LQR Controller for AUV Depth Regulation

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In this phase, an LQR (Linear Quadratic Regulator) controller was designed to regulate the depth of the AUV using a linearized model of the system. The purpose was to design a controller that minimizes a quadratic cost function while ensuring stability and performance.

System Model:

The linearized state-space representation is:

$$\dot{x} = Ax + Bu, \qquad y = Cx$$

with the matrices:

- $A = [0 \quad 10 \quad -0.8]$
- $B = [\,0 \quad 0.5]$
- $C = [1 \quad 0]$

LQR Design:

The controller minimizes the cost function:

$$J = \int_0^\infty (x^T Qx + u^T Ru)dt$$

With selected weights:

- $Q = diag(100, 1)$
- $R = 0.01$

Using MATLAB's lqr function, the optimal gain matrix K was obtained. The closed-loop control law is:

$$u = -Kx$$

Simulation Result:

The resulting depth response of the AUV shows excellent stability. The system remains at the zero-depth position with no oscillation, overshoot, or drift — confirming a well-tuned controller.

Figure_LQR Depth Response