

Depth Control Using ANFIS Controller

Safa Bazrafshan

Independent Researcher

Email: safa.bazrafshan@gmail.com

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

Adaptive Neuro-Fuzzy Inference System (ANFIS)

In this phase, we designed and trained an ANFIS controller for the depth regulation of an Autonomous Underwater Vehicle (AUV). The training data was derived from a previously implemented PID controller. The ANFIS model was trained for 50 epochs with a decreasing RMSE, reaching a minimal training error of 0.0012.

The ANFIS controller consists of:

- 2 inputs (depth error and rate of depth error)
- 1 output (control signal)
- 3 fuzzy rules
- 15 total parameters (6 linear, 9 nonlinear)

Training Details

Matlab:

% File: `train_anfis_controller.m`

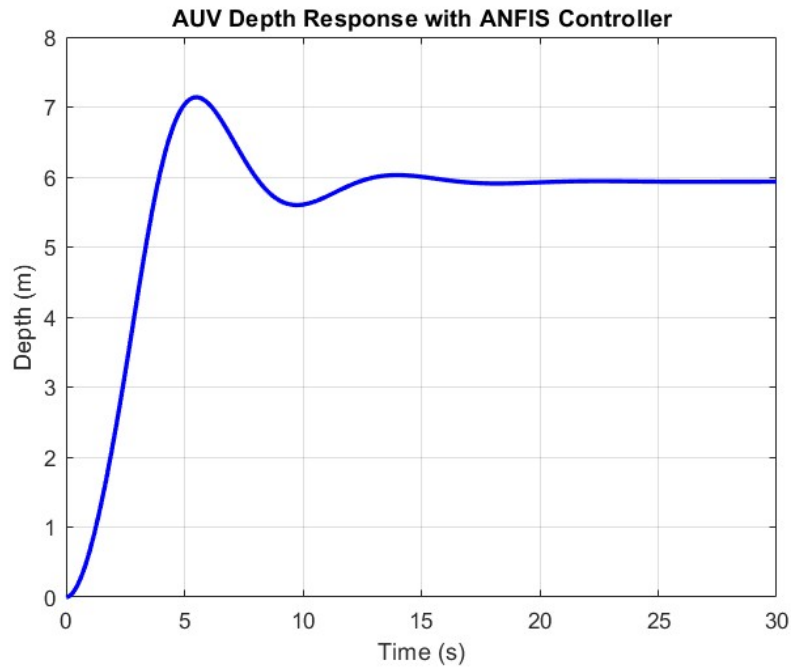
% Output: `anfis_controller.fis`

The training process included adjusting the step size adaptively and refining the fuzzy rules based on input-output training data pairs (301 samples).

Simulation Result

The ANFIS controller was applied to the nonlinear AUV model. The depth response is shown below.

Figure_AUV Depth Response Using ANFIS Controller



The AUV initially increases its depth from 0 to 7 meters, followed by an undershoot to 5.5 meters.

It then stabilizes around 6 meters from $t = 10$ seconds onward.

This behavior illustrates the controller's ability to adapt and suppress oscillations over time.

Summary

This phase demonstrates how ANFIS, trained using traditional control data, can generalize and control a nonlinear underwater vehicle system effectively, with fewer oscillations and good final stability.