

RC Car Position-Control Latency Analysis

Autonomous RC Pacer Car Project

April 11, 2025

1 Introduction

This document tracks the relationship between waypoint radius, maximum speed, and implied position-control latency in the autonomous RC car project. The goal is to identify the maximum performance achievable with different system configurations.

2 Position-Control Latency Observations

Position-control latency refers to the delay between when the car should ideally begin adjusting its course (upon entering the waypoint radius) and when it actually responds. This latency can be approximated by:

$$L = 1000 \cdot \frac{R_{wp}}{v_{max}} \quad (1)$$

2.1 Current Core Configuration

Table 1: Position-control latency field measurements

Waypoint Radius (m)	Max speed without donuts (m/s)	Position-control latency ¹ (ms)	Core assignment ²
2.0	>> 4.4 ³	<<455 ³	1/1/1
0.5	2.5	200	1/1/1
0.5	1.2	417	0/1/1
0.5	0	big	1/0/1

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3 Future Testing Plans

This document will be updated with additional observations using different core configurations, including:

- Moving GNSSTask to Core 0
- Adjusting task priorities
- Testing with different sensor configurations

¹This is an upper bound including spikes

²GNSS/Control/Navigation tasks' core assignment

³Higher speeds not tested

4 Observations and Analysis

[This section will be updated as more data becomes available]

Initial observations with all critical tasks (GNSS, Control, and Navigation) on Core 1:

- With a 2.0m waypoint radius, the car achieved stable performance at speeds up to 4.4m/s with no donuting observed. Higher speeds were not tested for safety reasons. The implied position-control latency is certainly far less than the 455ms calculated in Table 1.
- With a 0.5m waypoint radius, the car operated successfully up to 3.0m/s, but exhibited occasional donuting behavior. This suggests intermittent latency spikes above the theoretical 167ms threshold. No donut behavior was observed at 2.5m/s. The implication is that the maximum spike in position-control latency is somewhere between 167 and 200ms using the 1/1/1 core configuration.

These results suggest that the system can maintain stable control with a minimum latency of approximately 167ms, but may experience occasional performance issues at this threshold. The inconsistent behavior points to intermittent processes potentially causing latency spikes.