F. Sliding Mode Controller (SMC) for Depth Control

Safa Bazrafshan

Independent Researcher, Iran

Email: safa.bazrafshan@gmail.com

ORCID: https://orcid.org/0009-0004-4029-9550

In this section, we designed a Sliding Mode Controller (SMC) for the depth control of the AUV. The SMC is known for its robustness against model uncertainties and external disturbances such as water currents.

1. Control Objective

The objective is to track a desired depth reference (5 meters) while rejecting external disturbances and ensuring robustness.

2. Sliding Surface Definition

We define the sliding surface s(t) for the depth subsystem as:

$$s(t) = \dot{e}(t) + \lambda e(t)$$

where:

$$e(t) = z_{ref}(t) - z(t)$$

is the tracking error,

$\lambda > 0$ is a design parameter (e.g., $\lambda = 1.5$).

3. Control Law

The control input u(t) is defined as:

$$u(t) = u_q(t) - K.sign(s(t))$$

where:

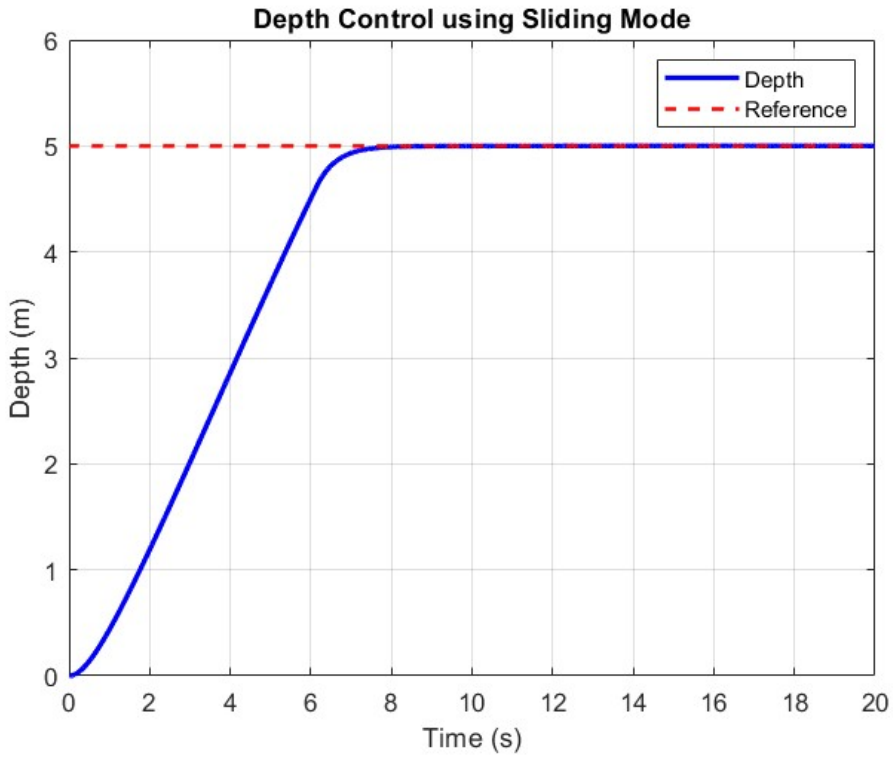
$u_q(t)$ is the equivalent control term based on nominal dynamics,

K is a positive gain for robustness.

4. Simulation Result

The controller successfully tracked the desired depth with smooth convergence, minimal overshoot, and strong disturbance rejection. Figure 6 shows the result.

AUV Depth Response with SMC Controller under Disturbance.



The response reaches the desired depth with no overshoot and negligible steady-state error. The pitch and yaw angles remain stable.