Elina Murtazina, BigHW2

1 Task

1.1 Tools

Overleaf, Google Collab, Photoshop (to compare plots), Arduino (to measure income data), videocamera (to film videos just in case), 105 tools like screwdrivers and level to make good measurements, scales, ruler and so on.

1.2 Link to simulation:

Click here!

1.3 Task description

Detailed task description

1. Obtain the required measurements of the stand (like needed masses, lengths and so on).
2. Gather the positions and velocities of the stand. You should run the same experiment 3 times each.
   Initial conditions:
   - $x = 0,\ \phi = 15°,\ \dot{x} = 0,\ \dot{\phi} = 0,\ t = 0$;
   - $x = 0.25\ m,\ \phi = 45°,\ \dot{x} = 0,\ \dot{\phi} = 0,\ t = 0$;
   - $x = 0.25\ m,\ \phi = -135°,\ \dot{x} = 0,\ \dot{\phi} = 0,\ t = 0$;
3. Substitute a real data to your math model from HW 7, 8 (you can choose any method your like) and compare the results (propose and justify the metric).
4. Explain, what affects the difference between math model and real data. Is it difference significant?
5. If so, change the model (add new forces, change the object representation), gather new needed data and compare it again.
6. Make a conclusion.

What report should contain

- The list of used tools and applications (I gathered a trajectory dataset using *x* tool), etc.
- The list of data you gathered from stand and how did you do it.
- Show how you conducted experiments. Is there any difference when you did the same experiment? Show it using plots and/or other metrics like *std*, *mse* and so on.
- Show the way how you chose the metrics for trajectory comparison, how you justify the answer.
- If the error is too large, explain how you wanted to change your model and why you chose such path.
- Summarize your experience.

1.4 Task explanation

Here is the video of the system in action Here are plots we tracked from irl system (at the end of document)

So the distribution of work was everyone does something with experiential part (Timur - prepared proper tools to work with stand, Leonid - made measurements themselves (experiments), I did measurements for different parts of stand and Muhammadrizo parced and ploted taken results) Then we suddenly splitted and I and Leonid tried to come up with the system of equations for the system with proper resistance forces, but we certainly made some mistakes and realized in while 'playing' with coefficients. So yes, we didn't get graphs even something close to the plots from irl. These are what we got:

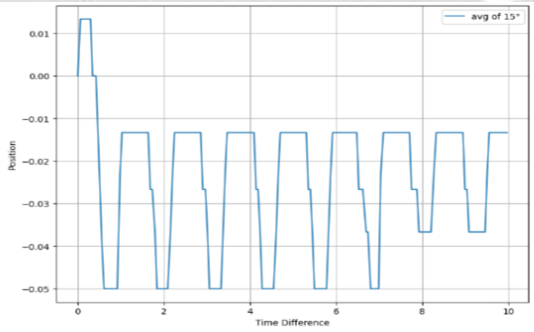
$$\ddot{\phi} = -\frac{g m_a m_b \sin(\phi)}{l m_a m_b \sin^2(\phi) + l m_a m_b \cos^2(\phi) + l m_b^2 \sin^2(\phi)} - \frac{g m_b^2 \sin(\phi)}{l m_a m_b \sin^2(\phi) + l m_a m_b \cos^2(\phi) + l m_b^2 \sin^2(\phi)} + \frac{k_1 m_b \cos(\phi)\dot{x}_a}{l m_a m_b \sin^2(\phi) + l m_a m_b \cos^2(\phi) + l m_b^2 \sin^2(\phi)} + \frac{k_2 m_a \sin(\phi)\dot{\phi}}{l m_a m_b \sin^2(\phi) + l m_a m_b \cos^2(\phi) + l m_b^2 \sin^2(\phi)} - \frac{k_2 m_a \cos(\phi)\dot{\phi}}{l m_a m_b \sin^2(\phi) + l m_a m_b \cos^2(\phi) + l m_b^2 \sin^2(\phi)} + \frac{k_2 m_b \sin(\phi)\dot{\phi}}{l m_a m_b \sin^2(\phi) + l m_a m_b \cos^2(\phi) + l m_b^2 \sin^2(\phi)} - \frac{l m_b^2 \sin(\phi)\cos(\phi)\dot{\phi}^2}{l m_a m_b \sin^2(\phi) + l m_a m_b \cos^2(\phi) + l m_b^2 \sin^2(\phi)}$$

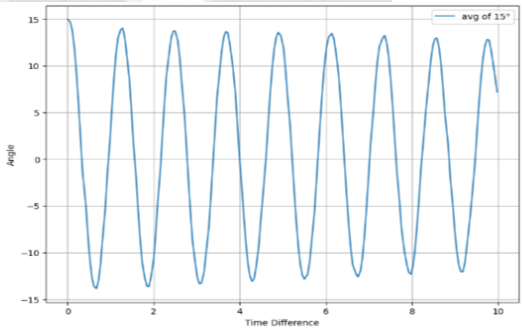
$$\ddot{x}_a = \frac{g m_b \sin(\phi)\cos(\phi)}{m_a \sin^2(\phi) + m_a \cos^2(\phi) + m_b \sin^2(\phi)} - \frac{k_1 \sin^2(\phi)\dot{x}_a}{m_a \sin^2(\phi) + m_a \cos^2(\phi) + m_b \sin^2(\phi)} - \frac{k_1 \cos^2(\phi)\dot{x}_a}{m_a \sin^2(\phi) + m_a \cos^2(\phi) + m_b \sin^2(\phi)} - \frac{k_2 \sin^2(\phi)\dot{\phi}}{m_a \sin^2(\phi) + m_a \cos^2(\phi) + m_b \sin^2(\phi)} - \frac{k_2 \sin(\phi)\cos(\phi)\dot{\phi}}{m_a \sin^2(\phi) + m_a \cos^2(\phi) + m_b \sin^2(\phi)} + \frac{l m_b \sin^3(\phi)\dot{\phi}^2}{m_a \sin^2(\phi) + m_a \cos^2(\phi) + m_b \sin^2(\phi)} + \frac{l m_b \sin(\phi)\cos^2(\phi)\dot{\phi}^2}{m_a \sin^2(\phi) + m_a \cos^2(\phi) + m_b \sin^2(\phi)}$$

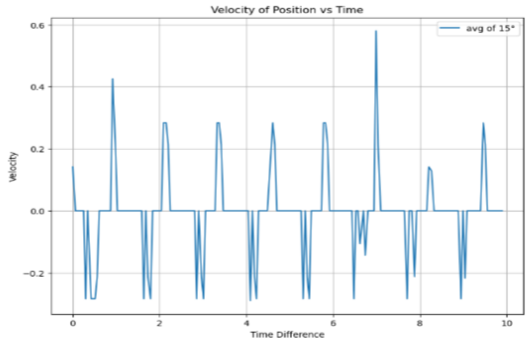
Maybe we didn't communicate well with Python and what's why we got wrong equations. Main problem - both ofresistance forces affects both parts of system, even tho every should control only one (theoretically)

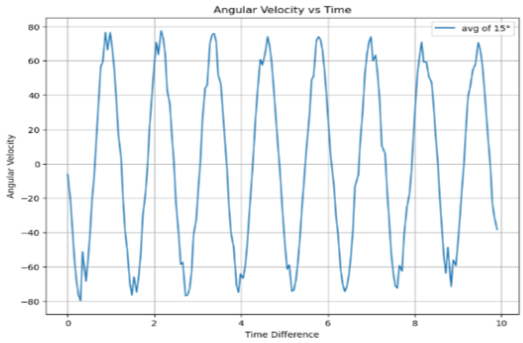
Error is too large and model basically doesn't describe the reality at all. We went through Newton-Euler method, I would go through Euler-Lagrange next time because I think it might be better it terms of defining the formulas. Or just take derivative by hand one/two more times more just to trust no one. Overall experience was enjoyable in terms of new actions (never touched Arduino or work with any similar things) but the final result is obviously disappointing since we spent a lot of time on it.

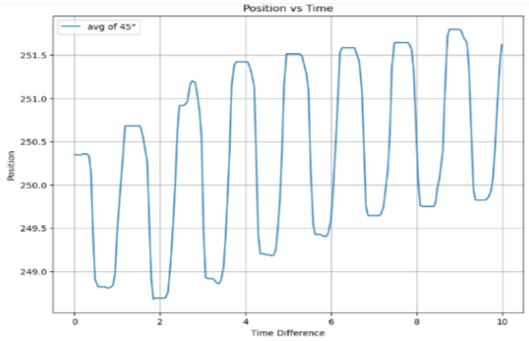
Here is the meme that describes the whole situation(not funny):

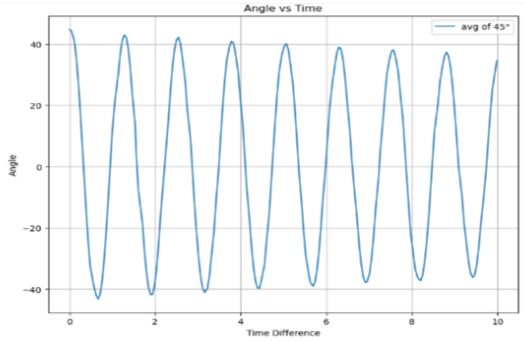


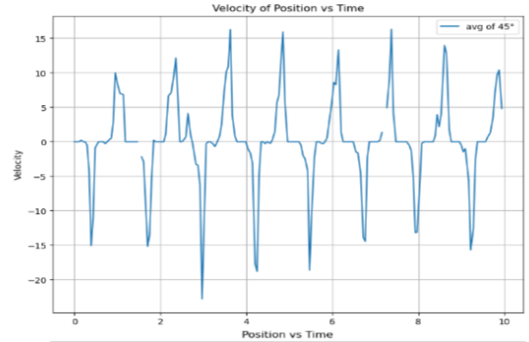


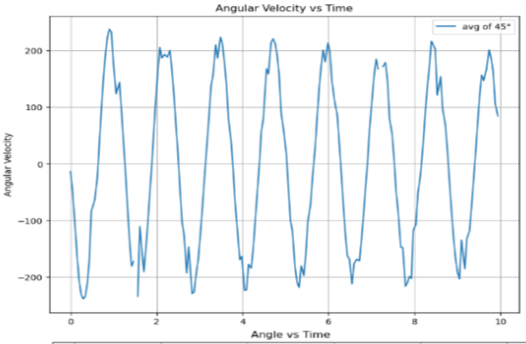


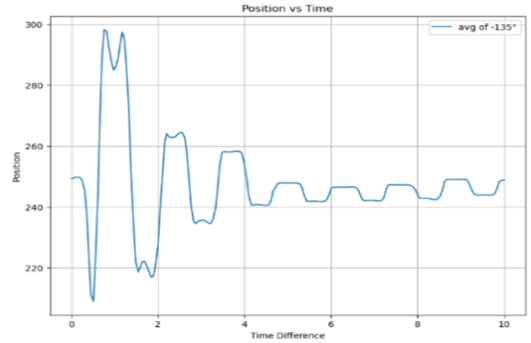


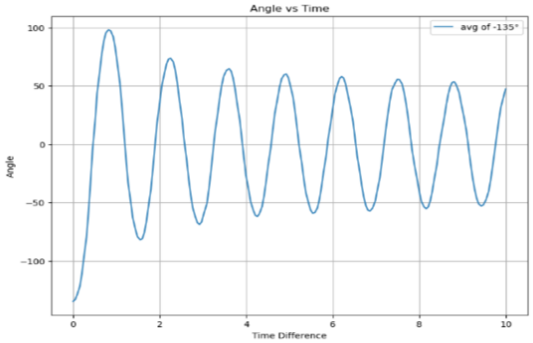

Position vs Time
avg of 45°
Position
Time Difference

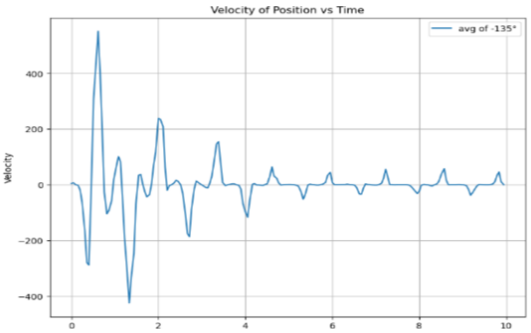

Angle vs Time
avg of 45°
Angle
Time Difference

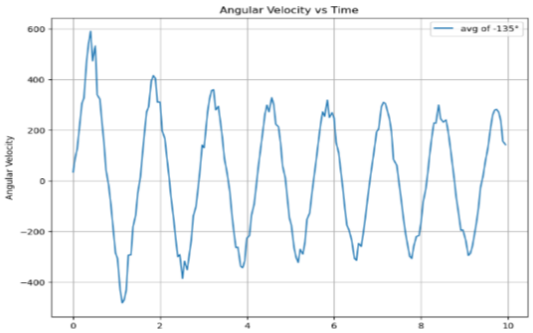

Velocity of Position vs Time
avg of 45°
Velocity


Angular Velocity vs Time
avg of 45°
Angular Velocity


Position vs Time
avg of -135°
Position
Time Difference


Angle vs Time
avg of -135°
Angle
Time Difference


Velocity of Position vs Time
avg of -135°
Velocity


Angular Velocity vs Time
avg of -135°
Angular Velocity