Request for ROM Cost, Parametric Oscillator for NGWFC

Chris Neyman, W. M. Keck Observatory
Erik Johansson, Consultant

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1. **Background.**

The Keck Adaptive Optics (AO) system suffers from the effects of vibration at 29 Hz due to rotating machinery in the telescope and dome enclosure. The 29Hz frequency is typically close to or above the tip-tilt control bandwidth and cannot be completely eliminated by the AO system. The vibration amplitude varies, but it is often large enough to be seen in the closed-loop power spectrum of the AO tip-tilt system, resulting in poor system performance and reduced Strehl [1]. The proposed Keck Next Generation AO system, which is currently in the design phase, requires very high-Strehl performance over a large fraction of the sky and cannot operate properly in the presence of these vibrations. A "parametric oscillator" has been proposed as a notch filter to drastically reduce or eliminate the effects of these vibrations for NGAO. We would like to implement the parametric oscillator in the current NGWFC system on the Keck II telescope as test system to verify the performance as a vibration canceller and reduce the overall risk for the NGAO project. The purpose of this note is to give Migrogate, S.r.l., Italy, enough information to generate a Rough Order of Magnitude (ROM) cost estimate to implement the parametric oscillator in the NGWFC system.

2. **Parametric Oscillator.**

The parametric oscillator is described in detail in [1]. A block diagram is shown below. The input parameters to the filter are ω, the estimated angular frequency of the disturbance, ϕ, a phase offset, and k, a gain factor.

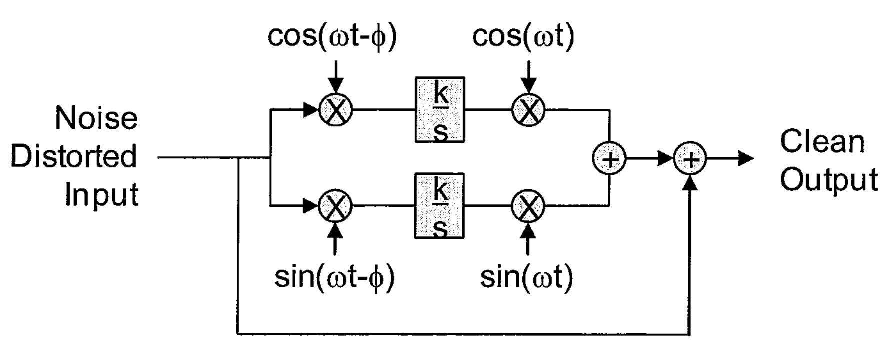

Figure 1: A block diagram of the parametric Oscillator.

The distorted input signal is modulated by sine and cosine signals of the same frequency as the distortion, run through integrators, and then modulated again. The resulting signals are summed with the original distorted signal resulting in a clean output signal.

3. Implementation in NGWFC.

A block diagram of the existing NGWFC tip-tilt controller is shown below in Figure 2.

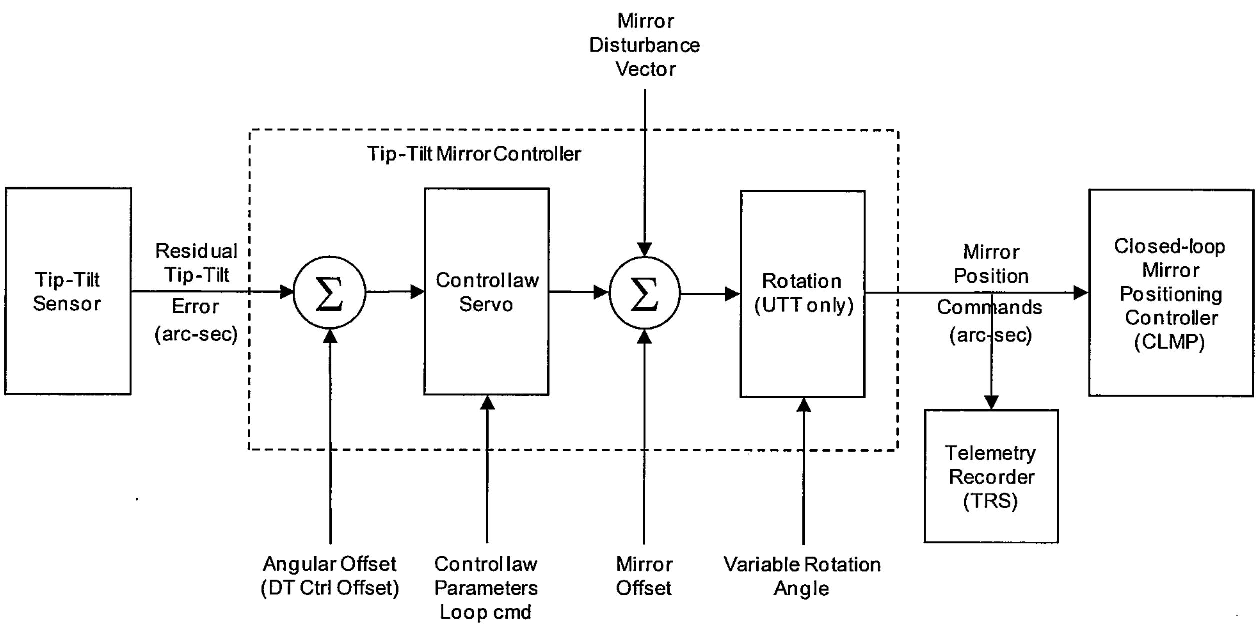

Figure 2: A block diagram of the tip-tilt controller in the NGWFC system.

The residual tip-tilt error signal is passed through a 3rd order control servo which computes the appropriate tip-tilt mirror commands to correct for the error. The parametric oscillator could easily be added as a post-processing stage to this controller in the NGWFC, before the commands are fed to the Closed Loop Mirror Positioning System (CLMP). A block diagram of the system with this modification is shown below in Figure 3. The frequency, phase offset, gain, and an enable flag are the input parameters required for the filter. All the computations in the parametric oscillator are accomplished with the same sample rate as the incoming tip-tilt error signal (the NGWFC loop rate in NGS mode, or the STRAP loop rate in LGS mode).

The addition of the parametric oscillator to the NGWFC would require the following modifications:

- Adding the input parameters (frequency, offset, gain, enable flag) to the MVME 6100 wif parameters and wif commands.
- Modifying the BCU DSP data structures and software to accommodate the additional data.
- Modifying the DTT tip-tilt controller to add the parametric oscillator computational logic and enable feature.

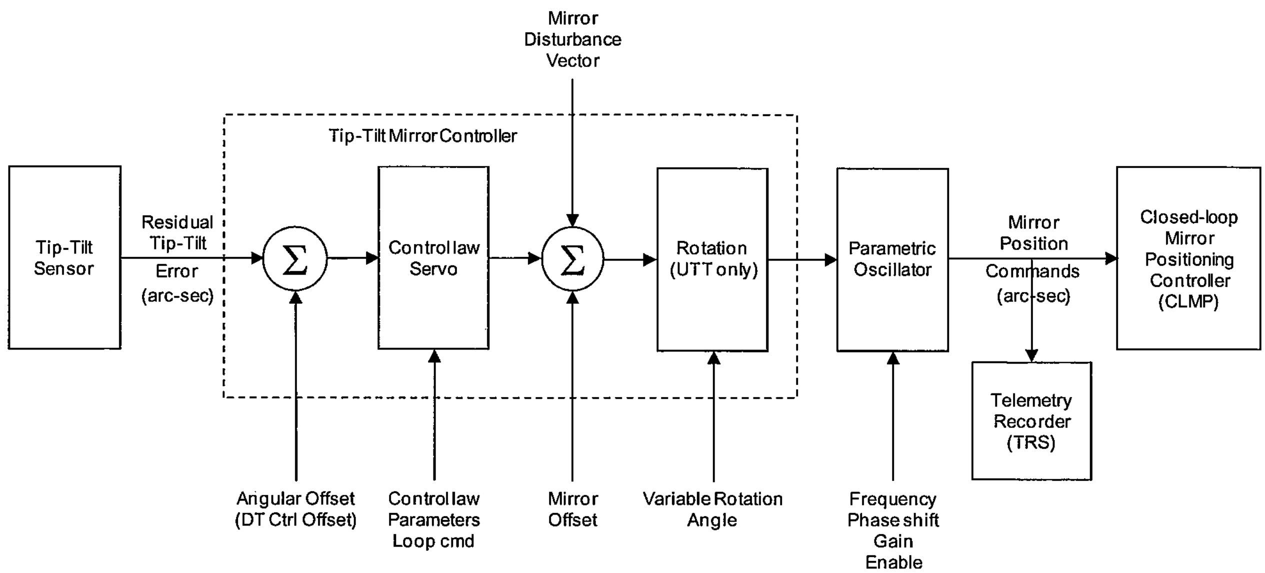

Figure 3: A block diagram of the NGWFC tip-tilt controller showing the addition of the parametric oscillator for noise cancellation.

Implementation of the parametric oscillator should not require any hardware changes to the NGWFC, only the addition of the filter computations, and modification of data structures to support the input parameters.