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ЛАБОРАТОРНАЯ РАБОТА №4

Вариант №2 (Optimus)

Параметры optimus:

L1=0,073 м; L2=0,0949 м; L3=0,1095 м; L4=0,073 м; L5=0,365 м.

Параметры q1:

AMP= 16,43°; FREQ=3,86 Гц; BIAS=2,2 °

Листинг кода xml файла с добавлением <actuaor> и <sensor>:

```xml
<?xml version='1.0' encoding='UTF-8'?>
<mujoco>

  <option timestep="1e-3"/>
  <option gravity="0 0 -9.8"/>

  <asset>
    <texture type="skybox" builtin="gradient" rgb1="0.9 0.9 1.0" rgb2="0.4 0.4 0.6" width="256" height="256"/>
    <texture name="floor" type="2d" builtin="checker" rgb1="0.2 0.2 0.2" rgb2="0.5 0.5 0.5" width="300" height="300"/>
    <material name="floor_mat" texture="floor" texrepeat="8 8" reflectance="0.1"/>
    <material name="node_color" rgba="0.95 0.2 0.2 0.7"/>
    <material name="rod_color" rgba="0.25 0.45 0.85 0.7"/>
    <material name="slider_color" rgba="0.3 0.7 0.3 0.7"/>
  </asset>

  <worldbody>

    <light pos="2 1 5" dir="0 0 -1" directional="true"/>
    <light pos="1 0 5" directional="false"/>

    <geom type="plane" size="0.6 0.6 0.1" material="floor_mat"/>

    <body name="arm1_base" pos="0 0 1" euler="0 0 0">
      <joint name="pivot1" type="hinge" axis="0 -1 0" stiffness="0" springref="0" damping="0"/>
      <geom name="base_node" type="cylinder" pos="0 0 0" size="0.005 0.005" material="node_color" euler="0 0 0" contype="0"/>
      <geom name="first_segment" type="cylinder" pos="0 0 0.0365" size="0.005 0.0365" material="rod_color" euler="0 0 0" contype="0"/>
```

```xml
<site name="privA" size="0.005" pos="0 0 0.07"/>

<body name="arm1_extension" pos="0 0 0.073" euler="0 0 0">
    <joint name="elbow1" type="hinge" axis="0 -1 0" stiffness="0" springref="0" damping="0.1"/>
    <geom name="middle_node" type="cylinder" pos="0 0 0" size="0.005 0.005" material="node_color" euler="0 0 0" contype="0"/>
    <geom name="second_segment" type="cylinder" pos="0 0 0.04745" size="0.005 0.04745" material="rod_color" euler="0 0 0" contype="0"/>
    <site name="end_effector1" size="0.005" pos="0 0 0.0949"/>
</body>
</body>


<body name="arm2_base" pos="0.073 0 1" euler="0 0 0">
    <joint name="pivot2" type="hinge" axis="0 -1 0" stiffness="0" springref="0" damping="0.1"/>
    <geom name="side_node" type="cylinder" pos="0 0 0" size="0.005 0.005" material="node_color" euler="0 0 0" contype="0"/>
    <geom name="side_rod" type="cylinder" pos="0 0 0.05475" size="0.005 0.05475" material="rod_color" euler="0 0 0" contype="0"/>
    <site name="end_effector2" size="0.005" pos="0 0 0.1095"/>
</body>


<body name="slider_assembly" pos="0.365 0 1" euler="0 0 0">
    <joint name="fixed_pivot" type="hinge" axis="0 -1 0" stiffness="0" springref="0" damping="0"/>
    <geom name="anchor_node" type="cylinder" pos="0 0 0" size="0.005 0.005" material="node_color" euler="0 0 0" contype="0"/>
    <geom name="vertical_rod" type="cylinder" pos="0 0 0.12" size="0.005 0.12" material="slider_color" euler="0 0 0" contype="0"/>

    <body name="sliding_part" pos="0 0 0.07" euler="0 0 0">
        <joint name="prismatic" type="slide" axis="0 0 1" limited="true" range="-0.1 0.1" stiffness="0" springref="0" damping="0"/>
        <geom name="slider_node" type="cylinder" pos="0 0 0" size="0.005 0.005" material="node_color" euler="0 0 0" contype="0"/>
        <geom name="extended_rod" type="cylinder" pos="0 0 0.08" size="0.005 0.12" material="slider_color" euler="0 0 0" contype="0"/>
        <site name="end_effector3" size="0.005" pos="0 0 0.205"/>
    </body>
</body>


</worldbody>


<equality>
    <connect site1="end_effector1" site2="end_effector2"/>
    <connect site1="end_effector1" site2="end_effector3"/>
</equality>
```

```xml
    <actuator>
        <position name="prismatic" joint="prismatic"/>
    </actuator>

    <sensor>
        <framepos objtype="site" objname="privA"/>
    </sensor>

</mujoco>
```

В код python задаём значения и ПД регулятор. Листинг кода:

```python
import time
import mujoco
import mujoco.viewer
import numpy as np

paused = False

def key_callback(keycode):

    if chr(keycode) == ' ':
        global paused
        paused = not paused

m = mujoco.MjModel.from_xml_path('Task_4.xml')
d = mujoco.MjData(m)

def PD_contr(mj_data, KP, KV, theta):

    mj_data.ctrl[0] = KP * (-mj_data.qpos[0] + theta) + KV * (0 - mj_data.qvel[0])

TIME = 15
dt = 0.01
Ndt = int(TIME / dt)
t = np.linspace(0, TIME, Ndt)

FREQ = 3.86
AMP = np.deg2rad(16.43)
BIAS = np.deg2rad(2.2)

theta_des = AMP * np.sin(FREQ * t) + BIAS
```

```
with mujoco.viewer.launch_passive(m, d, key_callback=key_callback) as viewer:
    start_time = time.time()

    for i in range(Ndt):
        if not viewer.is_running():
            break

        step_start = time.time()

        if not paused:

            PD_contr(d, 35, 12, theta_des[i])

                    mujoco.mj_step(m, d)

                    viewer.sync()

        time_until_next_step = dt - (time.time() - step_start)
        if time_until_next_step > 0:
            time.sleep(time_until_next_step)
```

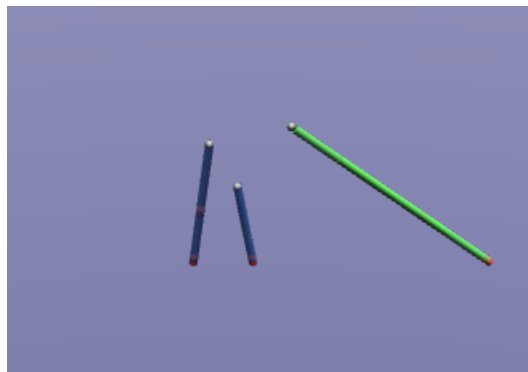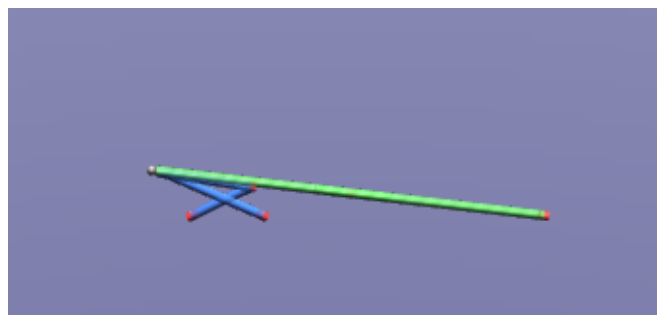Результат моделирования начальное положение (рис.1) и конечное положение (рис.2):

Рисунок 1 «Начальное положение в симуляции»

Рисунок 2 «Конечное положение в симуляции»