

The trajectory of a swinging triple pendulum

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1. Introduction

We tried to determine the equation of the motion of a triple pendulum and to simulate the trajectory in an ideal world. Also, we made the triple pendulum and we analyzed the movement of a real trajectory of a pendulum and we compared those trajectories.

2. Results

We succeeded in determining the equation of motion as shown sentence below. However, the simulation doesn't move exactly as it should. We thought that there may be something wrong in the calculations or the programing. We are looking for the reasons of this problem.

3. The equation of motion

- $\frac{1}{2}l_3\dot{\omega}_3m_3 + l_2m_3\dot{\omega}_2\cos\Delta_2 + l_1m_3\dot{\omega}_1\cos\Delta_3 + l_2m_3\omega_2^2\sin\Delta_2 + l_1m_3\omega_1^2\sin\Delta_3 + m_3g\sin\theta_3 = 0$
- $\frac{1}{2}l_1(m_2 + 4m_3)\dot{\omega}_2 + l_1(m_2 + 2m_3)\dot{\omega}_1\cos\Delta_1 + l_3m_3\dot{\omega}_3\cos\Delta_2 - l_1(m_2 + 2m_3)\omega_1^2\sin\Delta_1 + l_3m_3\omega_3^2\sin\Delta_2 + (m_2 + 2m_3)g\sin\theta_2 = 0$
- $\frac{1}{2}l_1(m_1 + 4m_2 + 4m_3)\dot{\omega}_1 + l_1(m_2 + 2m_3)\dot{\omega}_2\cos\Delta_1 + l_3m_3\dot{\omega}_3\cos\Delta_3 - l_3m_3\omega_3^2\sin\Delta_3 + l_2(m_2 + 2m_3)\omega_2^2\sin\Delta_1 + (m_1 + 2m_3 + 2m_3)g\sin\theta_1 = 0$

4. Experience

We made a real triple pendulum and recorded the trajectory of motion. We set the organized angle to about 135 degrees because pendulums move in an extreme way in this case when we drop them.

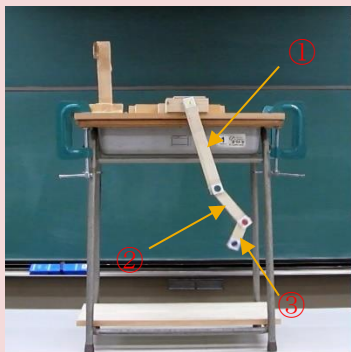


Figure1

This is a real triple pendulum.

- ① 300mm
- ② 150mm
- ③ 100mm

6. Effects and consideration

We analyzed the angles that were chased and led.

We checked some data which moved alike.

We are classifying every data into different types by using AI now.

We will pick up something that caused the effects.

5. Chasing trajectories

We checked the movement of the triple pendulum every 15 seconds for about 60 times by recording coordinates on 30 sheets with the software called "kinovea".

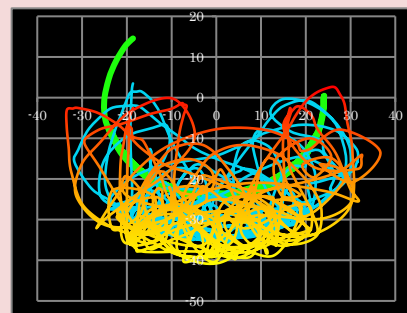


Figure 2

One example of a trajectory

7. Perspective

Including clustering with AI, we would like to search for the rules of motion. And we want to compare the difference of the motion between an ideal place and a real place. Lastly, we want to make more simulations by considering frictional force and air resistance.

8. Works Cited

https://www.math.ryukoku.ac.jp/~tsutomu/undergraduate/2014/14_hayakawa_pa.pdf Ryukoku university