Study of Communication Delay in Servo Actuator Networks

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Abstract

Robotics has seen greater widespread use and implementation in recent decades. Automating complex tasks in industry will require a proportionally complex robotics system. It becomes necessary to examine the effect of a large network of servos (an important component in robotic systems) on the communication delay between command and action. Communication delay will have a fundamental impact on system's stability and performance. An experimental study of the delays through the servo network will help us analyze and ensure stability of the system. To accomplish this, we developed an experimental apparatus which will determine the time delay between the system controller and the servo action. We then compare the effect of a single servo to three servos, then six, then nine servos. Across hundreds of trials, we determined that there is little difference in the time delay when increasing the number of servo motors in a network.

Introduction

The motivation of this study is a result of the development of a bipedal humanoid robot, which uses up to twenty AX12 servos simultaneously in order to perform functions such as legged locomotion. AX12 servos are high performance servos capable of precise position control, and are also capable of continuous rotation, making them useful in developing particularly complicated robots. Demonstration of this system may be viewed at the following URLs:

https://youtu.be/M-Mx4f-Z-WA
https://youtu.be/ItA4fxoOeQk

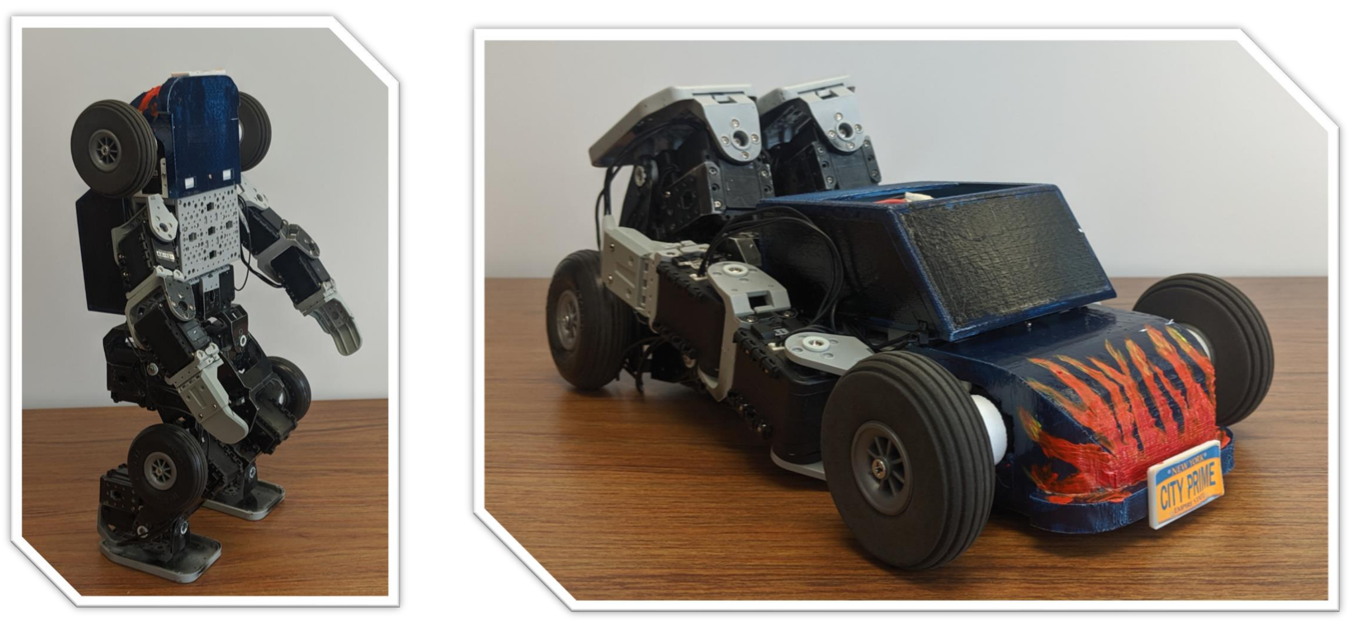


Fig. 1. Heteromorphism robot design that warranted further study of servo networks.

Methodology

To determine the delay between the microcontroller command signal and the servo response, an oscilloscope probe is placed at the signal wire between the microcontroller and the servo, while another probe is similarly placed at the voltage wire, between the supply and the servo. As the command is executed, the microcontroller sends out a command packet to the servo, and the servo will draw current from the power supply in order to move. This procedure is done on a single servo setup, a three servo setup, a six servo setup and a nine servo setup.

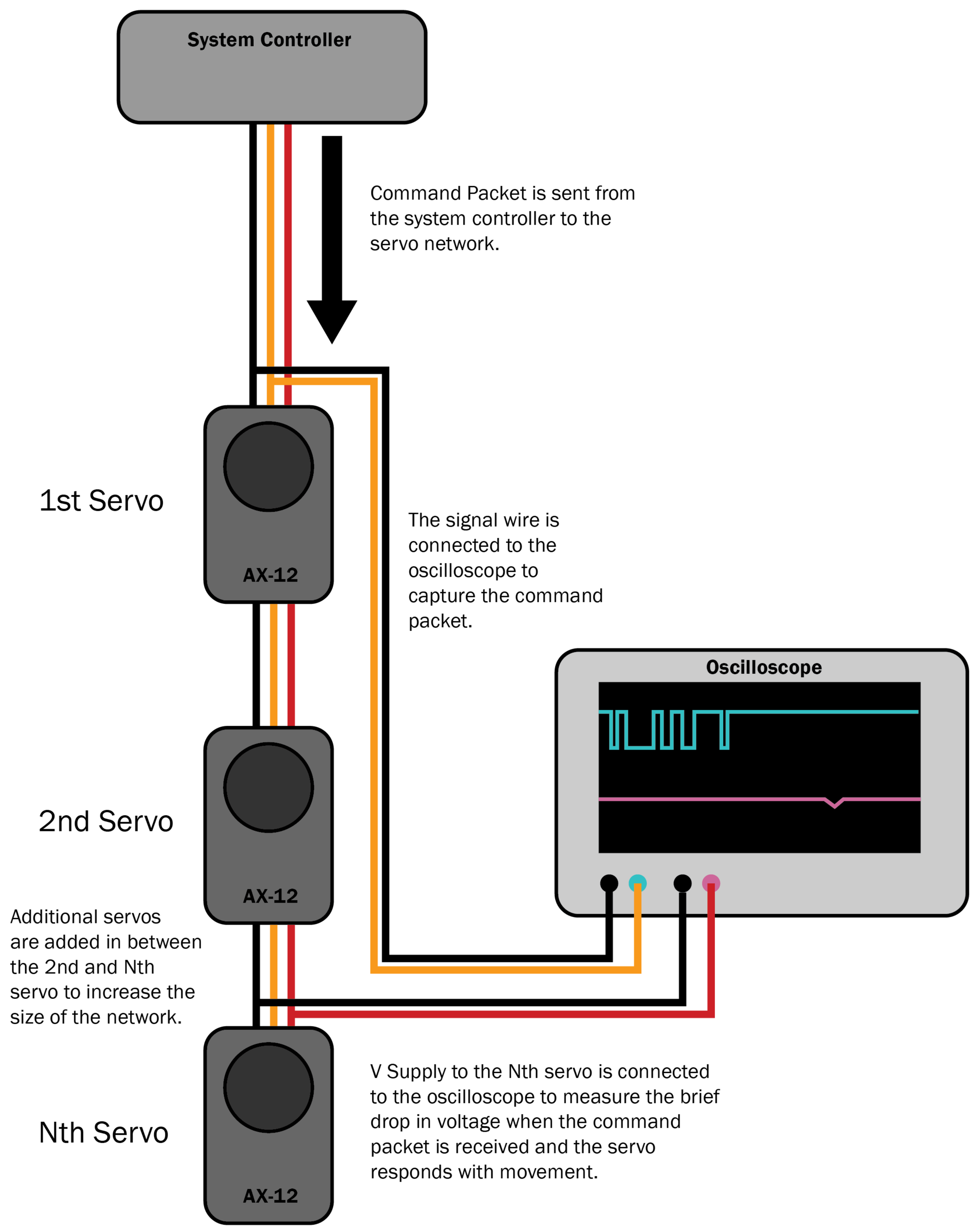


Fig. 2. Diagram of the experimental apparatus that is used for all servo network setups.

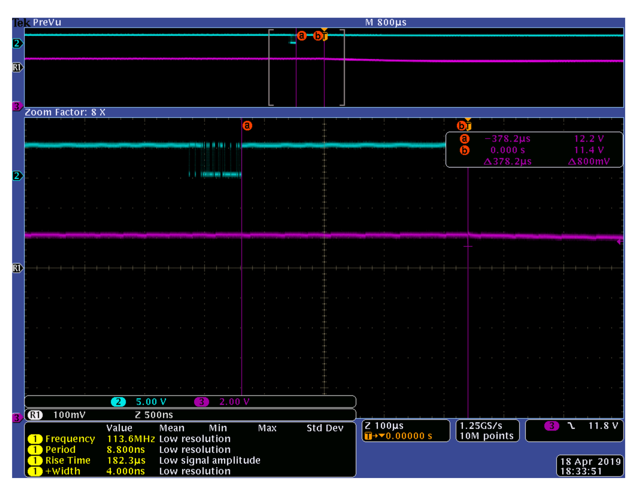
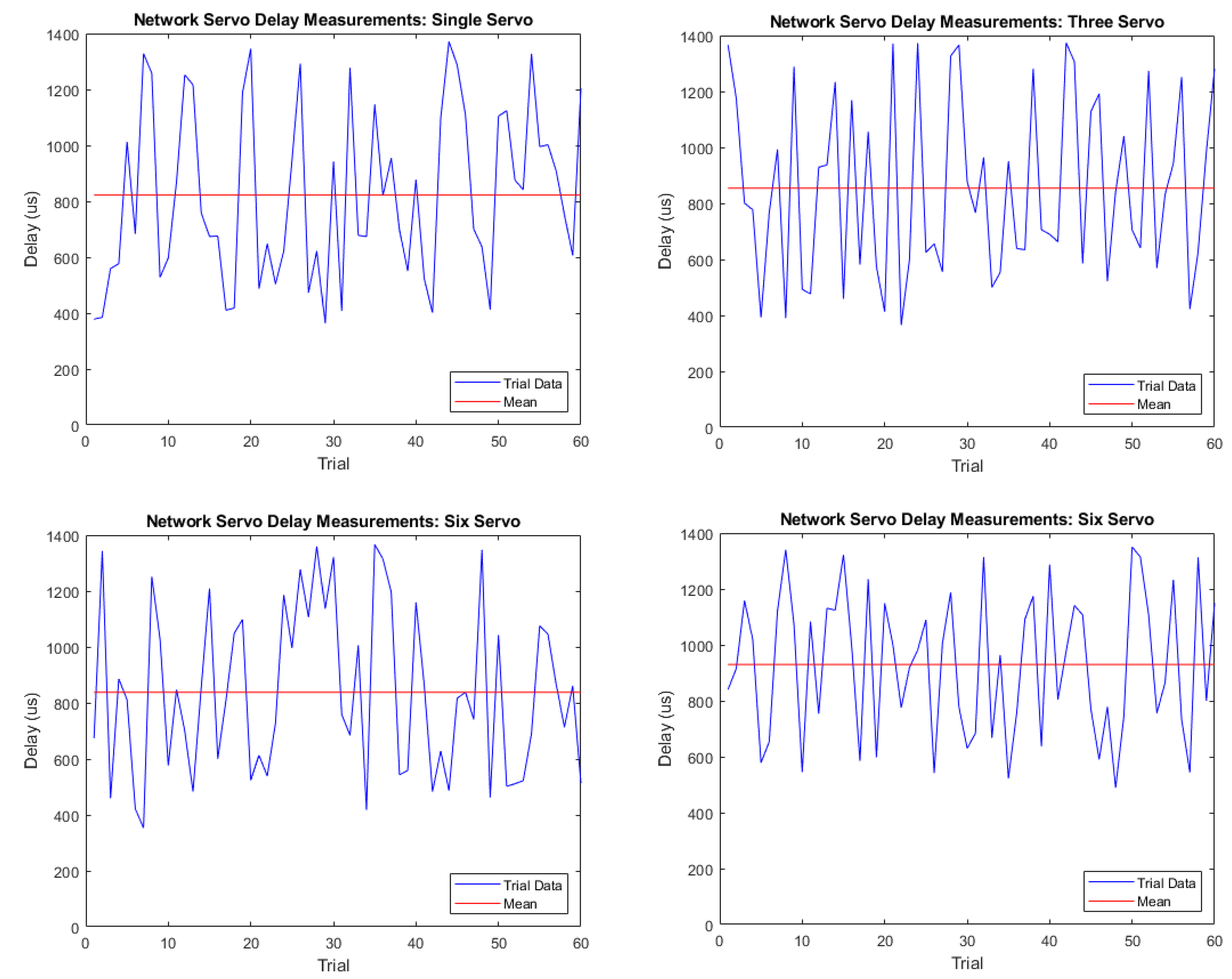


Fig. 3. Example of oscilloscope capture of the servo response.

Results



Sixty trials were performed for each setup, making for a total of 240 trials:

- Single servo setup had a mean delay of 822.95 us.
- Three servo setup had a mean delay of 854.25 us.
- Six servo setup had a mean delay of 837.63 us.
- Nine servo setup had a mean delay of 876.71 us.

Conclusion

Based on the results, we can conclude that the communication delay between the control signal and the servo response is largely not affected by increases in the number of servos in the network.

References

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