EVALUATION OF DRIVELINE NONLINEARITIES FOR AN EXPERIMENTAL OSWEC

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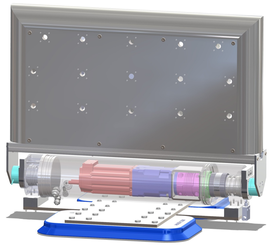
Motivation & Background

- We are building an experimental Oscillating Surge Wave Energy Converter (OSWEC) with power-take-off emulated by a regulating motor and 15:1 gearbox
- OSWEC experiments will require precise control of flap position
- Gearbox backlash and coupler flexion may result in nonlinear discrepancies between commanded and realized position

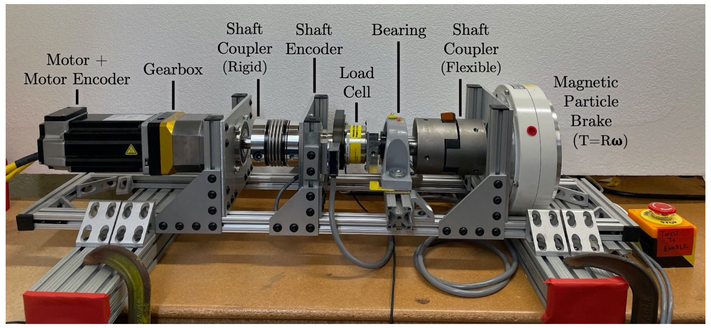


OSWEC design with motor, gearbox, shaft coupler, encoder, and load cells highlighted

Objective

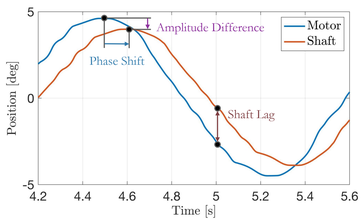
- Characterize positional differences between the motor and flap
- Use trends in phase shift and amplitude difference to 'correct' motor position data, reducing error between it and the actual shaft position

Methods



Mechanical components of the benchtop rig designed to evaluate positional nonlinearities under variable loads

- 15 experiments of 26 oscillations each
- Oscillation amplitudes and resistive damping coefficients vary from 5° to 20° and 42 to 104 Nms respectively
- Apply 15:1 gear ratio to motor position measurements for appropriate comparison

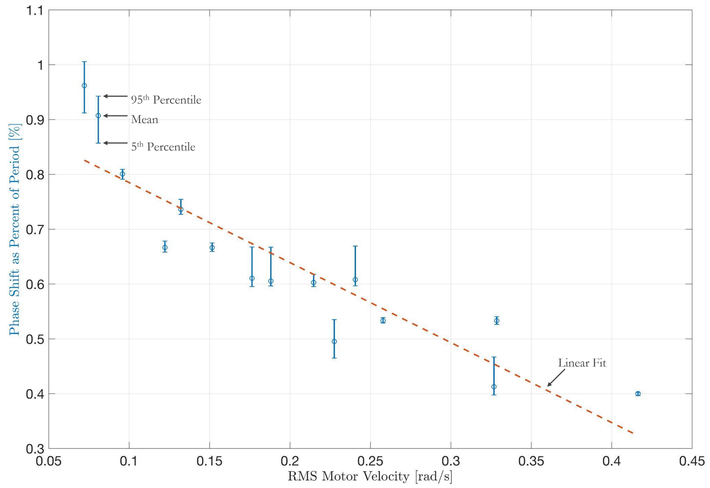


Parameters defined to evaluate positional nonlinearity.
Positional differences exaggerated for clarity.

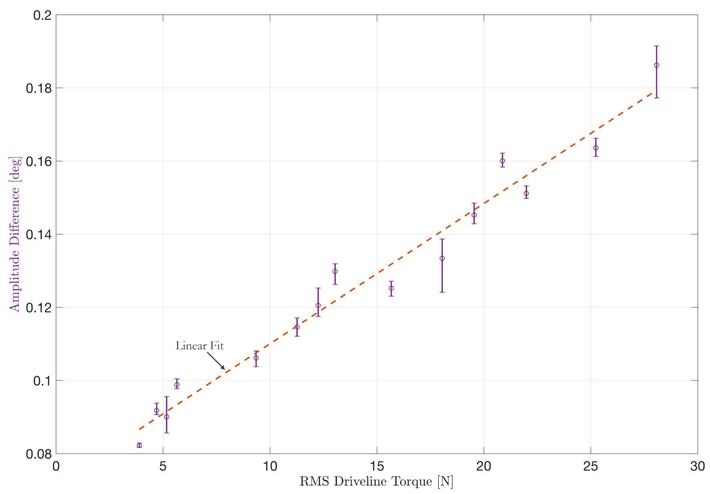
Results

Phase Shift & Amplitude Difference

- Phase and amplitude differences between motor and shaft positions vary among experiments but trend linearly with RMS motor velocity and driveline torque



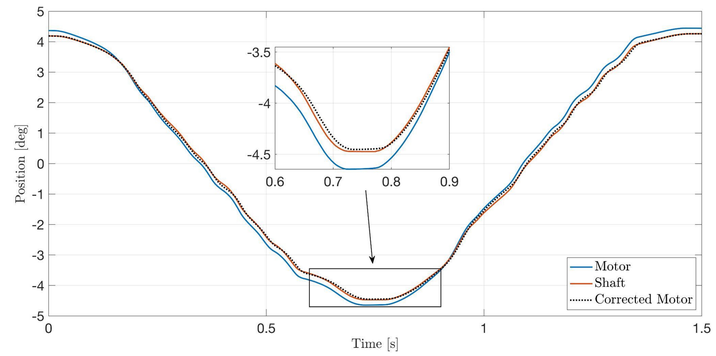
Phase shift statistics as a function of root mean square (RMS) motor velocity



Amplitude difference statistics as a function of RMS driveline torque

Emulated Corrected Motor Position

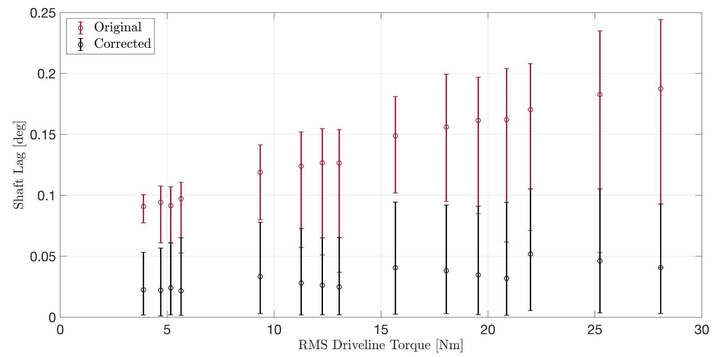
$$\left(\frac{1 - Amplitude\ Difference}{Motor\ Position\ Amplitude}\right) FFT(Motor\ Position)\left(e^{-i\omega(Phase\ Shift)}\right)$$



Motor, shaft, and corrected motor position during one period of an experiment with R = 104 Nms

Positional Lag

- Correction reduces 95th percentiles of lag by a factor of 2 (from < 0.25° to < 0.11°).



Positional lag of the shaft behind the motor before and after applying corrections to the motor position

Conclusion

- Overall positional differences between the motor and flap are safely within ½ degree, and fall well under ¼ degree with applied correction

PMEC Member Universities

UAF University of Alaska Fairbanks · Oregon State University · University of Washington

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