

0.0.1 Experimental validation of the plastic oscillator in simulation

The simulations have been run in V-REP Simulation software with the Kinova Mico robotic arm. A gripper has been added to the robotic arm. We simulate the handshake with a ball placed inside the gripper. It moves up and down according to a 2 Hz sinusoidal signal of amplitude 0.1. Since both objects are collidable, it forces the arm to move.

The same equations mentioned previously have been used. Only the parameters were slightly changed to get better results. The natural frequency of the oscillator depends on the values of τ_M , τ_S and σ_S . Knowing that we want to be able to reach frequencies from 0 to 3.5 Hz, we chose $\tau_M = 0.35$ and $\tau_S = 3.5$ (See Figure 7). $\epsilon = 0.05$, $\sigma_F = 10.0$, $A_F = 0.05$ and $\tau_R = 0.005$ yield the best results for the simulation.

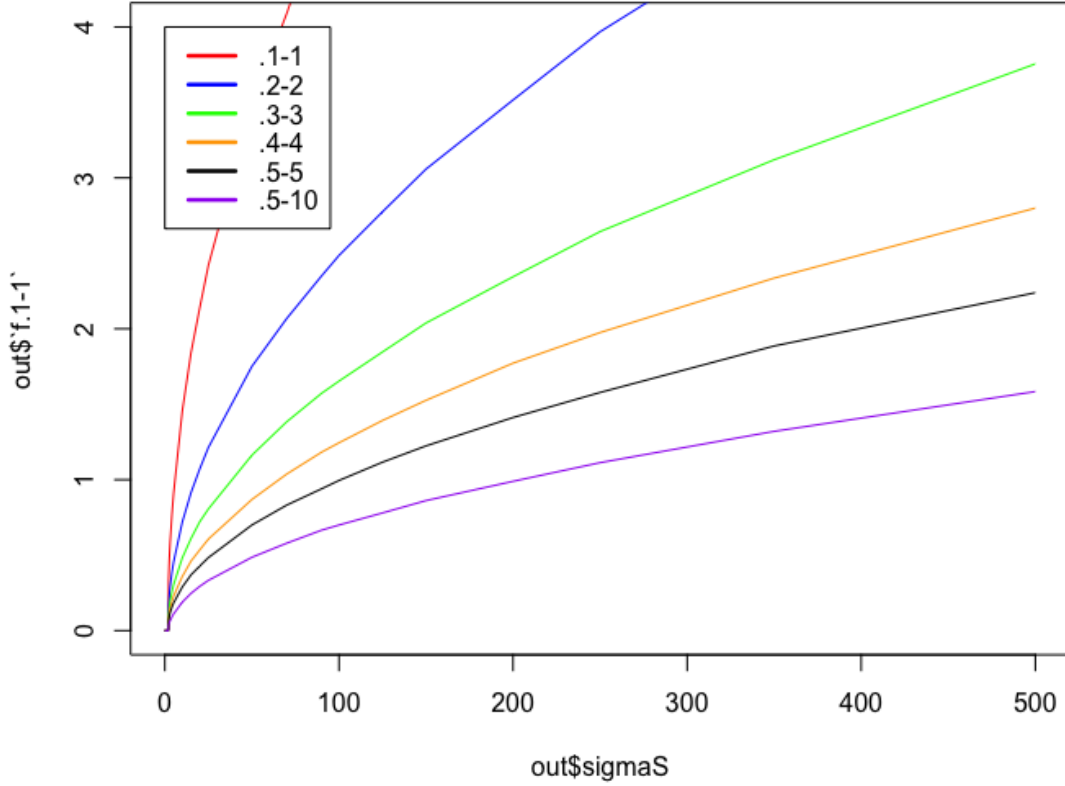


Figure 1. Evolution of the natural frequency of the oscillator given different original values of σ_S for various (τ_M, τ_S) . For the handshaking process, we are interested in frequencies between 0 and 3.5 Hz. Hence, the curves suiting our purpose are (0.3, 3) and (0.4, 4).

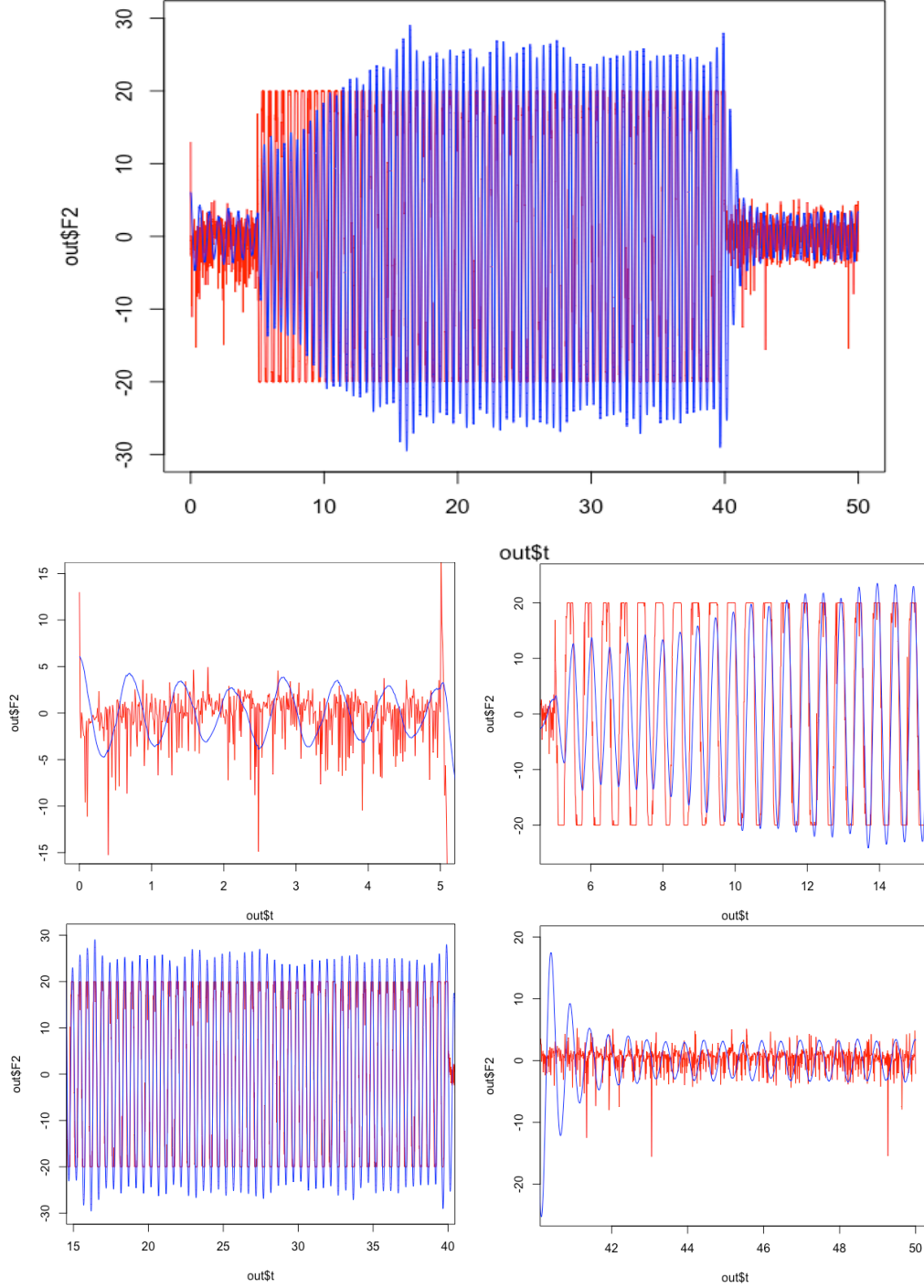


Figure 2. Evolution of V2E and F2 (Input of the cell) during the experiment. It can be divided into four parts (depicted in the bottom pictures). During the first phase, there is no physical interaction so the arm oscillates at its natural frequency. The second phase corresponds to the synchronisation phase. We can observe the natural frequency of the oscillator changing until it matches the input frequency. In the third phase, the two signals are synchronised. Finally, at 40s, the interaction stops but the arm keeps oscillating at the frequency learned during the interaction

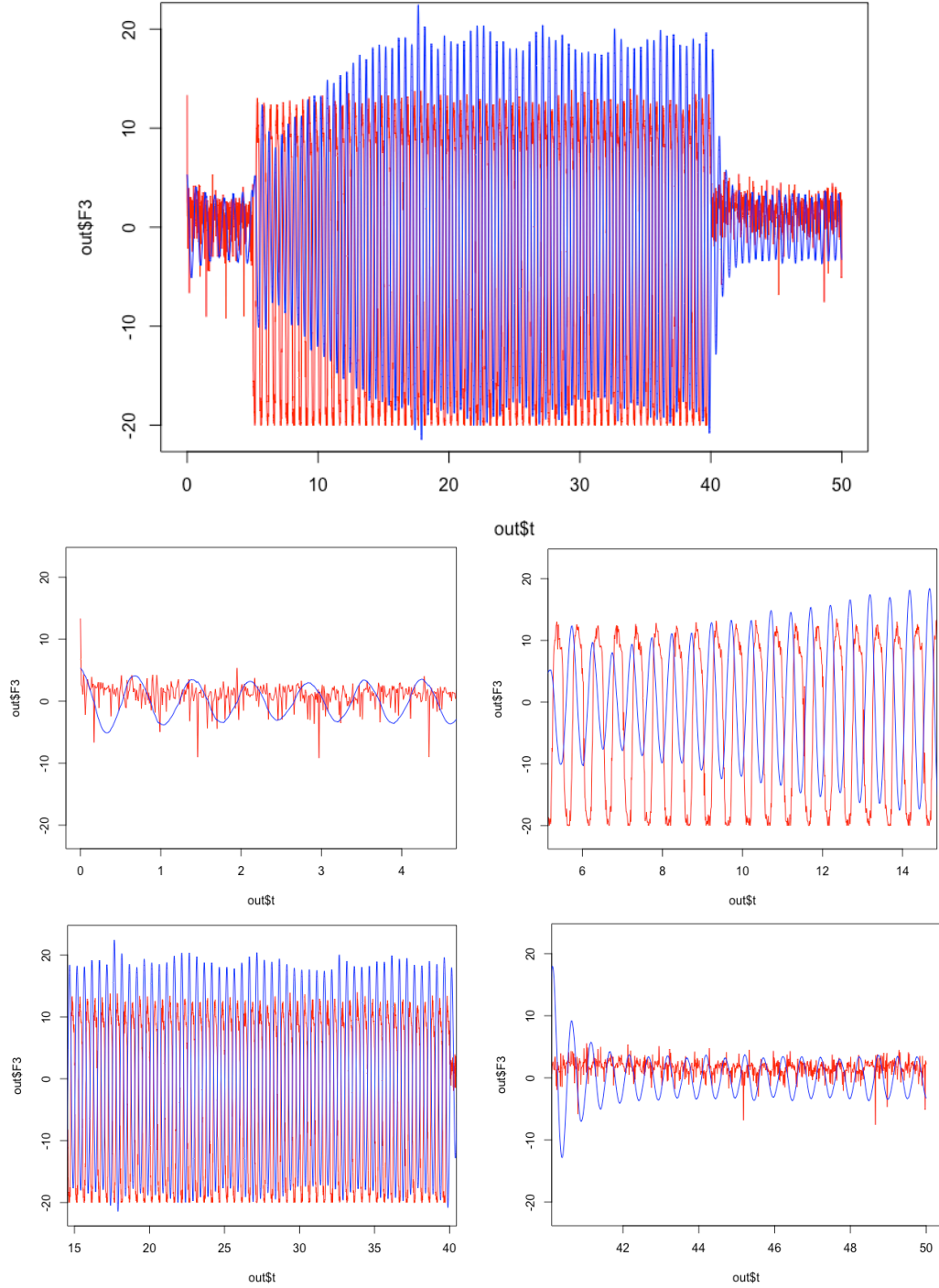


Figure 3. Evolution of V2E and F2 (Input of the cell) during the experiment. It can be divided into four parts (depicted in the bottom pictures). During the first phase, there is no physical interaction so the arm oscillates at its natural frequency. The second phase corresponds to the synchronisation phase. We can observe the natural frequency of the oscillator changing until it matches the input frequency. In the third phase, the two signals are synchronised. Finally, at 40s, the interaction stops but the arm keeps oscillating at the frequency learned during the interaction

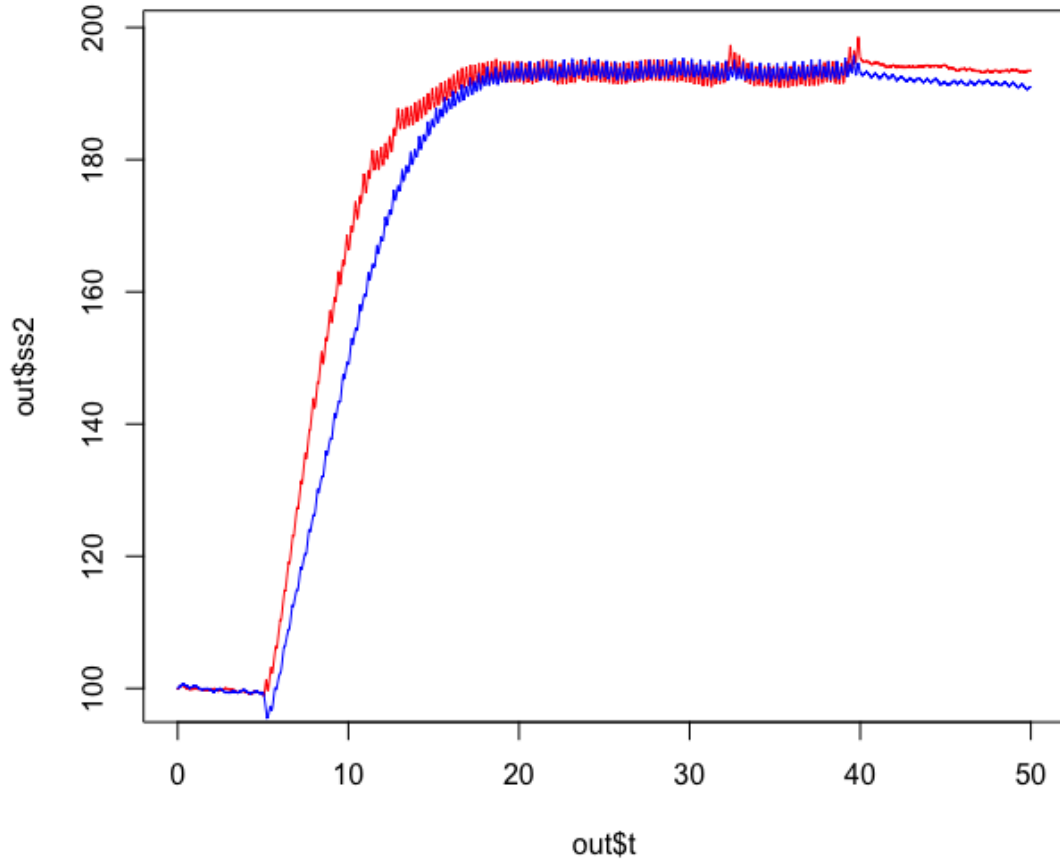


Figure 4. Evolution of σ_S2 and σ_S3 . The initial value is 100 for both σ_S . They stay mainly stable at 100 until $t = 5$ s when the interaction starts. Then they start increasing, though σ_S3 is slightly slower than σ_S2 but it finally catches up around $t = 15$ s. From $t = 19$ s onwards, the σ_S are mostly stable around 190. When the interaction stops at $t = 40$ s, σ_S stay stable, showing that the new value has indeed been learned.