THE MINISTRY OF SCIENCE AND HIGHER EDUCATION
OF THE RUSSIAN FEDERATION

ITMO University
(ITMO)

Faculty of Control Systems and Robotics

# SYNOPSIS
for the subject
*"Simulation of Robotic Systems"*

on the topic:
practice 3

Student:
*R4131c, 506185* *Movsesyan Arthur*

Tutor:
*Assistant, MSc* *Rakshin Egor*

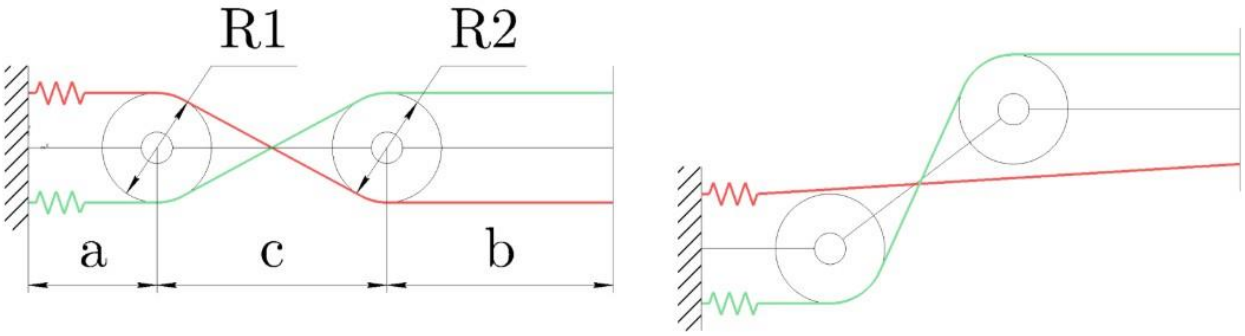
Saint Petersburg 2025

## Task

1. Look in the table and find yourself:

2. Choose one of the passive mechanisms according to your list and model .xml files.

Variant 1 - tendon connected 2R planar mechanism:




3. Write python script with `model`, `data` and `viewer` methods. Run the simulation.

4. Examples of .xml models are in the "Examples" folder.

I have the first variant, so my parameters are for tendon connected 2R planar mechanism.

| R1, m | R2, m | a, m | b, m | c, m |
|---|---|---|---|---|
| 0.014 | 0.042 | 0.039 | 0.043 | 0.073 |

Mechanism analysis:
The mechanism forms closed kinematic chain with two rotational links R1 and R2. It has three linear segment a, b, c.

Implementation of the xml-model in Python with Mujoco and Mujoco_viewer libraries:

```
import mujoco
import mujoco_viewer
import numpy as np
import os

# XML
model_xml = """
<mujoco model="tendon">
  <option gravity="0 -9.81 0" integrator="Euler"/>
  <statistic center="0 0 0" extent="0.2"/>

  <visual>
    <rgba haze="0.9 0.9 0.95 1"/>
  </visual>

  <default>
    <joint axis="0 1 0" damping="0.00005"/>
    <geom type="capsule"/>
  </default>

  <asset>
    <texture name="texplane" type="2d" builtin="checker"
             rgb1="0.2 0.2 0.2" rgb2="0.2 0.2 0.2"
             width="512" height="512" mark="none"/>
    <material name="matplane" reflectance="0"
              texture="texplane" texrepeat="1 1" texuniform="true"/>
  </asset>

  <worldbody>
    <light pos="0 0 0.25"/>
    <light pos="0 0 3" dir="0 0 -1" directional="false"/>
    <geom name="floor" pos="0 0 -0.14" size="2 2 0.1"
          type="plane" material="matplane" conaffinity="15" condim="3"/>

    <body pos="0 0 0">
      <geom name="left_bound" type="box"
            size="0.002 0.03 0.03"
            rgba="0.3 0.5 1 1" pos="0 0 0"/>
      <geom fromto="0 0 0 0.039 0 0"
            rgba="0.8 0.8 0.3 0.6" size="0.002"
            contype="0" conaffinity="0"/>
      <site name="s1" pos="0.002 0 0.014" size="0.002" rgba="1 1 0 1"/>
      <site name="s2" pos="0.002 0 -0.014" size="0.002" rgba="1 1 0 1"/>

      <body pos="0.039 0 0">
        <joint name="elbow"/>
        <geom fromto="0 0 0 0.073 0 0"
              rgba="0.8 0.8 0.3 0.6" size="0.002"/>
        <body name="bullet_body" pos="0 0 0">
          <joint name="bullet_hinge" type="hinge"
                 axis="0 1 0" stiffness="5" damping="0.005"/>
          <geom name="Pulley" type="cylinder"
                fromto="0 0.005 0 0 -0.005 0"
                size="0.014"
                rgba="0.3 0.3 0.9 0.9"/>
          <site name="s3" pos="0 0 0.014" size="0.002" rgba="1 1 0 1"/>
          <site name="s4" pos="0 0 -0.014" size="0.002" rgba="1 1 0 1"/>
        </body>

        <body pos="0.073 0 0">
          <joint name="wrist"/>
          <geom fromto="0 0 0 0.043 0 0"
                rgba="0.8 0.3 0.6 1" size="0.002"/>
          <body name="pulley2_body" pos="0 0 0">
            <joint name="pulley2_hinge" type="hinge"
                   axis="0 1 0" stiffness="5" damping="0.005"/>
```

```
            <geom name="Pulley2" type="cylinder"
                  fromto="0 0.005 0 0 -0.005 0"
                  size="0.042"
                  rgba="0.3 0.3 0.9 0.9"/>
            <site name="s5" pos="0 0 0.042" size="0.002" rgba="1 1 0 1"/>
            <site name="s6" pos="0 0 -0.042" size="0.002" rgba="1 1 0 1"/>
            <site name="s7" pos="0.043 0 0.042" size="0.002" rgba="1 1 0 1"/>
            <site name="s8" pos="0.043 0 -0.042" size="0.002" rgba="1 1 0 1"/>
          </body>

          <body>
            <geom name="right_bound" type="box"
                  size="0.002 0.03 0.03"
                  rgba="0.3 0.5 1 1"
                  pos="0.043 0 0"/>
          </body>
        </body>
      </body>
    </body>
  </worldbody>

  <tendon>
    <spatial name="tendon1" stiffness="5" rgba="0.4 0.2 1 1" width="0.0015">
      <site site="s1"/>
      <geom geom="Pulley" sidesite="s3"/>
      <site site="s3"/>
      <geom geom="Pulley2" sidesite="s6"/>
      <site site="s8"/>
    </spatial>

    <spatial name="tendon2" stiffness="5" rgba="0 0.85 0.7 1" width="0.0015">
      <site site="s2"/>
      <geom geom="Pulley" sidesite="s4"/>
      <site site="s4"/>
      <geom geom="Pulley2" sidesite="s5"/>
      <site site="s7"/>
    </spatial>
  </tendon>
</mujoco>
"""
with open('tendon_mechanism.xml', 'w') as f:
    f.write(model_xml)

model = mujoco.MjModel.from_xml_path('tendon_mechanism.xml')
data = mujoco.MjData(model)

viewer = mujoco_viewer.MujocoViewer(model, data)

try:
    while viewer.is_alive:
        mujoco.mj_step(model, data)
        viewer.render()
finally:
    viewer.close()
    if os.path.exists('tendon_mechanism.xml'):
        os.remove('tendom_mechanism.xml')
```

As the result I got the run-time simulation of the mechanism that I constructed.

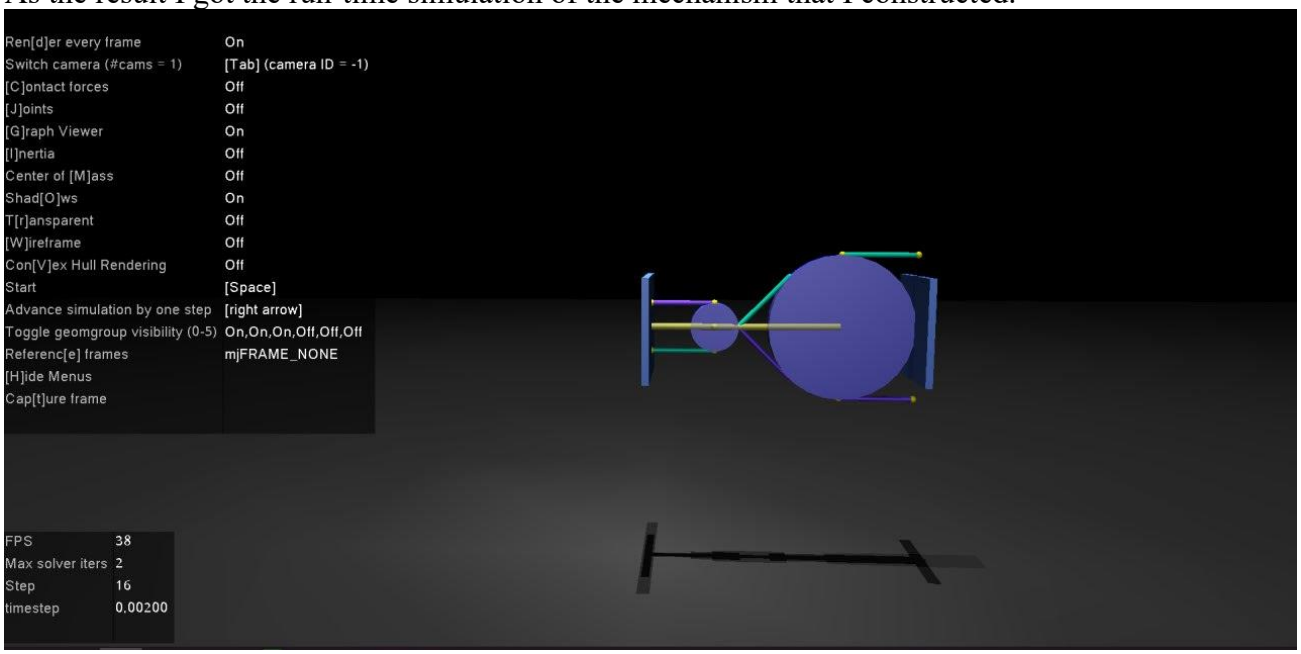



Fig. 1. Simulation of the mechanism in mujoco_viewer.

**Conclusion:**

During the course of the laboratory work, a tendon-driven mechanism was successfully designed and implemented using the MuJoCo physics engine.