and Simple Pulse

Time Domain

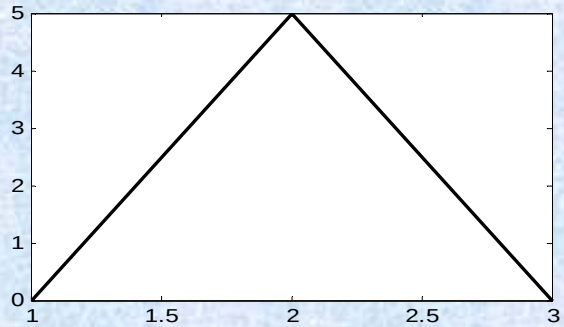


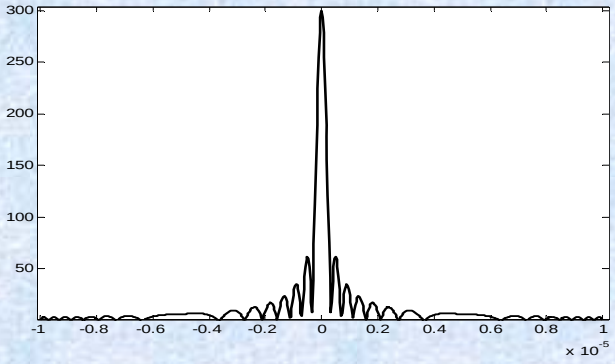
Simple Pulse



LFM Waveform

Matched Filter Output





- Range sidelobes are inherent part of the pulse compression technique

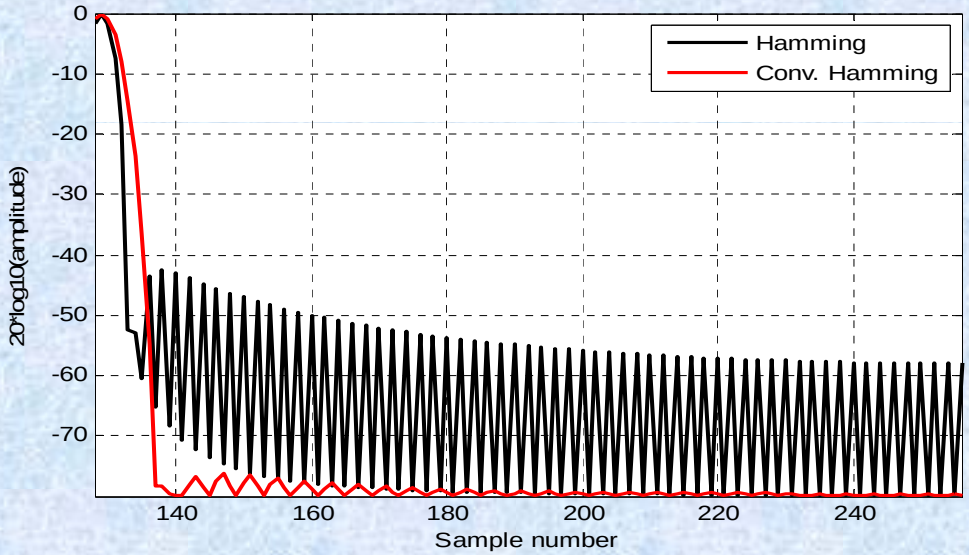
- Weighing technique in time or in the frequency domain is mostly used to reduce these range sidelobes with broadening in the mainlobe.

- Time domain weighing is preferred to frequency domain weighing, because it produces lower sidelobe compression output .

- Although weighing when used both on transmitter and receiver provides better results, weighing on receive is preferred because weighing on transmit leads to a power loss since the available transmit power cannot be fully utilizes.

Convolutional Window

Convolutional windows are derived by convolving the window with itself

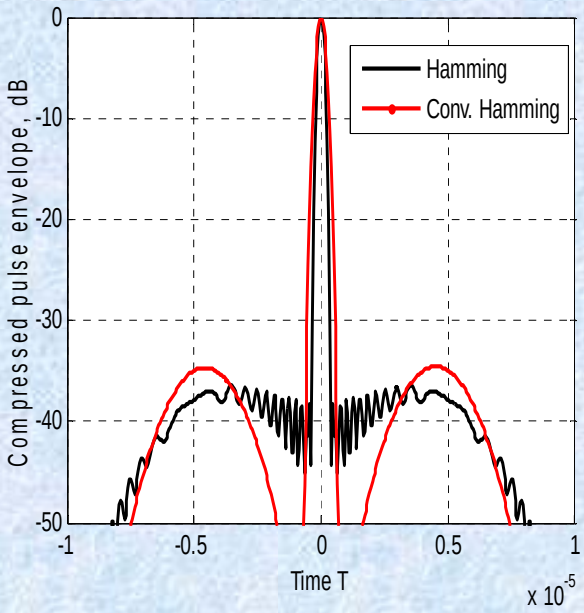


Frequency response

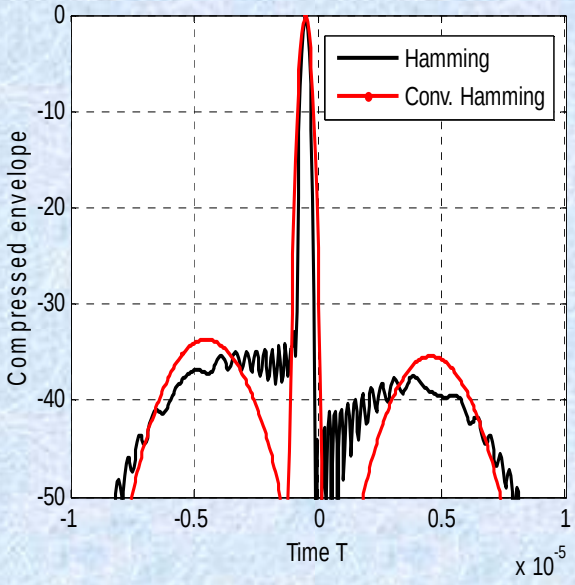
Simulation Results

$$S(t) = \exp\left[j2\pi\left(f_0 t + \frac{B}{2T} t^2 \right)\right] \qquad |t| \le \frac{T}{2}$$

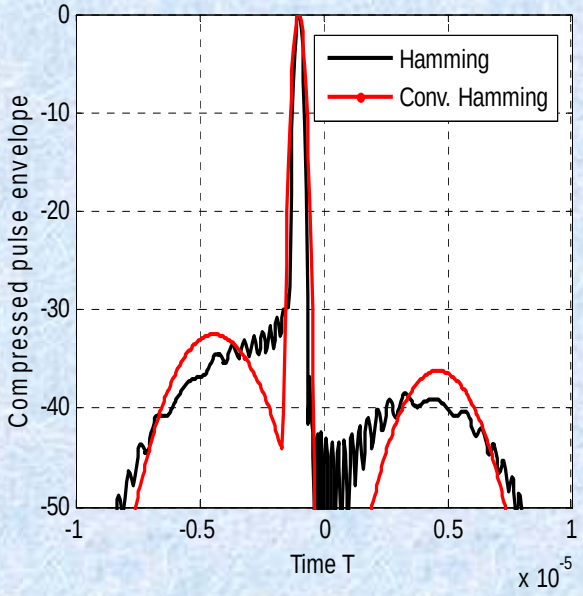
f_0=centre frequency =30MHz
B = Bandwidth= 5MHz
T=Duration.= 10μs



(a)without Doppler shift



(b)0.05 Doppler shift



(c) 0.1 Doppler shift

Effect on sidelobes due to Doppler shift

Simulation Results Contd…

Doppler shift $\left(\frac{f_d}{B}\right)$	PSR using Hamming window in dB	PSR using convolutional hamming window in dB
0.01	36.2	34.46
0.05	32.8	33.67
0.1	28.6	32.5
0.15	25.2	31
0.2	22.2	29
Doppler shift $\left(\frac{f_d}{B}\right)$	PSR using Hanning window in dB	PSR using convolutional Hanning window in dB
0.01	31.68	33.67
0.05	30.32	33
0.1	27.62	31.79
0.15	24.47	30.44
0.2	22	28.7

Conclusion

- In this paper convolutional windows are applied for radar pulse compression and compared with the performance of conventional windows.

- From the simulation results it is evident that variation of PSR values in case of convolutional windows is less as compared to that of conventional windows and also PSR of convolutional windows is greater at higher Doppler shifts.

- However in case of convolutional windows the sidelobes have been lowered but mainlobe width is increased.

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Thank You