Real-Time Gunshot Localization Using Acoustics

Simulations

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Equations used for Generating Signature Waveforms

Muzzle Blast signature:

$$f_{\text{Friedlander}}(t) = \begin{cases} 0, & t \le t_0, \\ A\,(t - t_0)/t_r\,, & t_0 < t \le t_0 + t_r, \\ A\,[1 - (t - t_0 - t_r)/t_d]\,\mathrm{e}^{-(t-t_0-t_r)/t_d}, & t > t_0 + t_r. \end{cases}$$

A = peak amplitude

t_0 = TOA

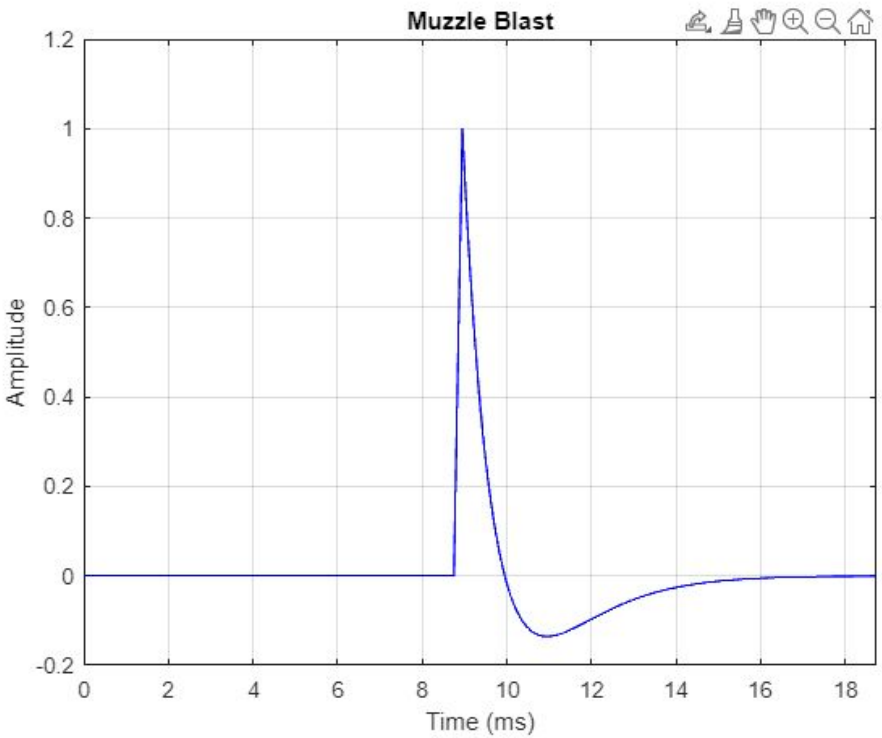
t_r = Rise Time (Can be neglected)

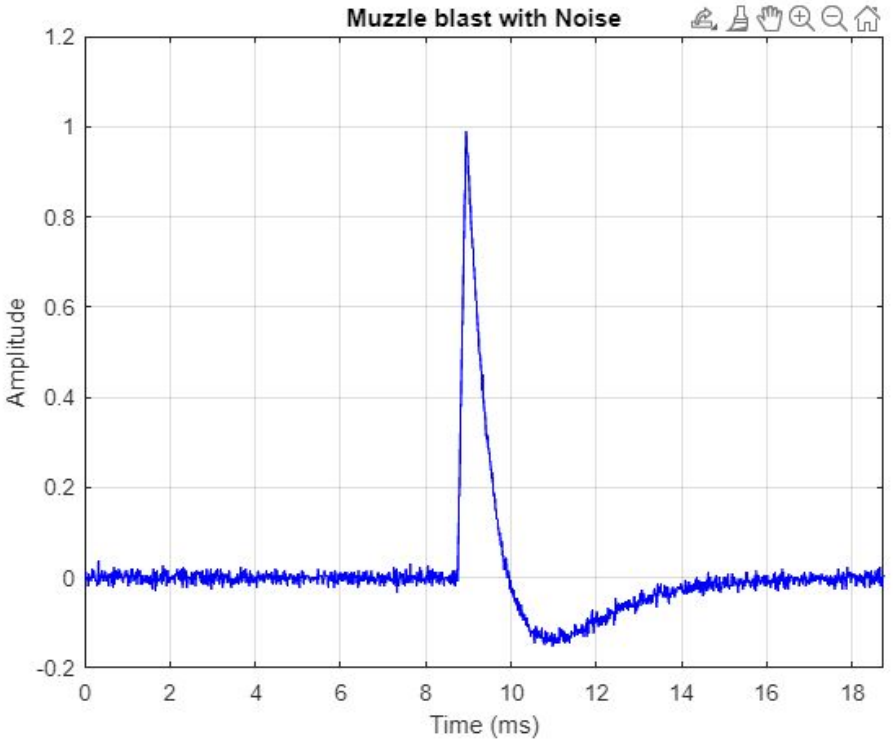
t_d = Decay time

'N' wave signature for ballistic shocks:

$$f_{\text{N-wave}}(t) = \begin{cases} 0, & t \le T_0, \\ B\,(t - T_0)/T_r\,, & T_0 < t \le T_0 + T_r, \\ B\,[1 - 2(t - T_0 - T_r)/T_d]\,, & T_0 + T_r < t < T_0 + T_r + T_d, \\ B\,[(t - T_0 - T_r - T_d)/T_r - 1]\,, & T_0 + T_r + T_d < t < T_0 + 2T_r + T_d, \\ 0, & t > T_0 + 2T_r + T_d. \end{cases}$$

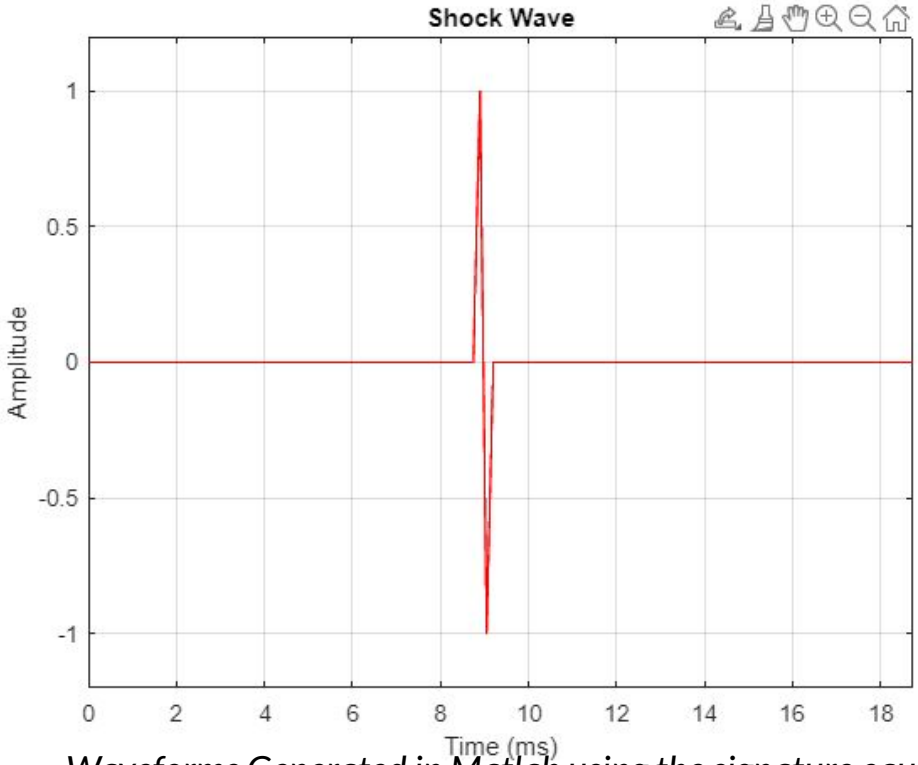
Muzzle Blast Simulated Waveform

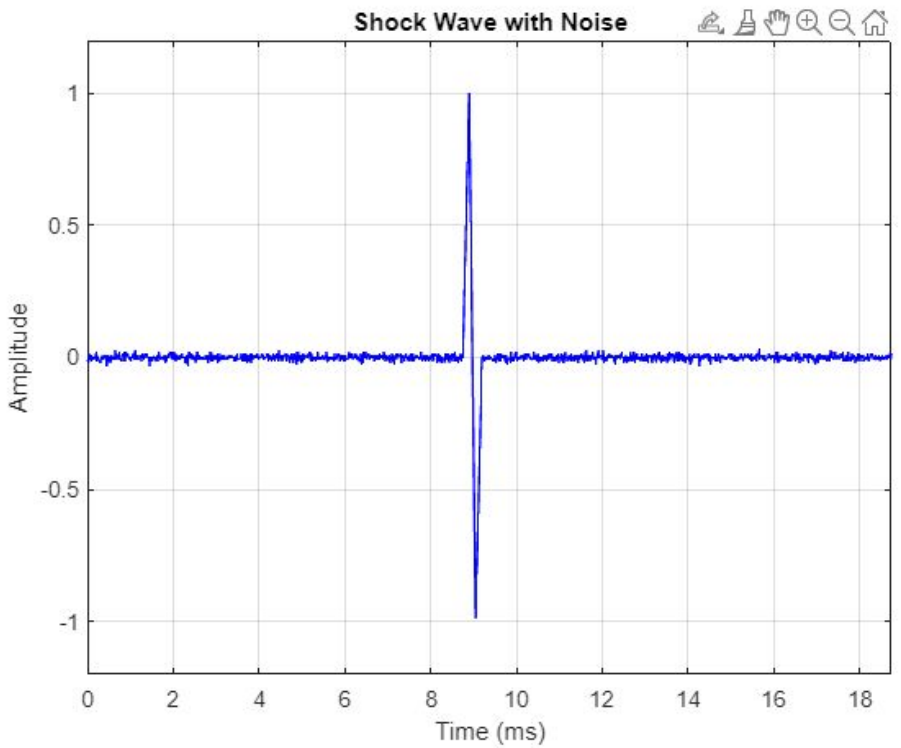




Waveforms Generated in Matlab using the signature equations and adding White Gaussian Noise

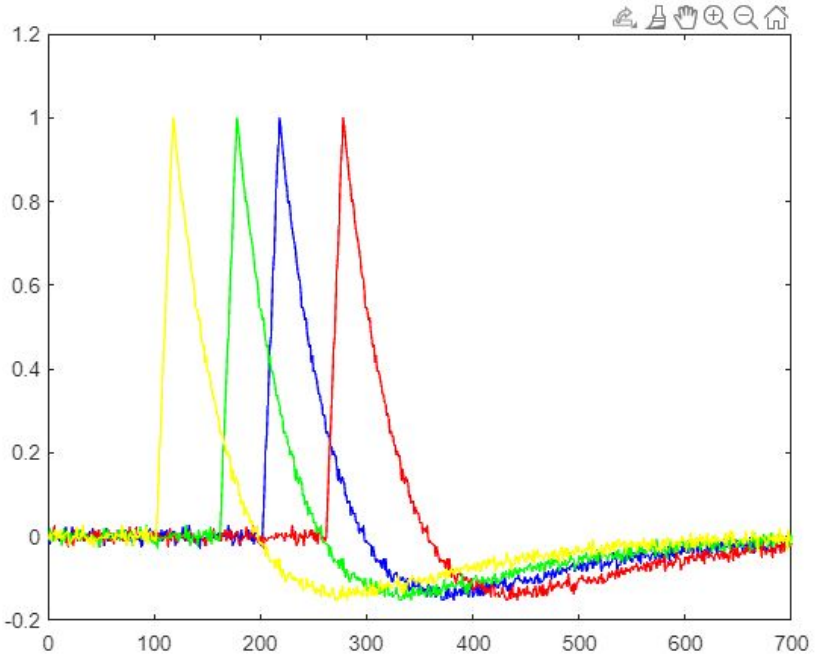
Shock Wave Simulated Waveform





Waveforms Generated in Matlab using the signature equations and adding White Gaussian Noise

Muzzle Blast Signature 4 Channel



The waveform was generated 4 times after adding a variable delay in time for the 4 microphones.
700 data samples(@80kHz) of this waveform were saved in a .mat file and transferred to RPi for further processing

Thank You