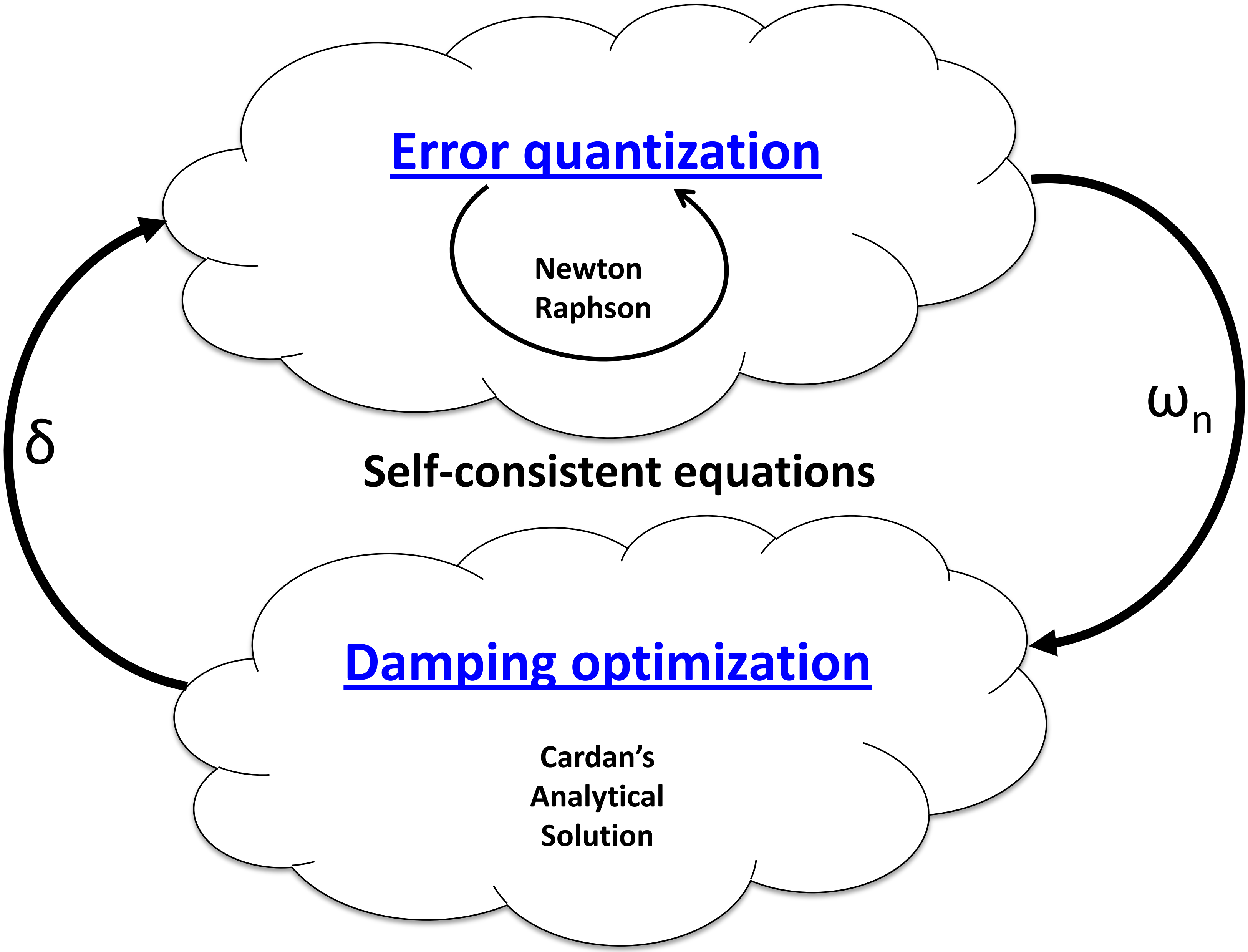
- **Recap**
  - SRF, DDSRF, DSOGI, MCCF, Discrete SRF were implemented in Simulink
  - Intuitive applet – plots and comparisons between schemes
- **Presently used design**
  - The design of the loop filter (k_p and k_i) used in all the schemes were taken as is, from literature
    - Intention was to match the results with those in the literature
  - All schemes rely on the **Wiener optimization method**
    - A good trade-off between filtering characteristic and dynamic response
- **Motivation for our design**
  - Filtering aspect of the PLL is taken care of by the modifications as seen in DDSRF, DSOGI, MCCF etc.
  - e.g. in MCCF
  - Result: decoupling of *filtering characteristic* and *dynamic performance*

done by additional stages

can be separately focused on

A novel design optimization method



How does it work?

- Gives a single (k_p , k_i) pair for a given grid condition, pertaining to user specifications
- Variables (grid situation + user specification) are:
  - ❑ Frequency excursion
  - ❑ Phase jump
  - ❑ Error band
  - ❑ Settling time
- Demo

Advantages

- Existing methods involve trial and error as infinitely many (k_p , k_i) pairs may arise for a particular situation
- Both error and damping is optimized
- 3D lookup table - can be loaded on the DSP/microcontroller
  - ✓ Depending on a set of grid situation at any time instant, the optimized values can be picked
  - ✓ Theoretical inferences can be made for educational purposes

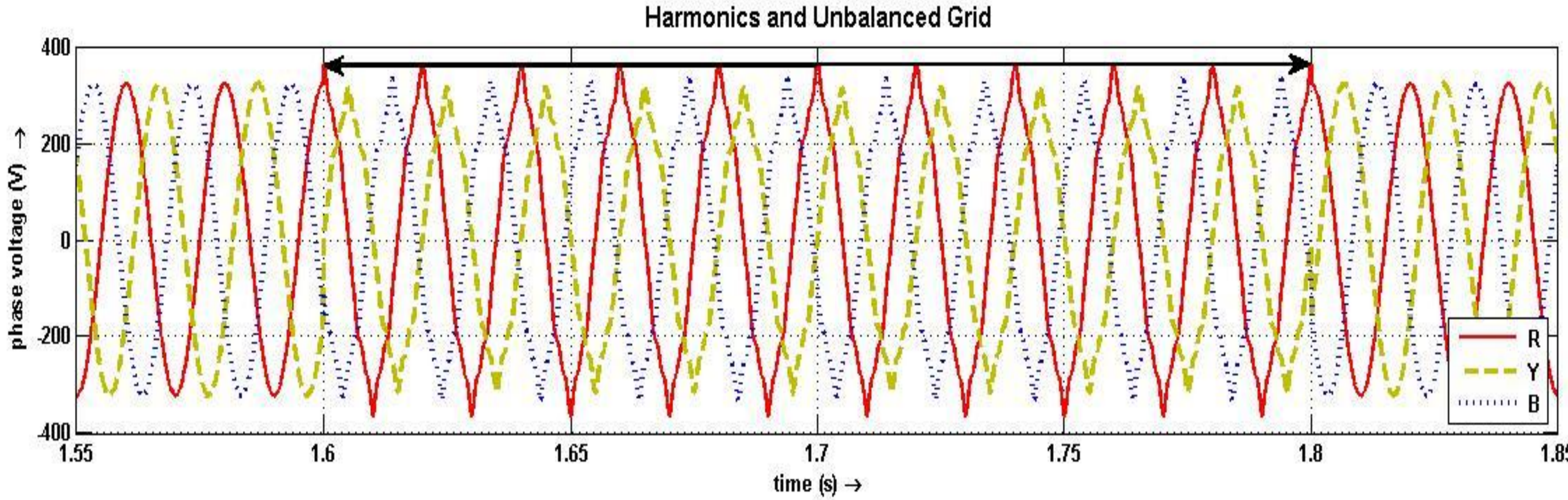
Hardware implementation

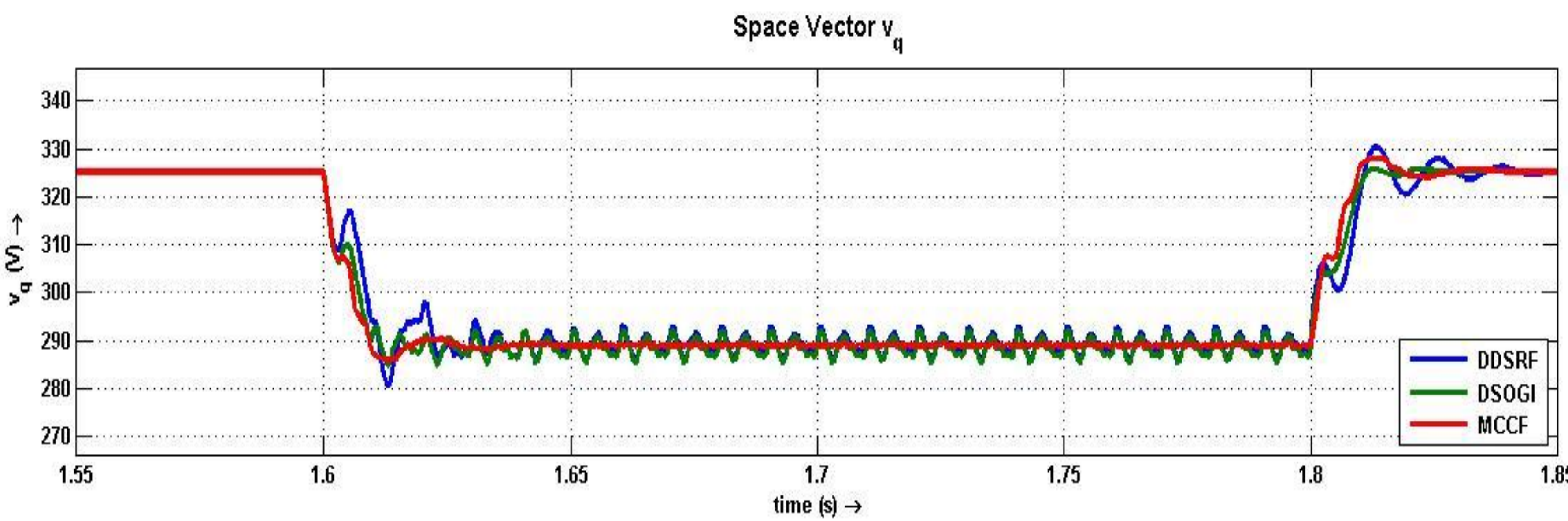
- Work has been started on the MSP430 Launchpad with basic testing and debugging of the ADC and PWM modules

Thank you

DDSRF, DSOGI, MCCF on Harmonics + Unbalanced Grid

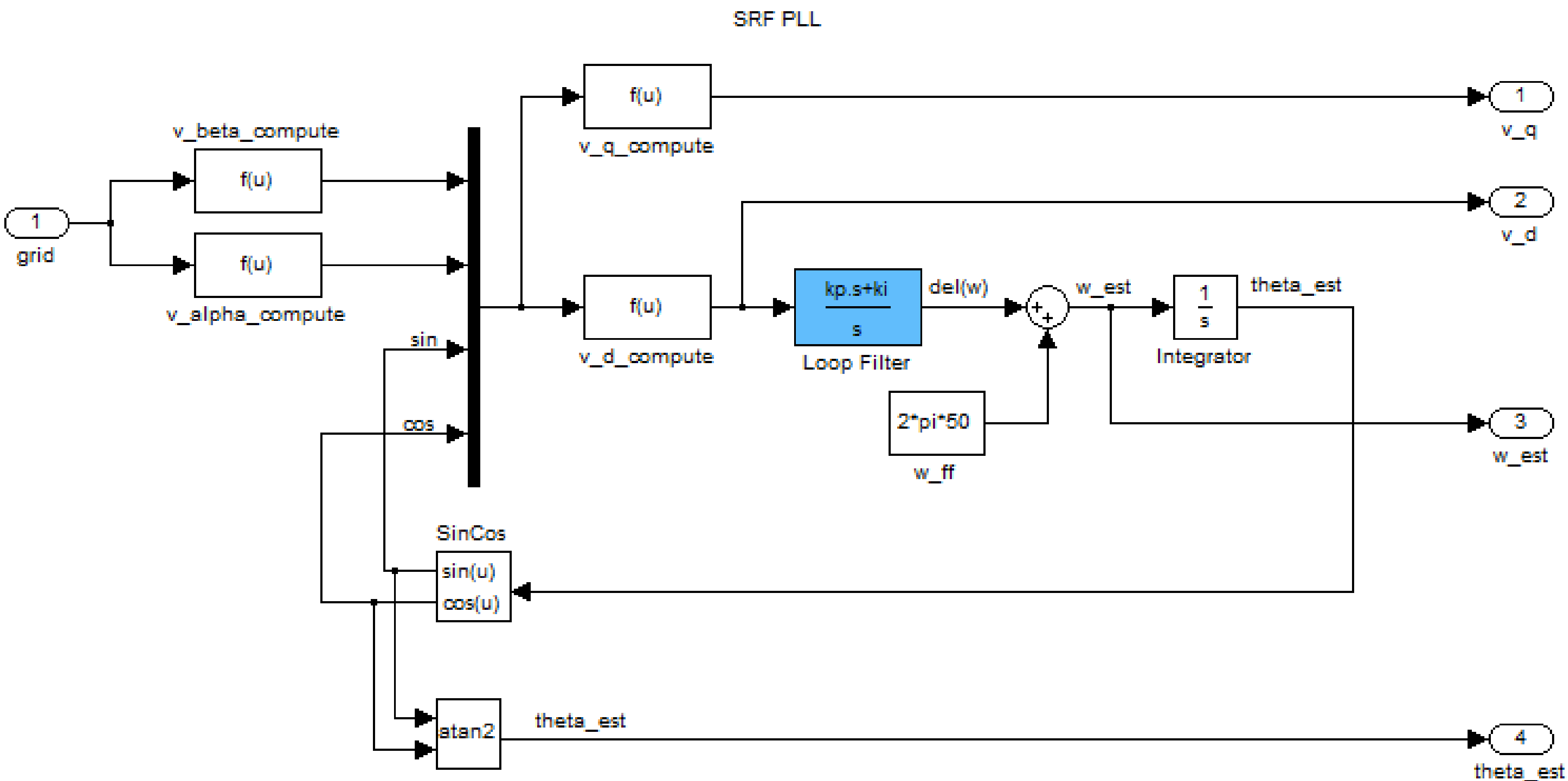
Back





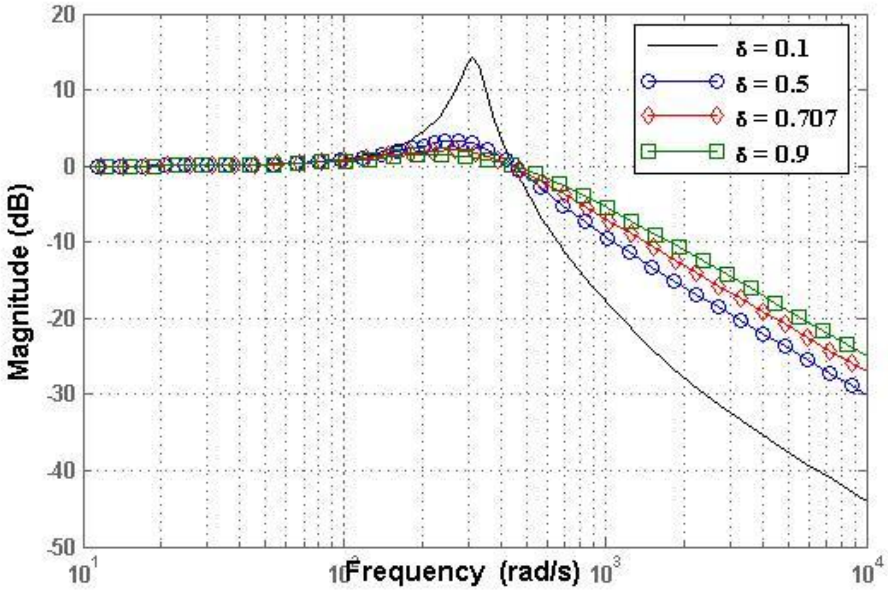
Conventional SRF PLL

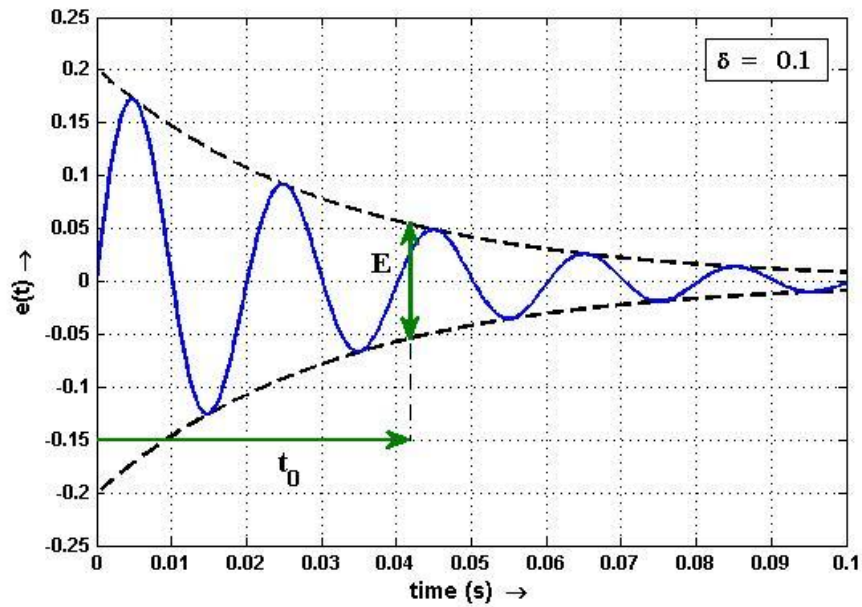
Back



[Back](#)

Filtering characteristic v/s Dynamic response





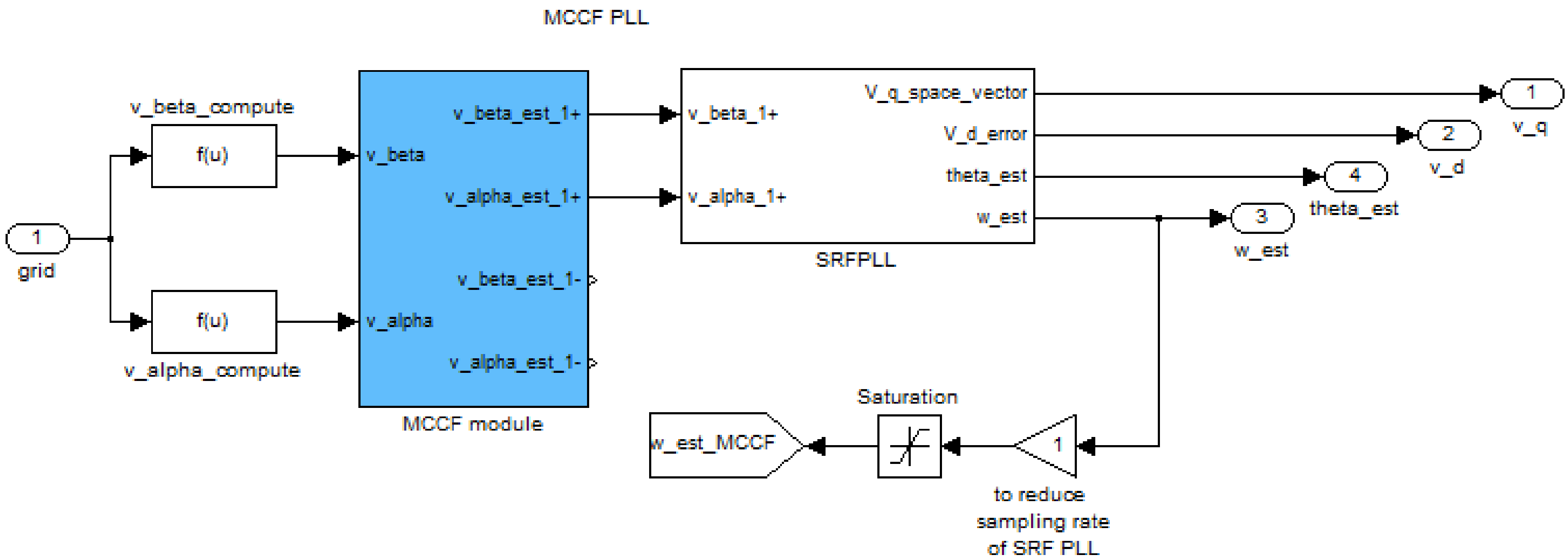
$$\textit{Filtering} \rightarrow \frac{1}{Bandwidth}$$

$$\textit{Dynamic performance} \rightarrow \textit{Bandwidth}$$

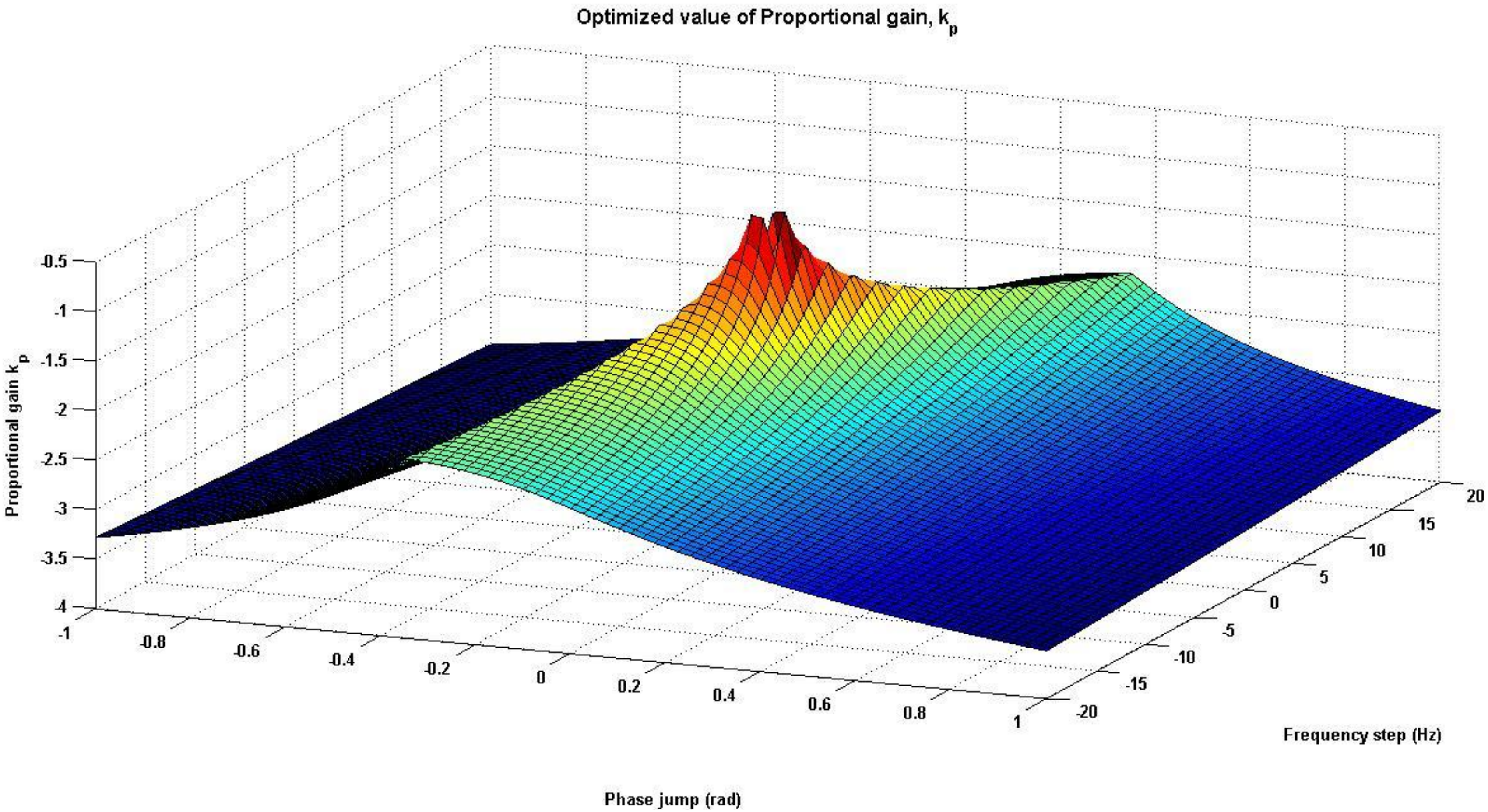
Wiener method: a good trade-off between filtering and dynamic response

MCCF - PLL

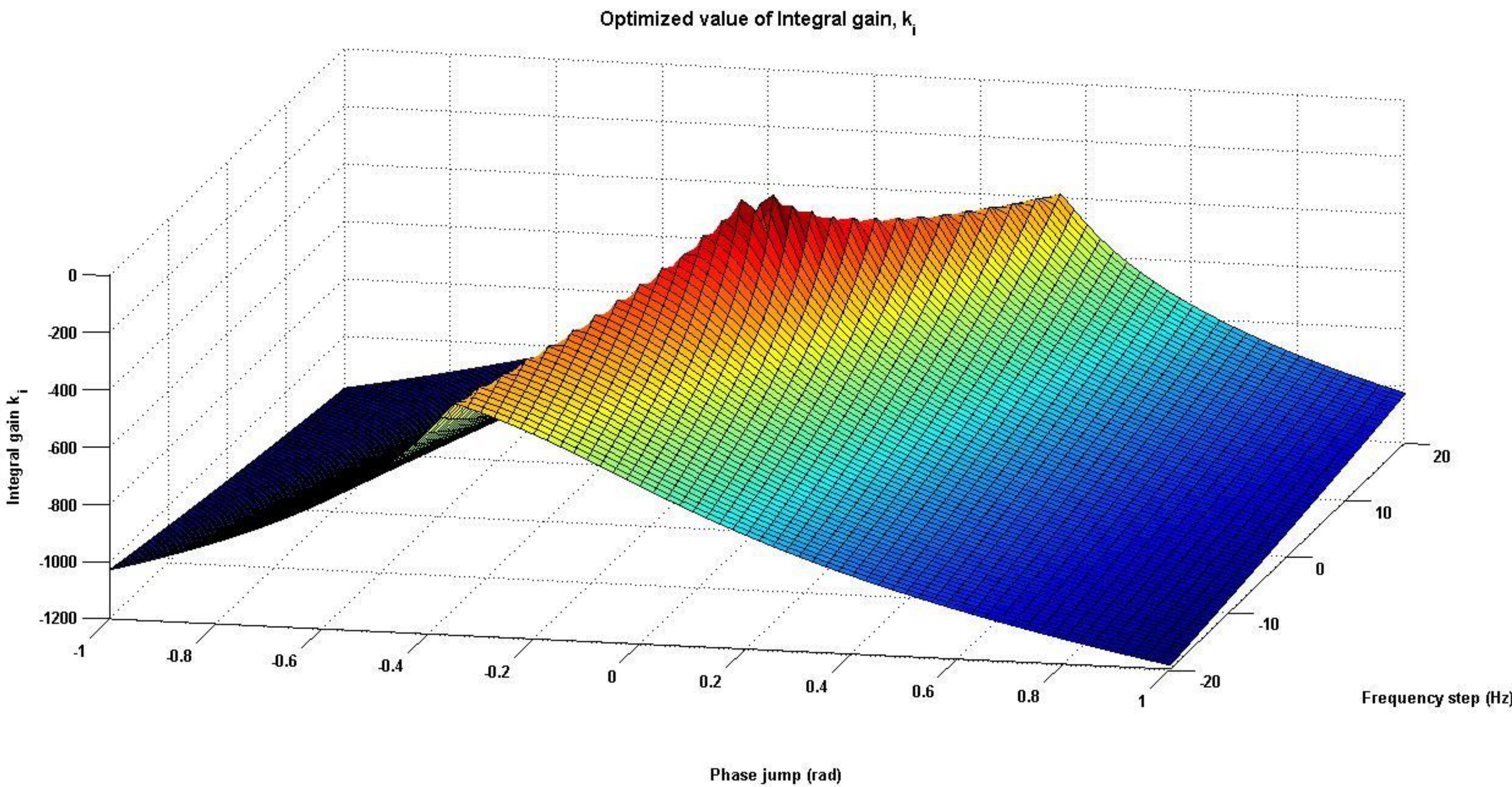
Back



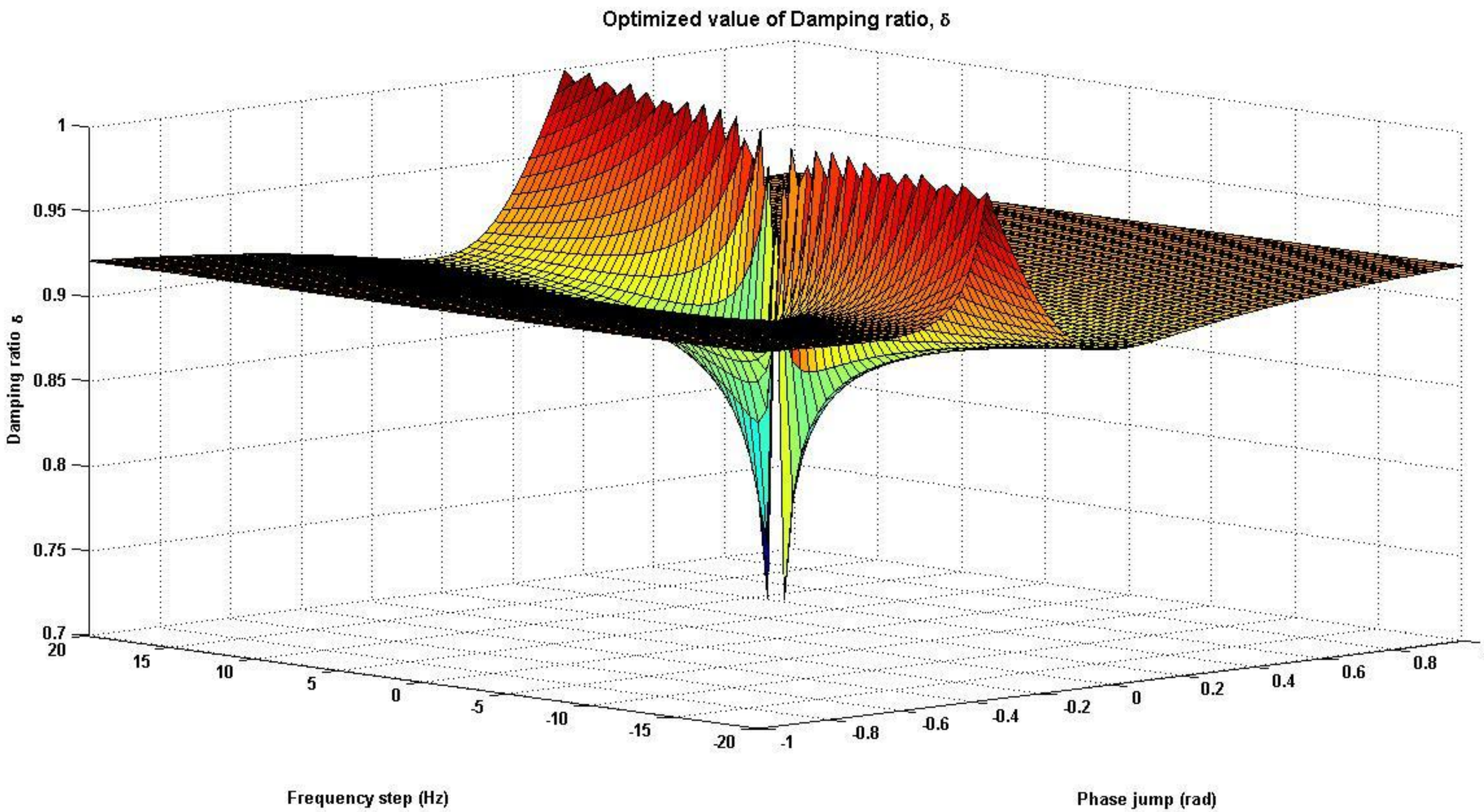
3D lookup table - k_p



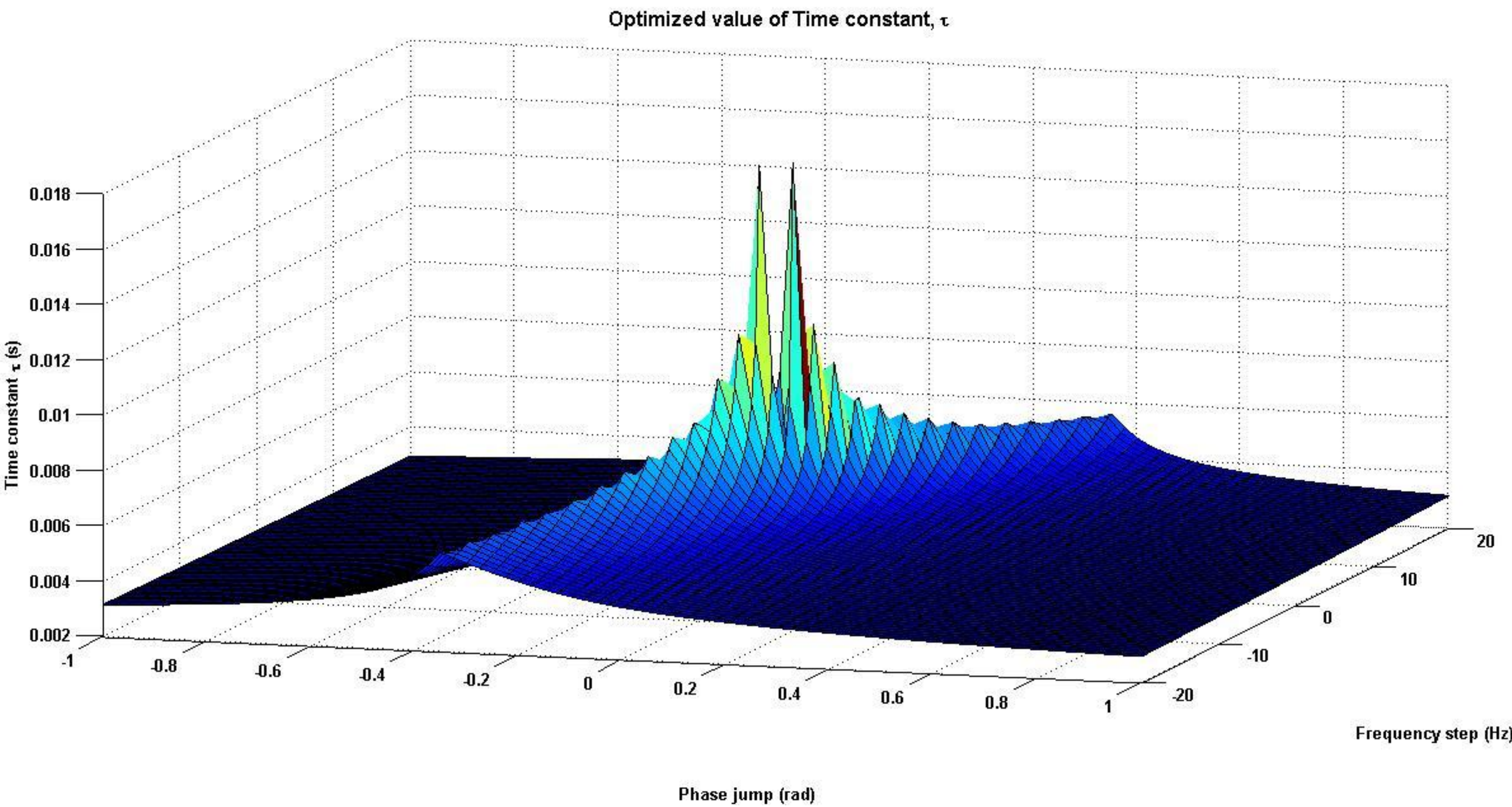
3D lookup table - k_i



3D lookup table – damping ratio

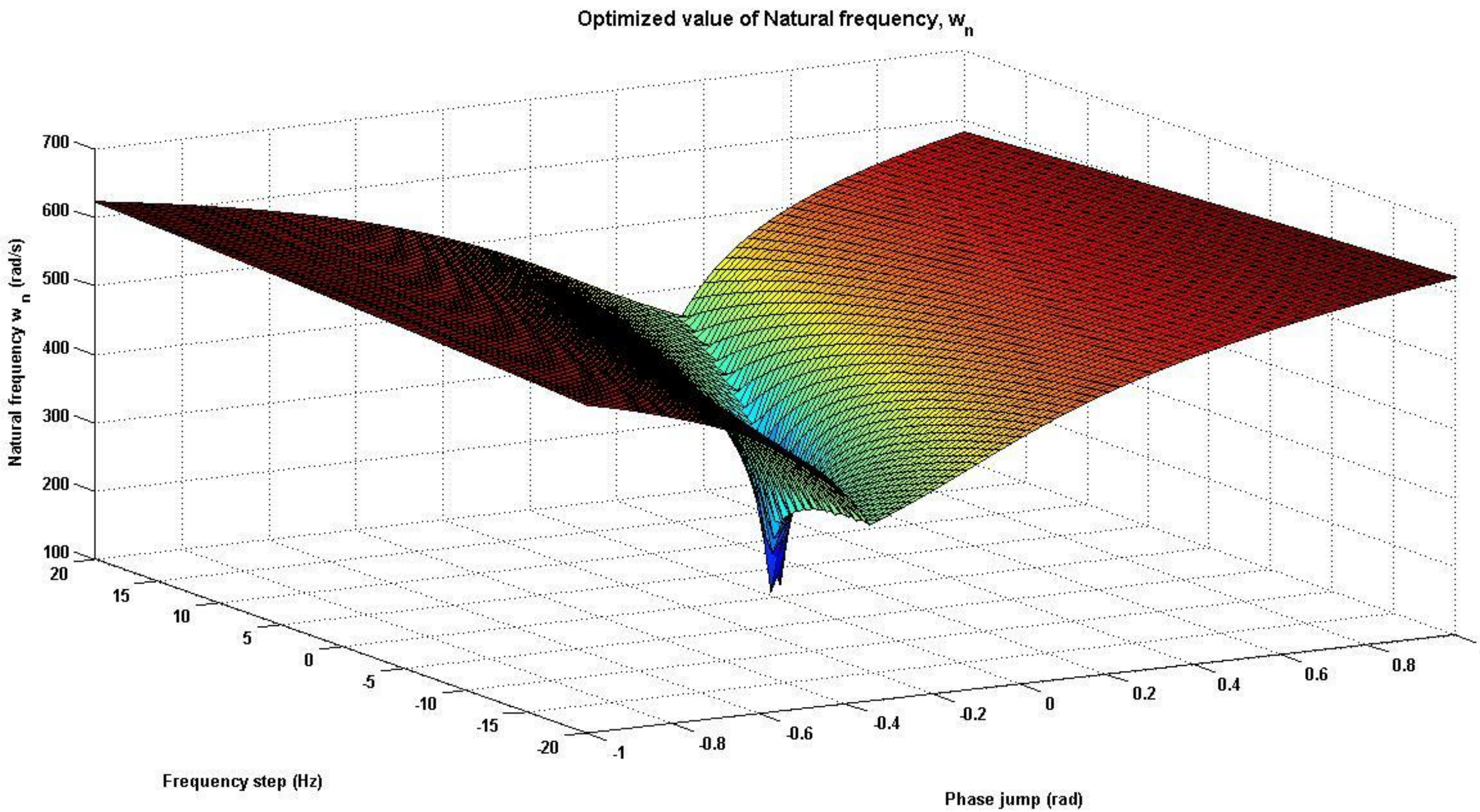


3D lookup table – time constant



3D lookup table - w_n

[Back](#)



[Back](#)

Error quantization

$$E = \frac{2e^{-\delta\omega_n t_0}}{\omega_n\sqrt{1-\delta^2}}\sqrt{{\Delta\omega_{step}}^2 + \phi^2{\omega_n}^2 - 2\Delta\omega_{step}\phi\omega_n\delta}$$

Damping optimization

Back

$$(-2\omega_n t_0 c_2)\delta^3 + (-c_2 + \omega_n t_0 c_1)\delta^2 + (c_1 + 2\omega_n t_0 c_2)\delta + (-c_2 - \omega_n t_0 c_1) = 0$$

where
$$c_1 = \Delta\omega_{step}{}^2 + \phi^2\omega_n{}^2$$
$$c_2 = \Delta\omega_{step}\phi\omega_n$$

Back

Damping optimization - comparisons