Simulation of a Marine Fuel Level Measurement System Using MATLAB

Subject: 24-215-0304 Instrumentation
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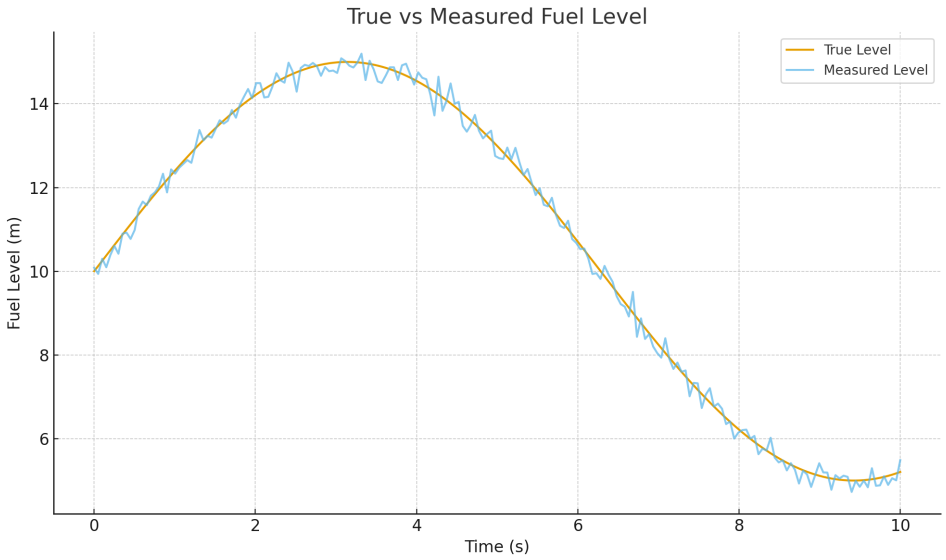
Objective: To simulate and analyze a marine fuel level measurement system using MATLAB based on capacitive transducer modeling.

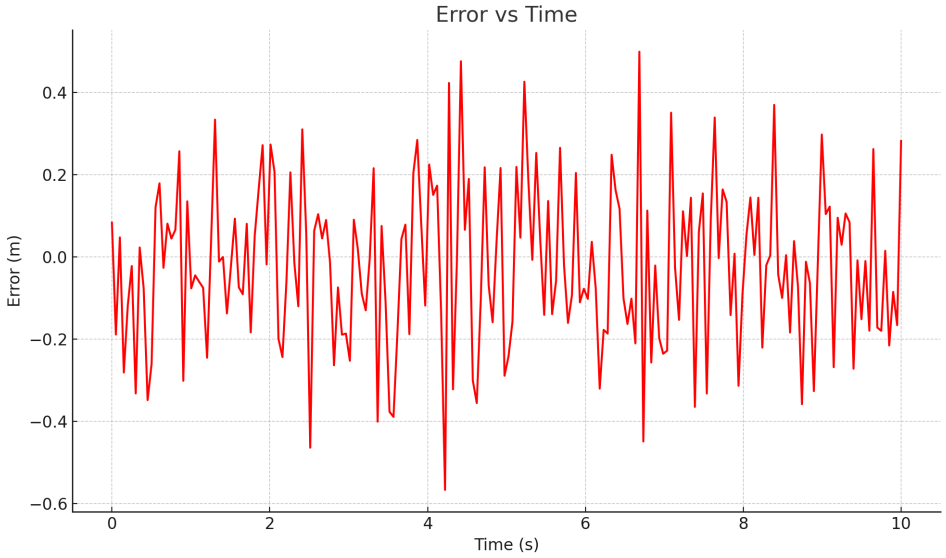
Theory: The capacitive transducer converts the change in fuel level into a corresponding change in capacitance, which is further converted into voltage using an instrumentation amplifier. The system is affected by noise, drift, and temperature variation, which are analyzed to determine accuracy and stability.

Methodology: MATLAB is used to generate the true and measured levels with Gaussian noise. The statistical performance is evaluated through mean, standard deviation, and probable error. Equations used include:

$C = \varepsilon A/d$
$V_{out} = K \times \Delta C$
Error = Measured - True

Results and Plots:





Statistical Analysis:
Mean Error = -0.0229 m
Standard Deviation = 0.1947 m
Probable Error = 0.1313 m

Discussion: The measured signal follows the true fuel level with minor fluctuations caused by random noise. The statistical analysis shows the accuracy and reliability of the measurement system. Such modeling helps in designing transducers with better signal conditioning and filtering.

Conclusion: The MATLAB simulation effectively demonstrates the operation of a capacitive transducer-based marine fuel level measurement system, showing that error can be minimized using proper filtering and calibration.

Appendix: MATLAB Code

% MATLAB Code for Marine Fuel Level Measurement Simulation t = linspace(0,10,200); true_level = sin(t/2)*5 + 10; noise = randn(size(t))*0.2; measured_level = true_level + noise; error = measured_level - true_level; figure; plot(t, true_level, 'b', t, measured_level, 'r'); xlabel('Time (s)'); ylabel('Fuel Level (m)'); title('True vs Measured Fuel Level'); grid on; figure; plot(t, error, 'k'); xlabel('Time (s)'); ylabel('Error (m)'); title('Error vs Time'); grid on; mean_err = mean(error); std_err = std(error); prob_err = 0.6745 * std_err; disp([mean_err, std_err, prob_err]);