event signal occurring at the mixing zone of the first and second acoustic signals; and characterizing properties of the medium or creating a 3D image of the properties of the medium, or both, based on the emulated micro-seismic event signal.

[0007] Another aspect of the present disclosure is to provide a system for generating a micro-seismic event in a medium from a non-linear interaction to characterize the medium. The system includes a first acoustic source configured to generate a first coded acoustic signal comprising a first plurality of pulses arranged as a time sequence, the first plurality of pulses being separated in time, each pulse comprising a modulated signal at a central frequency, wherein central frequencies of two consecutive pulses are different; and a second acoustic source configured to generate a second coded acoustic signal comprising a second plurality of pulses arranged as a time sequence, the second plurality of pulses being separated in time, wherein a separation in time between centers of two consecutive pulses is the same as a separation in time between centers of two corresponding pulses in the first plurality of pulses, wherein a start time difference is provided between a start time of a broadcast of the second plurality of pulses and a start time of a broadcast of the first plurality of pulses, wherein each pulse comprises a modulated signal and a central frequency of the modulated signal within each pulse in the second plurality of pulses is a selected fraction d of the central frequency of the modulated signal for the corresponding pulse in the first plurality of pulses. The first acoustic source and the second acoustic source are controllable such that trajectories of the first and the second acoustic signals intersect in a mixing zone within the medium. The system also includes a receiver configured to receive a detected signal including a third signal being generated by a non-linear mixing process from the first acoustic signal and the second acoustic signal in the mixing zone. The system further includes a processor configured to perform data processing on the received signal, or correlate with a coded signal template, or both, to extract the third signal generated by the non-linear mixing process over noise or over signals generated by a linear interaction process, or both, to obtain an emulated micro-seismic event signal occurring at the mixing zone of the first and second acoustic signals so as to characterize properties of the medium or create a 3D image of the properties of the medium, or both, based on the emulated micro-seismic event signal.

[0010] These and other objects, features, and characteristics of the present invention, as well as the methods of operation and functions of the related elements of structure and the

28. The system according to claim 2729, further comprising:

Wherein the processor is configured to extract the third signal from the emulated micro-seismic event at the mixing zone of the first and second acoustic signals by correlating the detected signal at a receiver Ri with a coded template signal $u_S(t)$, and

repeat for a plurality of start time differences δ between the second plurality of pulses and the first plurality of pulses and for a plurality of frequency ratios d between the central frequency of the modulated signal within each pulse in the second plurality of pulses and the central frequency of the modulated signal with each corresponding pulse in the first plurality of pulses, the correlating between the template signal and the detected signal to yield, for each start time difference δ and for each frequency ratio d, a correlated signal for each receiver Ri denoted as M(Ri, t), which contains emulated micro-seismic events generated by non-linear interaction at specific mixing locations according to selection rules of non-linear interaction.

29. The system according to claim 28, wherein the processor is configured to calculate, for each start time difference δ and for each frequency ratio d and the corresponding correlated signal M(Ri, t), the spatial coordinates of emulated micro-seismic events where the two acoustic signals interact non-linearly using locus analysis and travel time calculations based on a velocity model for compression or shear wave velocity.

30. The system according to claim 28, wherein the processor is configured to apply time reversal operations to propagate backward in time the signals of the emulated micro-seismic events to the time and location of origination of the micro-seismic events with a propagation velocity model.

31. The system according to claim 30, wherein the processor is configured to determine relative strengths of the micro-seismic events at the locations of origination, wherein the relative strengths at the locations of origination are proportional to non-linear properties of the medium at the locations of origination of the micro-seismic events.