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import numpy as np
import matplotlib.pyplot as plt

# --- Robot Parameters ---
link1_len = 1.0
link2_len = 1.0

def forward_kinematics(theta1_deg, theta2_deg):
    t1 = np.deg2rad(theta1_deg)
    t2 = np.deg2rad(theta2_deg)
    x0, y0 = 0, 0

    #task 1
    # Elbow position (Link 1)
    x1 = link1_len * np.cos(t1)
    y1 = link1_len * np.sin(t1)
    # End-Effector position (Link 2)
    x2 = x1 + link2_len * np.cos(t1 + t2)
    y2 = y1 + link2_len * np.sin(t1 + t2)

    return (x0, y0), (x1, y1), (x2, y2)

test_cases = [
    ("Straight Arm", 60, 0),
    ("Bent Elbow", 45, 75),
    ("Folded Arm", 0, 180)
]

plt.figure(figsize=(16, 5))

for i, case in enumerate(test_cases):
    label = case[0]
    deg1 = case[1]
    deg2 = case[2]
    base, elbow, end_eff = forward_kinematics(deg1, deg2)

    # to verify
    print(f"Case: {label}")
    print(f"   Elbow: ({elbow[0]:.2f}, {elbow[1]:.2f})")
    print(f"   End-Effector: ({end_eff[0]:.2f}, {end_eff[1]:.2f})\n")

    # subplot
    plt.subplot(1, 3, i + 1)

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# plot-Link 1 (Red) and Link 2 (Blue)
plt.plot([base[0], elbow[0]], [base[1], elbow[1]], color='red',
linewidth=3, label='Link 1')
plt.plot([elbow[0], end_eff[0]], [elbow[1], end_eff[1]],
color='blue', linewidth=3, label='Link 2')

# markers
plt.plot(0, 0, 'ko', markersize=10) # Base
plt.plot(elbow[0], elbow[1], 'ko', markersize=8) # Elbow Joint
plt.plot(end_eff[0], end_eff[1], 'go', markersize=8) # End Effector

# Visual settings
plt.xlim(-2.5, 2.5)
plt.ylim(-2.5, 2.5)
plt.grid(True, linestyle='--', alpha=0.6)
plt.axhline(0, color='black', linewidth=0.8)
plt.axvline(0, color='black', linewidth=0.8)
plt.gca().set_aspect('equal')

plt.title(f"{label}\n $\theta_1 = \text{{deg1}}^\circ$ ,  $\theta_2 = \text{{deg2}}^\circ$ ")

plt.text(elbow[0] + 0.1, elbow[1], f"({elbow[0]:.1f},
{elbow[1]:.1f})", fontsize=9)
plt.text(end_eff[0] + 0.1, end_eff[1], f"({end_eff[0]:.1f},
{end_eff[1]:.1f})", fontsize=9)

plt.legend(loc='lower right')

plt.tight_layout()
plt.show()

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Explanation-

- 1- effect of q_1 -when we change q_1 it rotates entire system around origin i.e the base. So we if just change the q_1 while fixing q_2 end-effector follows a circle
- 2- effect of q_2 - to reach any point in all the area in the circle of radius l_1+l_2 . I.e to increase its reach.