

Project Report

Title: Autonomous Robot Controller Design

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1. Diagrams

a) Simulink Model Architecture

The system is modeled using a closed-loop architecture. The "Controller" subsystem (Stateflow) receives sensor data and outputs velocity commands (v, w) which are fed into a kinematic plant model to simulate position (x, y, θ).

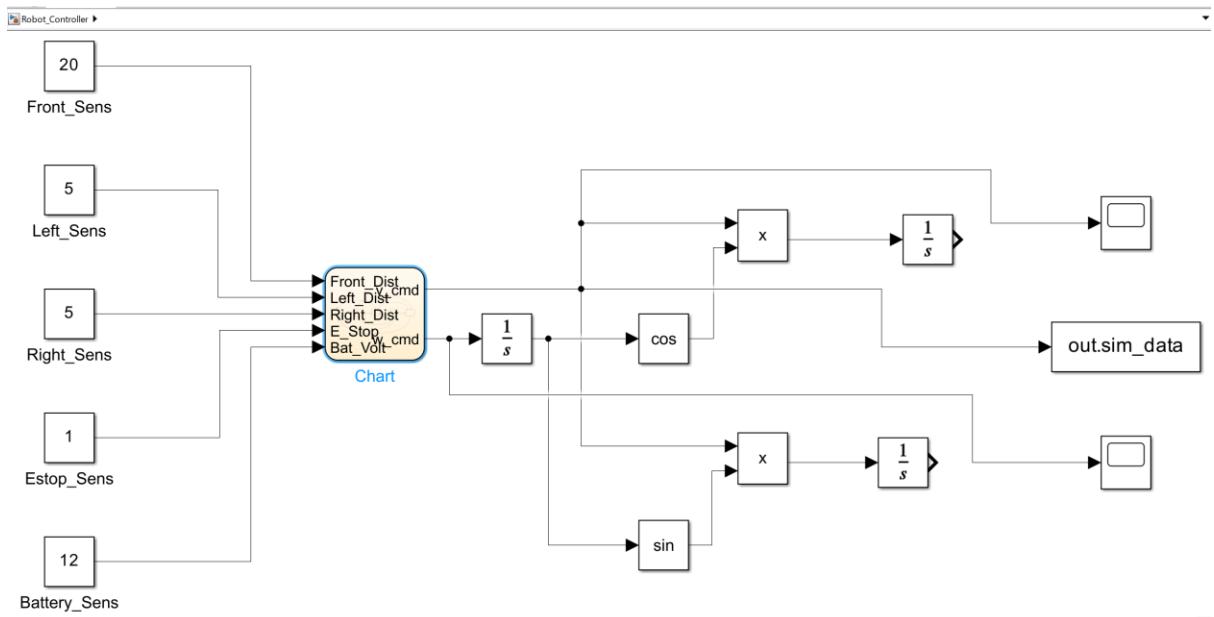


Figure 1: Top-Level Simulink Model with Controller Logic and Kinematic Plant Dynamics.

b) Control Logic (Stateflow)

The decision-making logic is implemented using a State Machine. It manages states such as MoveForward, TurnLeft, and Emergency, with transitions guarded by sensor thresholds (e.g., $Front_Dist < 0.5$).

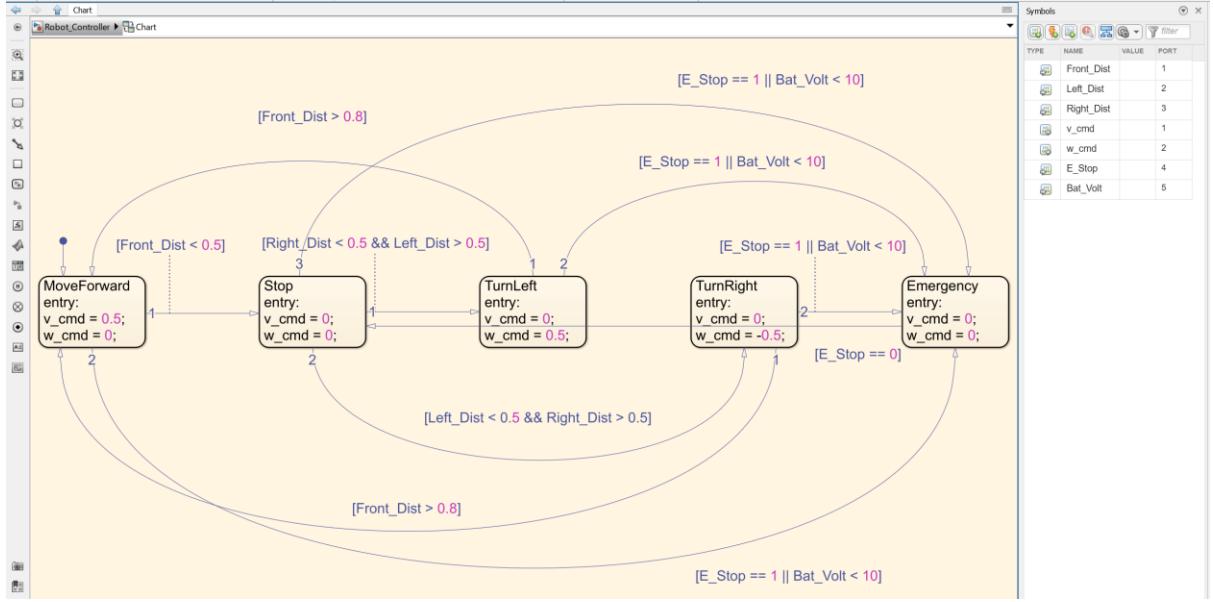


Figure 2: Stateflow Logic implementation showing states and transition conditions.

2. Assumptions

- **Kinematics:** The robot follows a standard unicycle kinematic model:
 - $x' = v * \cos(\theta)$
 - $y' = v * \sin(\theta)$
 - $\theta' = w$
- **Sensors:** Distance sensors are modeled as ideal inputs. Thresholds are set to **0.5m** for obstacle detection.
- **Safety:** The Emergency Stop signal is treated as a hard interrupt that overrides all other behaviors, forcing velocity to zero immediately.

3. Results

Functional Verification (Emergency Stop) The controller successfully validated safety scenarios. As shown below, when the Emergency Stop signal is triggered (at $t=5s$), the linear velocity (v) drops immediately from 0.5 m/s to 0 m/s.

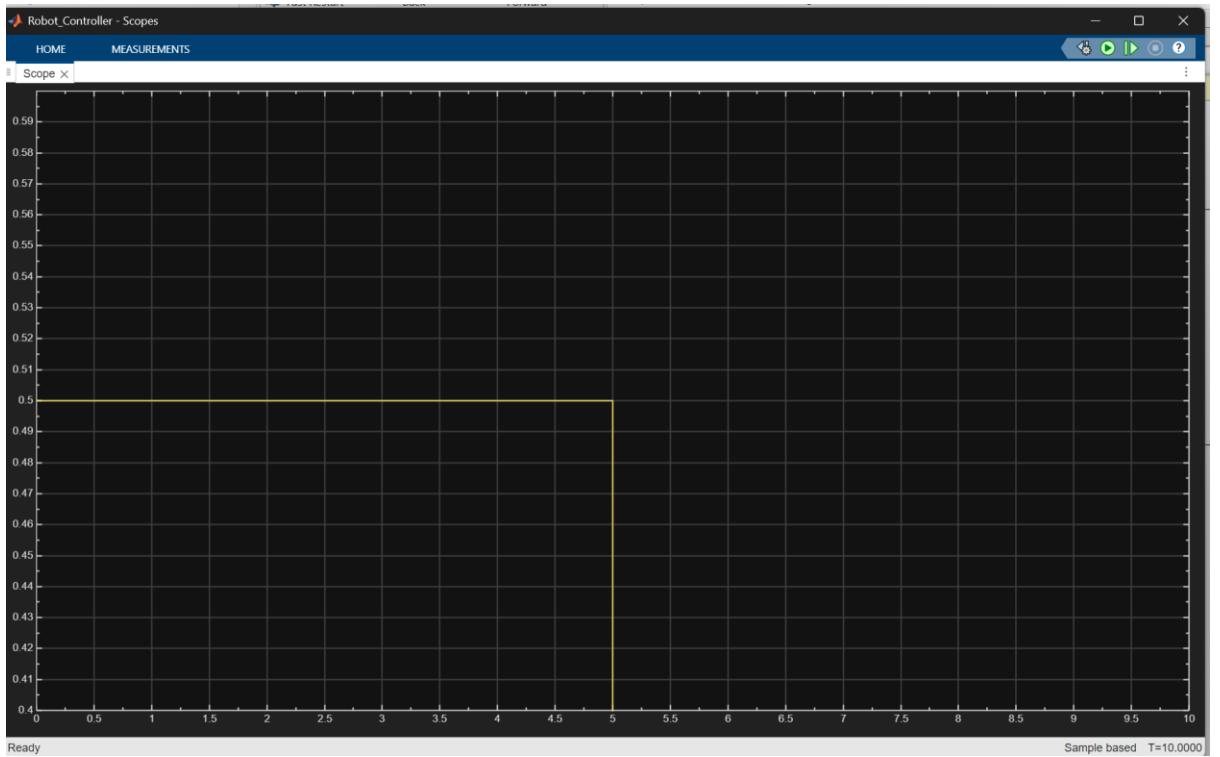


Figure 3: System Response to Emergency Stop – Velocity drops instantly to zero.

Automated Testing A Test Suite was created using **Simulink Test Manager** to automate four scenarios:

1. Front Obstacle
2. Left Obstacle
3. All Directions Blocked
4. Emergency Stop

Outcome: All 4 test cases **PASSED** (100% Pass Rate).

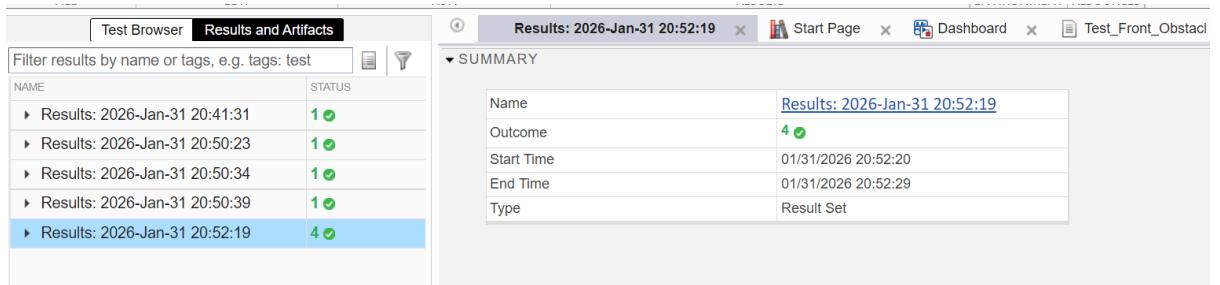


Figure 4: Automated Test Suite Results showing 100% Pass Rate.

4. Issues

- **None.**
- The system met all functional and safety requirements.
- C-Code was successfully generated (Robot_Controller.c) for the embedded target.
- Automated testing confirmed logic stability across all defined test vectors.