Make a simulation of trajectory tracking control system using a machine learning method, with the following scenarios:

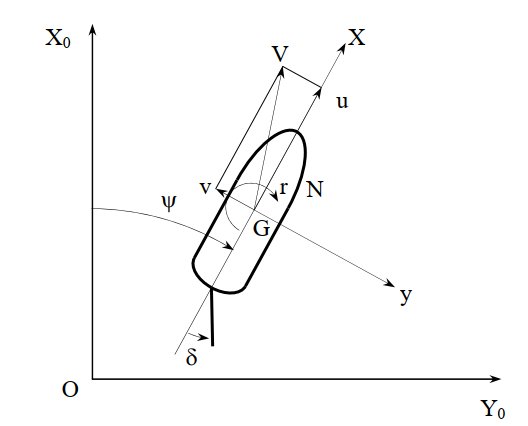
1. Autopilot
2. Speed control
3. Trajectory tracking control with a pattern (zigzag/lawn mowing)

To simulate these scenarios, develop a set of simulation with MATLAB (Problem 1) and Simulink (Problem 2) separately.

3 DOF:

* Motion in x-direction (surge)
* Motion in y-direction (sway)
* Rotational motion about z-axis (yaw)

Diagram of a ship with a diagram

Description automatically generated

|  |  |  |
| --- | --- | --- |
| Surge |  |  |
| Sway |  |  |
| Yaw |  |  |

|  |  |
| --- | --- |
| where | m : mass of ship [kg.s2/m] |
|  | : acceleration in x direction [m/s2] |
|  | : acceleration in y direction [m/s2] |
|  | : angular acceleration [rad/s2] |
|  | IZZ : inertia moment with respect to z-axis [kgs2m] |
|  | XH, YH : Hydrodynamic forces acting on ship’s hull [kg] |
|  | NH : Hydrodynamic moment acting on the ship’s hull [kg.m] |
|  | XP : Propulsive force of propeller [kg] |
|  | XR, YR : Hydrodynamic forces acting on ship’s rudder [kg] |
|  | NR : Hydrodynamic moment acting on ship’s rudder [kg.m] |
|  | YT : Hydrodynamic force induced by thruster [kg] |
|  | NT : Hydrodynamic moment induced by thruster [kg.m] |

The state equations of ship’s heading and position on the earth-fixed coordinate system:

|  |  |  |
| --- | --- | --- |
| Yaw rate |  |  |
| Position in x-axis |  |  |
| Position in y-axis |  |  |

1. Autopilot

* Primary control variable: yaw angle
* Goal: maintain a desired heading while moving at a constant speed
* Approach: the controller adjusts the rudder to correct the heading as disturbances push the vessel off course.

1. Speed control

* Primary control variable: speed
* Goal: maintain a target speed regardless of environmental disturbances
* Approach: the controller adjusts the thruster to keep the vessel’s speed steady

1. Trajectory tracking control

* Primary control variables: heading and speed
* Goal: follow a specific path or pattern to cover an area or reach specific waypoint
* Approach: The controller adjusts both heading and speed simultaneously to navigate the desired trajectory