1 Simulation Graph

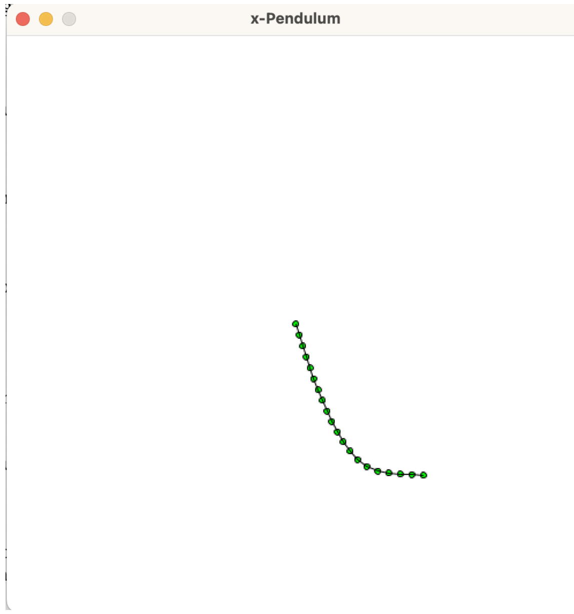


Figure 1: Simulation graph of x-Pendulum (x=20)

2 Graphs

All required graphs are shown on the next page in Fig 2.

3 Trend Observation

In Fig.2(a), simulation substep=1, the relaxation steps=100 and 10 show more stability in energy converse and relaxation step=100 is slightly higher in value, by conserving half of the energy after 30s.

In Fig.2(b), simulation substep=10, they all show some stability in energy converse and almost have the same performance, conserve about 700J after 30s.

In Fig.2(c), simulation substep=100, they all show some stability in energy converse and relaxation step=1 is slightly higher in value, it could conserve 100J more than relaxation step=100. The best result could converse about 800J after 30s.

In Fig.2(d), relaxation step=10, the simulation substeps=100 and 10 show more stability in energy converse and reaction step=100 is slightly higher in value.

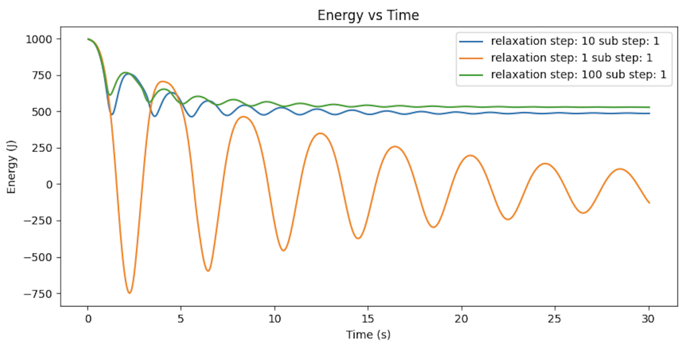
From those graphs, we can tell that **simulation substep** is really important, when more substeps are used, the result is largely improved. As for the relaxation step, there is not a large difference when the substep is in a rational value.

In Fig.2(e), compared with the length error with simulation substeps=1, the relaxation steps=100 and 10 show less error in the changing of the length of the rope. Relaxation step=100 is slightly lower in value.

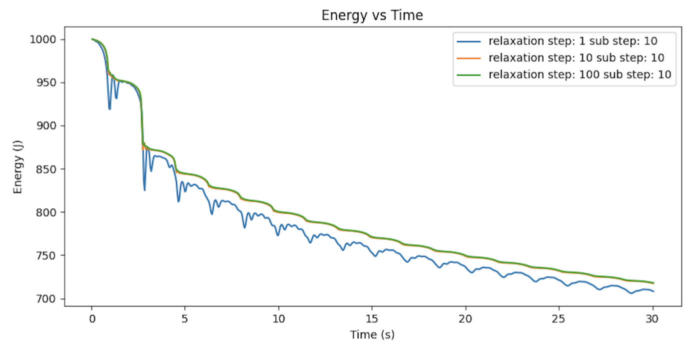
In the simulation, it is easy to observe that the relaxation step=1 always strength the rope for a longer distance between the base node and the first node.

4 Best results

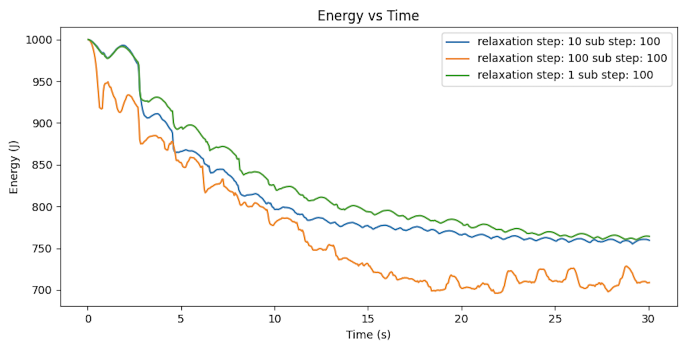
By plotting all the results in Fig.3(b), I discovered that the **purple** line has the highest energy conservation value and remains stable. At the same time, the length error is small. The best result is **Relaxation_steps=1, Simulation_substeps=100**.



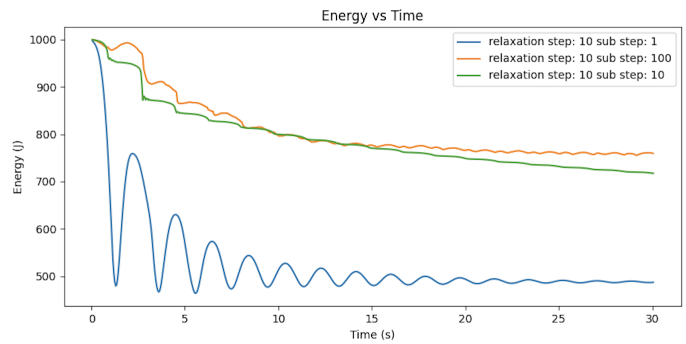
(a) Energy over time with 1 simulation substeps



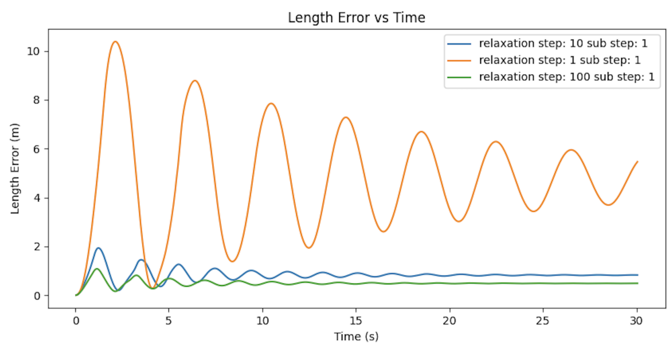
(b) Energy over time with 10 simulation substeps



(c) Energy over time with 100 simulation substeps

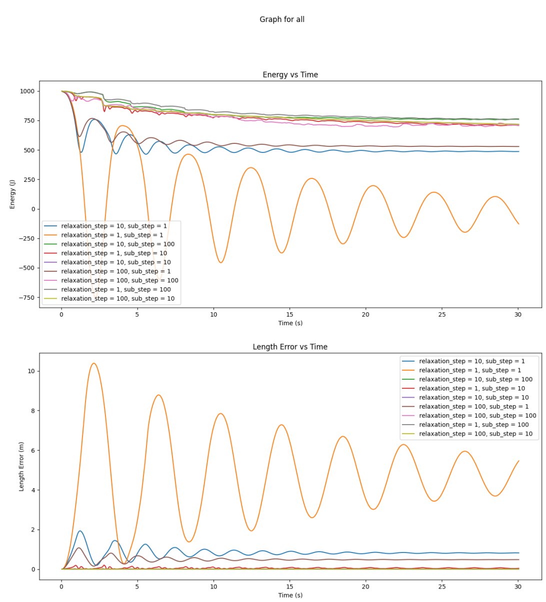


(d) Energy over time with 10 relaxation steps

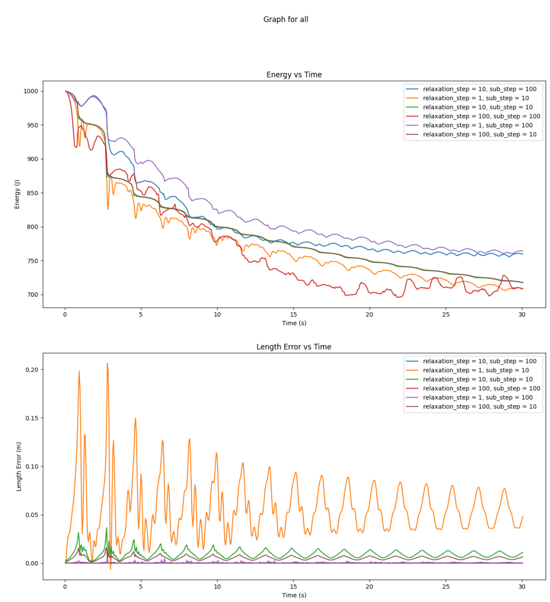


(e) Length error over time with 10 simulation substeps

Figure 2: Comparison Graph of Energy / Length Error Over Time



(a) All results



(b) Results without substeps=1, zoom in

Figure 3: Comparison Graph of Energy / Length Error Over Time (all in one)