Review of: "Optimal Latency Compensator for Improved Performance of Teleoperated UGVs on Soft Terrains"

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Potential competing interests: No potential competing interests to declare.

General Comment:

This paper presents research on bilateral teleoperation concerning low-speed Unmanned Ground Vehicles (UGVs) navigating soft terrains, with a specific focus on applications like lunar exploration. The primary concern is the impact of latency on UGV maneuvering and performance due to transmission delays within the teleoperation system.

In Section II, the study introduces the 2-degree-of-freedom (2-DOF) UGV dynamic model in Equation 3 and the predictor designs in Equation 11. By optimizing the cost function in Equation 12, the design goal is to minimize the difference between the actual value and the predicted value. Simultaneously, this optimization aims to reduce overshoot. The authors employ the GA algorithm to evaluate the fitness of parameter candidates for the cost function, looking for the best value within a specific interval.

In Section III, the authors present the impact of various types of delays, including no delay, constant delay, and varying delay. If the delay is excessively large, tracking error will increase, leading to instability of the system (Fig. 2, Fig. 3, and Fig. 4).

In Section IV, the authors show the performance of the delay predictor through two experiment segments: open-loop and closed-loop (the framework of the closed loop is shown in Figure 1). Additionally, they compare the performance of the delay predictor with and without the GA algorithm (Fig. 8 and Fig. 9).

In Section V, the authors conduct a human-in-the-loop experiment; the one-way delay is set around 0.98s to represent a long-distance network (380,000 km). The experiment is divided into three cases: ideal case, delay case, and delay case with GA-optimized predictor; the results are shown in Fig. 14 (ideal case), Fig. 15 (delay case), and Fig. 16 (with GA-optimized predictor), respectively.

Specific Comment:

This research paper investigates bilateral teleoperation for low-speed Unmanned Ground Vehicles (UGVs) navigating soft terrains, with a specific emphasis on applications like lunar exploration. The experimental simulation results present the challenges and potential solutions for teleoperating UGVs in scenarios with significant communication delays, such as those encountered in lunar exploration. However, the reviewer finds a few problems and poses some January 26, 2024, DRAFT 2 questions about the method. The following comments are provided to enhance the quality of the study.

I. The reviewer suggests the authors should demonstrate the stability of the delay compensator.

II. In Section II, it's recommended to include a descriptive figure for a clearer explanation of the 2-DOF UGV dynamic model.

III. While the experiments simulate Lunar exploration conditions with a 1-second communication delay between Earth and the Moon, the chosen simulation delays are 0.2, 0.6, and 1.0 seconds. The reviewer suggests adding scenarios with delays of 1.2 seconds or more to emphasize the method's reliability and robustness.

Based on the above discussion, my decision is "Prepare A Major Revision."