Similar to defining the auto-bicoherence, one can define a normalised cross-bispectrum to quantify the level of quadratic coupling in two signals. The normalized value is called the cross-bicoherence and is defined as

$$b_{yxx}^2(f_1, f_2) = \frac{|\widehat{\mathrm{B}}_{\mathrm{yxx}}(\mathrm{f}_1, \mathrm{f}_2)|^2}{\frac{1}{\mathrm{M}}\sum_{\mathrm{k}=1}^{\mathrm{m}} |\mathrm{X}_{\mathrm{T}}^{(\mathrm{k})}(\mathrm{f}_1)\mathrm{X}_{\mathrm{T}}^{(\mathrm{k})}(\mathrm{f}_2)|^2 \frac{1}{\mathrm{M}}\sum_{\mathrm{k}=1}^{\mathrm{m}} |\mathrm{Y}_{\mathrm{T}}^{(\mathrm{k})}(\mathrm{f}_1 + \mathrm{f}_2)|^2} \tag{15}$$

If no phase relationship exists among the frequency components at f_1, f_2 in x(t) and the frequency component at $(f_1 + f_2) =$ y(t), the value of the cross-bicoherence will be at or near zero. If a phase relationship does exist among these frequency components, the value of the cross-bicoherence will be near unity. Values of cross bicoherence between zero and one indicate partial quadratic coupling.

4.Metrics proposed to evaluate propeller cavitation

As the cavitation process sets in beyond certain hydrodynamic speed, both the magnitude and number of interactions are expected to increase. The following fundamental frequency components and their harmonics are expected due to any propeller rotation which can be measured using a hydrophone.

i) Shaft frequency (N_s)

ii) Blade pass frequency (N_p= N_s x No. Of blades)

iii) Blade natural frequency (N_N)

In any non-linear dynamical system, there could be many possibilities of generating overtones from the above frequency components as sum-interactions and difference-interactions. All these components are expected to be available in bi-coherence spectra as and when this magnitude is detectable by the hydrophone.

In order to quantify the quadratic phase coupling with inception of cavitation, a metric called QPC I_n (Quadratic Phase Coupling index) is proposed to be introduced [3].