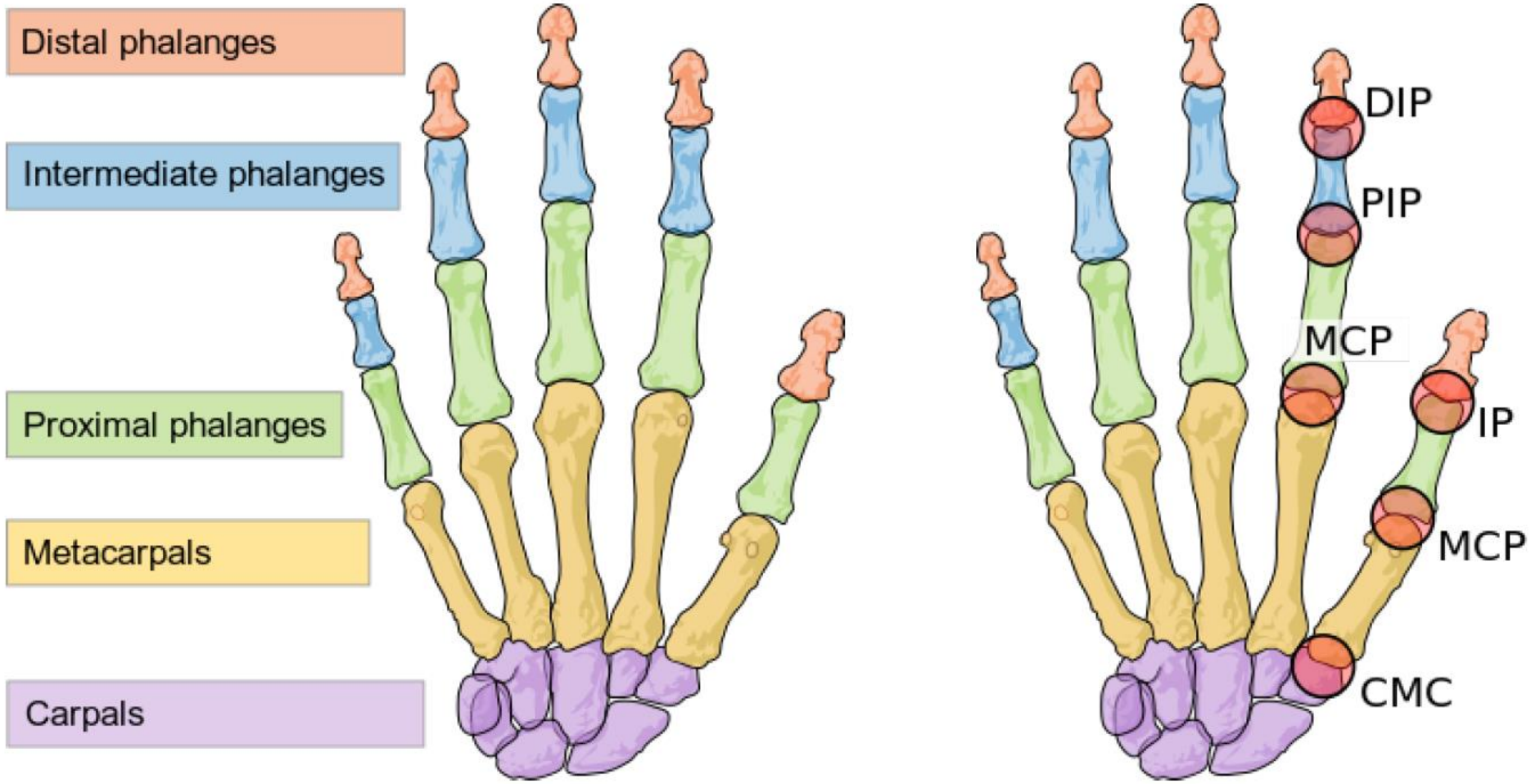
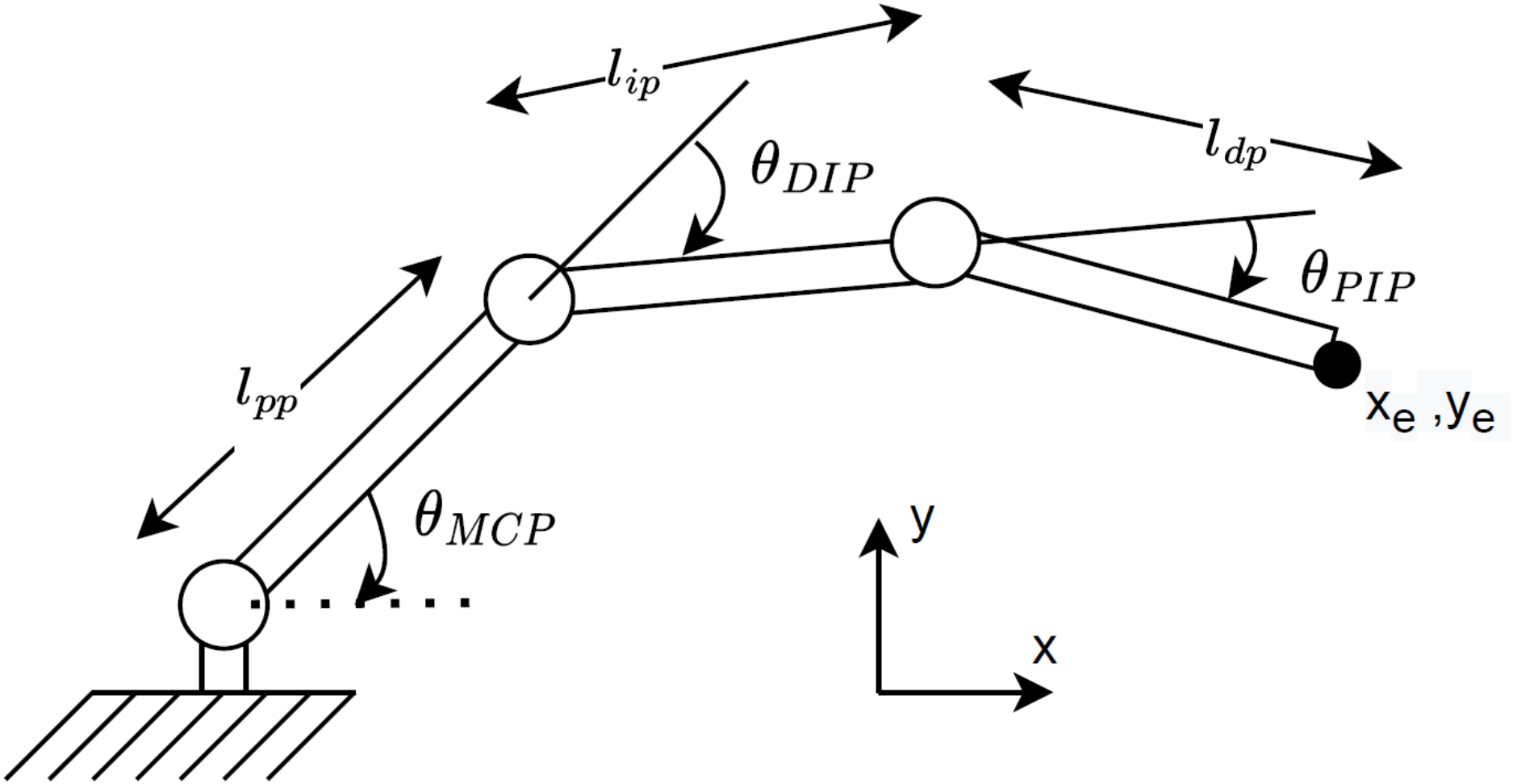
Exercise 1 – Finger modeling and simulating

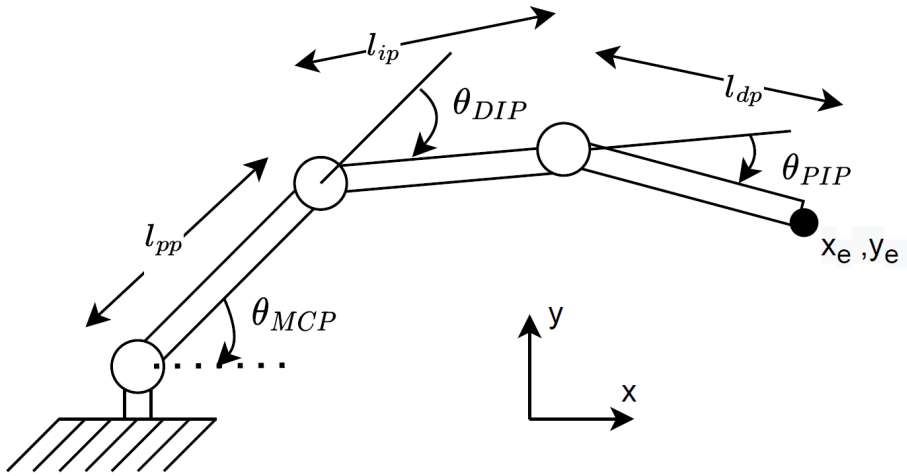


Index finger



Index finger

$$x_0 = 0$$
$$y_0 = 0$$

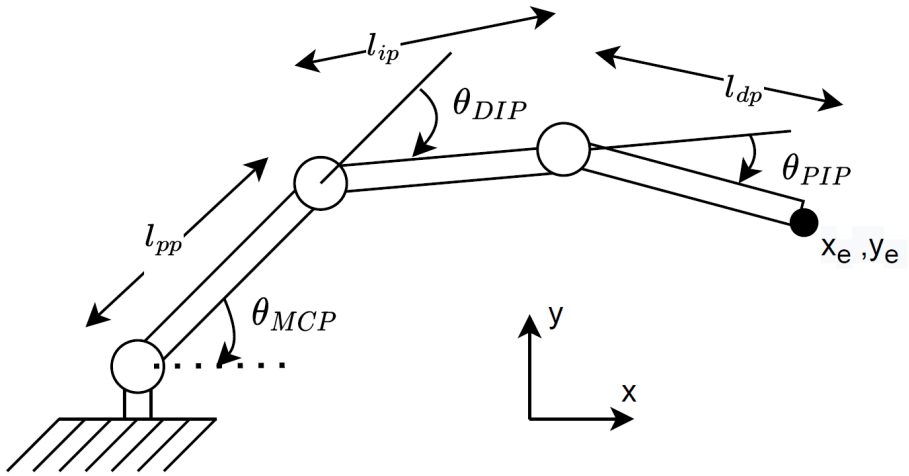


Index finger

$$x_0 = 0$$
$$y_0 = 0$$

$$x_{\mathrm{mcp}} = l_{\mathrm{pp}} \cos\left(\theta_{\mathrm{mcp}}\left(t\right)\right)$$

$$y_{\mathrm{mcp}} = l_{\mathrm{pp}} \sin\left(\theta_{\mathrm{mcp}}\left(t\right)\right)$$



Index finger

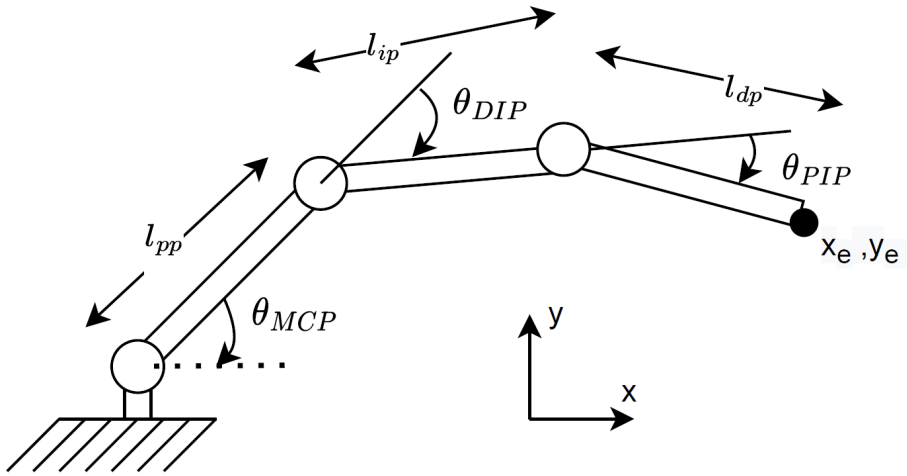
$$x_0 = 0$$
$$y_0 = 0$$

$$x_{\mathrm{mcp}} = l_{\mathrm{pp}} \cos\left(\theta_{\mathrm{mcp}}(t)\right)$$

$$y_{\mathrm{mcp}} = l_{\mathrm{pp}} \sin\left(\theta_{\mathrm{mcp}}(t)\right)$$

$$x_{\mathrm{dip}} = l_{\mathrm{pp}} \cos\left(\theta_{\mathrm{mcp}}(t)\right) + l_{\mathrm{ip}} \cos\left(\theta_{\mathrm{mcp}}(t) - \theta_{\mathrm{dip}}(t)\right)$$

$$y_{\mathrm{dip}} = l_{\mathrm{pp}} \sin\left(\theta_{\mathrm{mcp}}(t)\right) + l_{\mathrm{ip}} \sin\left(\theta_{\mathrm{mcp}}(t) - \theta_{\mathrm{dip}}(t)\right)$$



Index finger

$$x_0 = 0$$
$$y_0 = 0$$

$$x_{\text{mcp}} = l_{\text{pp}} \cos\left(\theta_{\text{mcp}}(t)\right)$$

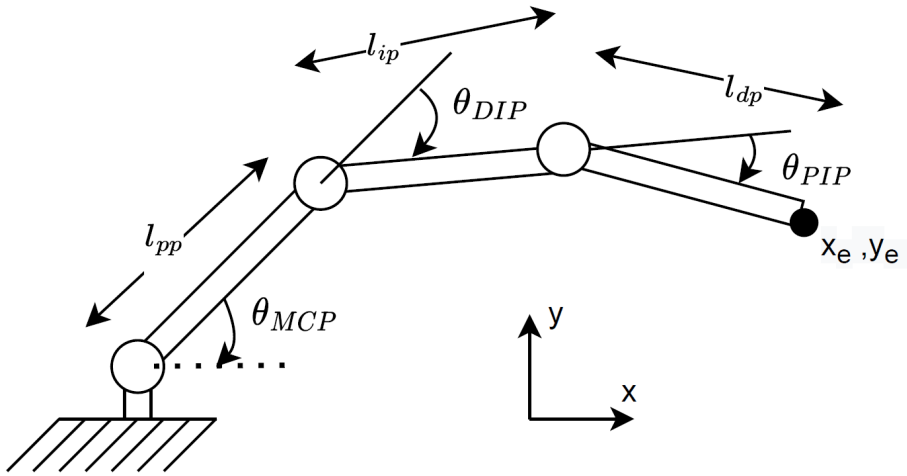
$$y_{\text{mcp}} = l_{\text{pp}} \sin\left(\theta_{\text{mcp}}(t)\right)$$

$$x_{\text{dip}} = l_{\text{pp}} \cos\left(\theta_{\text{mcp}}(t)\right) + l_{\text{ip}} \cos\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t)\right)$$

$$y_{\text{dip}} = l_{\text{pp}} \sin\left(\theta_{\text{mcp}}(t)\right) + l_{\text{ip}} \sin\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t)\right)$$

$$x_{\text{e}} = x_{\text{dip}} + l_{\text{dp}} \cos\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t) - \theta_{\text{pip}}(t)\right)$$

$$y_{\text{e}} = y_{\text{dip}} + l_{\text{dp}} \sin\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t) - \theta_{\text{pip}}(t)\right)$$



Index finger

$$x_0 = 0$$
$$y_0 = 0$$

$$x_{\text{mcp}} = l_{\text{pp}} \cos\left(\theta_{\text{mcp}}(t)\right)$$

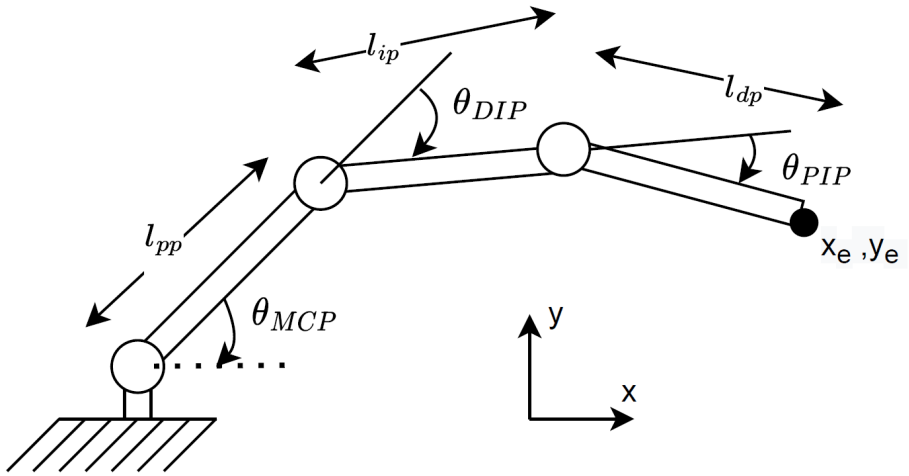
$$y_{\text{mcp}} = l_{\text{pp}} \sin\left(\theta_{\text{mcp}}(t)\right)$$

$$x_{\text{dip}} = l_{\text{pp}} \cos\left(\theta_{\text{mcp}}(t)\right) + l_{\text{ip}} \cos\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t)\right)$$

$$y_{\text{dip}} = l_{\text{pp}} \sin\left(\theta_{\text{mcp}}(t)\right) + l_{\text{ip}} \sin\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t)\right)$$

$$x_{\text{e}} = x_{\text{dip}} + l_{\text{dp}} \cos\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t) - \theta_{\text{pip}}(t)\right)$$

$$y_{\text{e}} = y_{\text{dip}} + l_{\text{dp}} \sin\left(\theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t) - \theta_{\text{pip}}(t)\right)$$



$$\theta_{\text{e}} = \theta_{\text{mcp}}(t) - \theta_{\text{dip}}(t) - \theta_{\text{pip}}(t)$$

Index finger

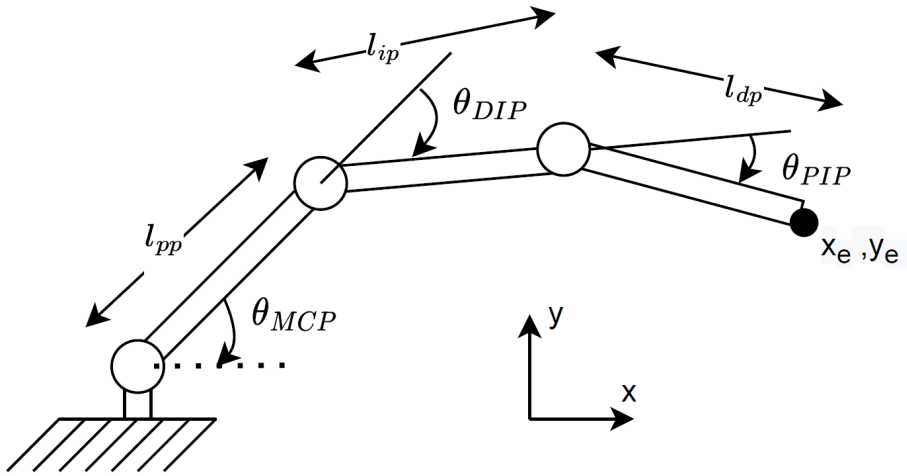
$$\theta_{\mathrm{e}} = \theta_{\mathrm{mcp}}(t) - \theta_{\mathrm{dip}}(t) - \theta_{\mathrm{pip}}(t)$$

$$x_{\mathrm{e}} = x_{\mathrm{dip}} + l_{\mathrm{dp}} \cos\left(\theta_{\mathrm{mcp}}(t) - \theta_{\mathrm{dip}}(t) - \theta_{\mathrm{pip}}(t)\right)$$

$$y_{\mathrm{e}} = y_{\mathrm{dip}} + l_{\mathrm{dp}} \sin\left(\theta_{\mathrm{mcp}}(t) - \theta_{\mathrm{dip}}(t) - \theta_{\mathrm{pip}}(t)\right)$$

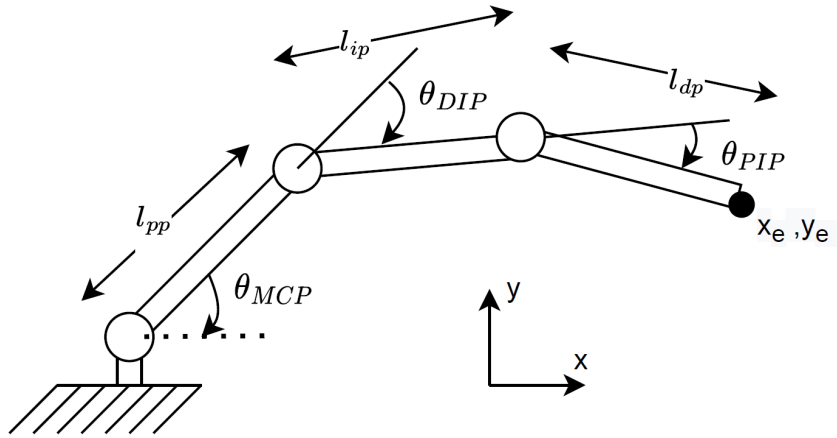
$$\frac{\mathrm{d}x_e}{\mathrm{d}t} = v_{x,e}$$

$$\frac{\mathrm{d}y_e}{\mathrm{d}t} = v_{y,e}$$



Index finger

```
theta_mcp= deg2rad(linspace(q1i,q1f,20));
theta_pip = deg2rad(linspace(q2i,q2f,20));
theta_dip = deg2rad(linspace(q3i,q3f,20));
```

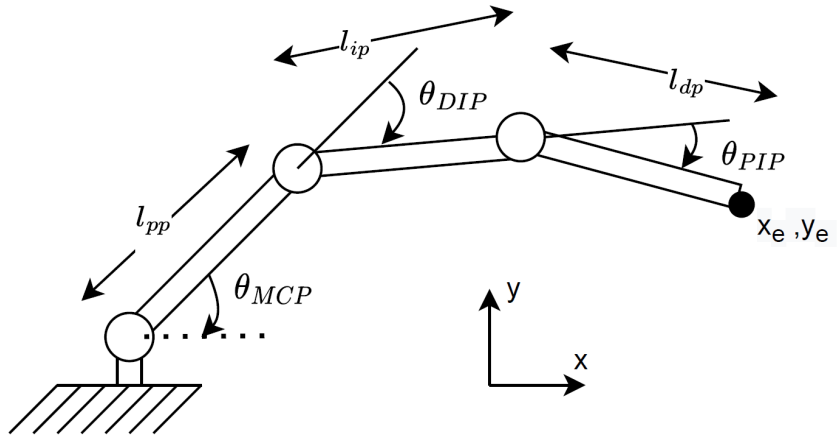


Index finger

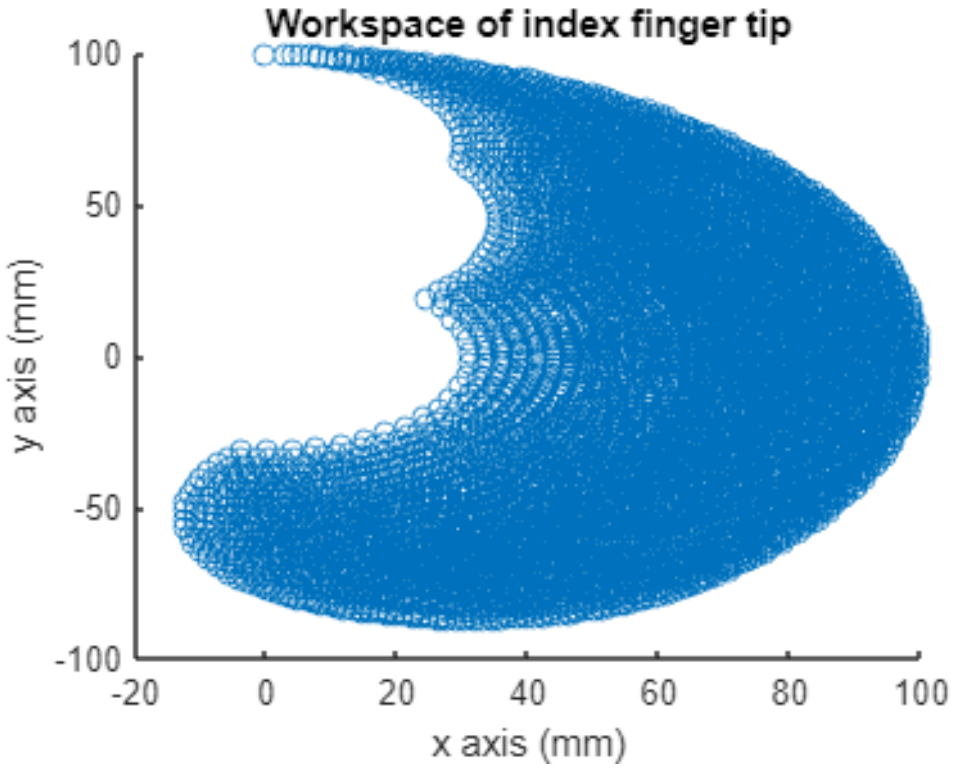
```
theta_mcp= deg2rad(linspace(q1i,q1f,20));
theta_pip = deg2rad(linspace(q2i,q2f,20));
theta_dip = deg2rad(linspace(q3i,q3f,20));
```

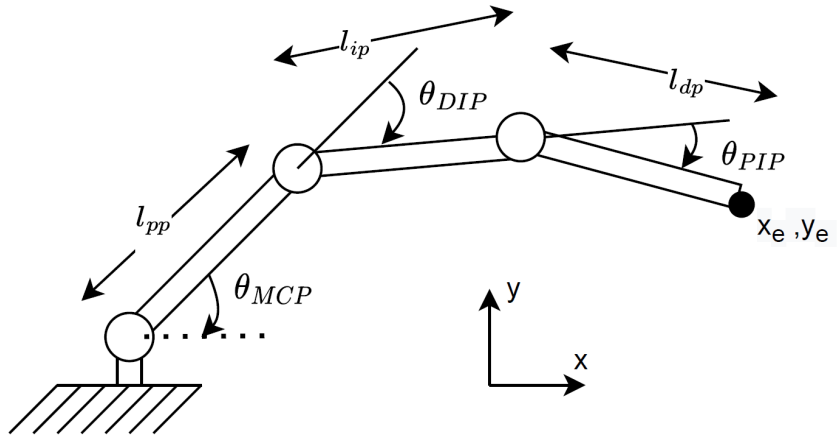
```
a=1;
for i=1:length(theta_mcp)
    for j=1:length(theta_dip)
        for k=1:length(theta_pip)
            x0=0;
            y0=0;
            x1 = l_pp* cos(theta_mcp(i));
            y1 = l_pp* sin(theta_mcp(i));
            x2 = x1 + l_ip*cos(theta_mcp(i)-theta_dip(j));
            y2 = y1 + l_ip*sin(theta_mcp(i)-theta_dip(j));
            x_e(a) = x2 + l_dp*cos(theta_mcp(i)-theta_pip(j)-theta_dip(k));
            y_e(a) = y2 + l_dp*sin(theta_mcp(i)-theta_pip(j)-theta_dip(k));
            a=a+1;
        end
    end
end

scatter(x_e,y_e)
```



Index finger





Index finger

```
line([x0 x1], [y0 y1], 'color' ,'r')
line([x1 x2], [y1 y2], 'color' ,'b')
line([x2 xe], [y2 ye], 'color' ,'g')
```