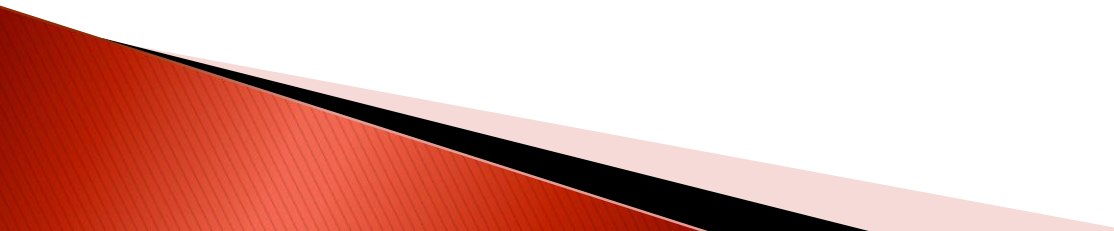


Modelarea robotului plan paralel cu 3 GDL

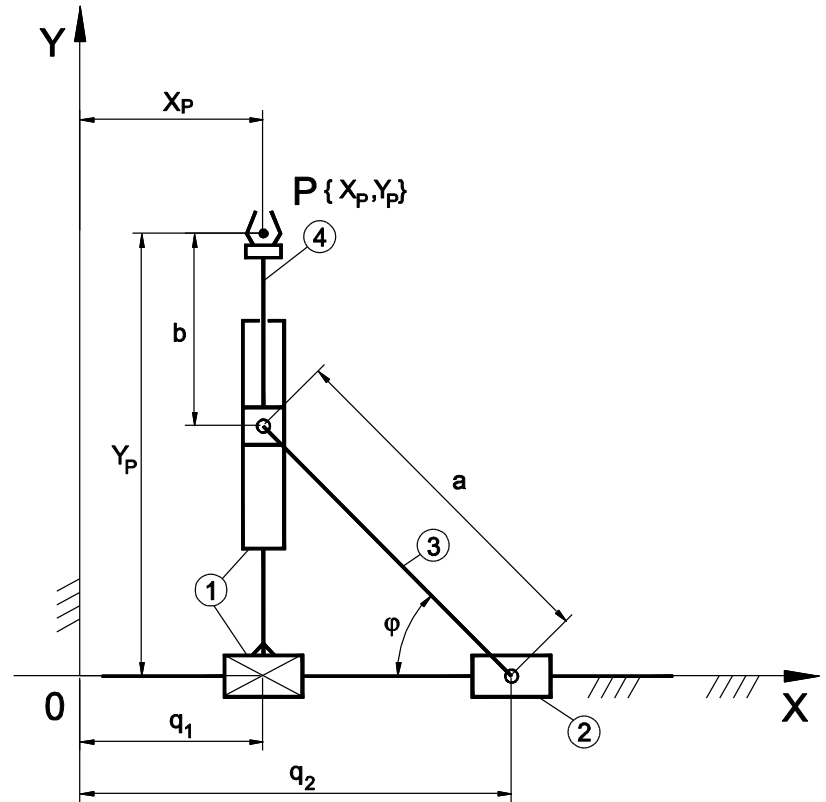
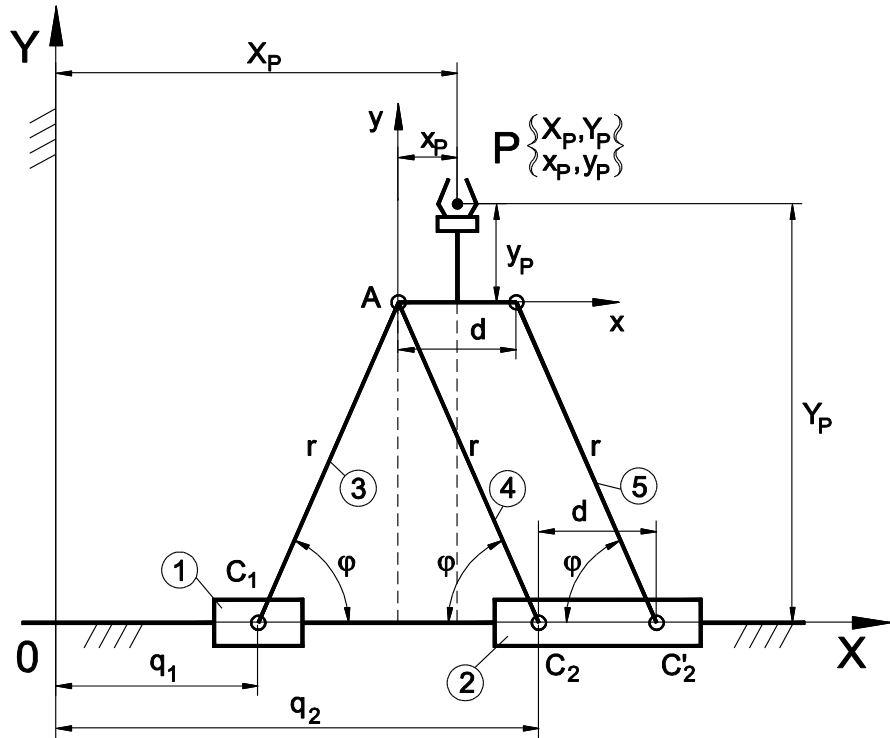
Studiu de caz

Cuprins

- Definierea si modelul geometric al unei structuri plan paralele.
 - Modelul cinematic al robotului.
 - Spatiului de lucru.
 - Proiectarea constructiva a robotului. Modelul CAD.
- 

Definirea si modelul geometric al unor structuri plane cu 2 GDL

Schema cinematica a structurii plan paralele



Modelul geometric

Modelul geometric invers

Date

$$X_P, Y_P$$



Necunoscute

$$q_i, i = 1, 2$$

Modelul geometric direct

Date

$$q_i, i = 1, 2$$



Necunoscute

$$X_P, Y_P$$

Modelul geometric direct

Date: q_1, q_2 $d, r; x_P, y_P$

Solutie analitica!

$$\begin{cases} X_P = X_A + x_P = q_1 + r \cos \varphi + x_P \\ Y_P = Y_A + y_P = r \sin \varphi + y_P \end{cases}$$

$$\cos \varphi = u = \frac{1}{2} \frac{q_2 - q_1}{r};$$

$$\sin \varphi = w = \frac{1}{2r} \sqrt{(2r)^2 - (q_2 - q_1)^2}$$

$$\varphi = \text{atan2}(u, w) = \text{atan2} \left[\sqrt{(2r)^2 - (q_2 - q_1)^2}, q_2 - q_1 \right]$$

$$\begin{cases} X_P = \frac{1}{2}(q_1 + q_2) + x_P \\ Y_P = \frac{1}{2} \sqrt{(2 \cdot r)^2 - (q_2 - q_1)^2} + y_P \end{cases}$$

Modelul geometric invers

Date: X_P, Y_P d, r, x_p, y_p

$$q_2 = 2X_P - q_1 - 2x_p \quad Y_P = \frac{1}{2}\sqrt{(2r)^2 - (q_2 - q_1)^2} + y_p \quad (Y_P - y_p)^2 = r^2 - \frac{(2X_P - 2q_1 - 2x_p)^2}{4}$$

$$\begin{cases} q_1 = X_p - x_p - \sqrt{r^2 - (Y_p - y_p)^2} \\ q_2 = 2 \cdot X_p - q_1 - 2 \cdot x_p \end{cases}$$

$$X_P = q_1 \quad Y_P = a \cdot s\varphi + b$$

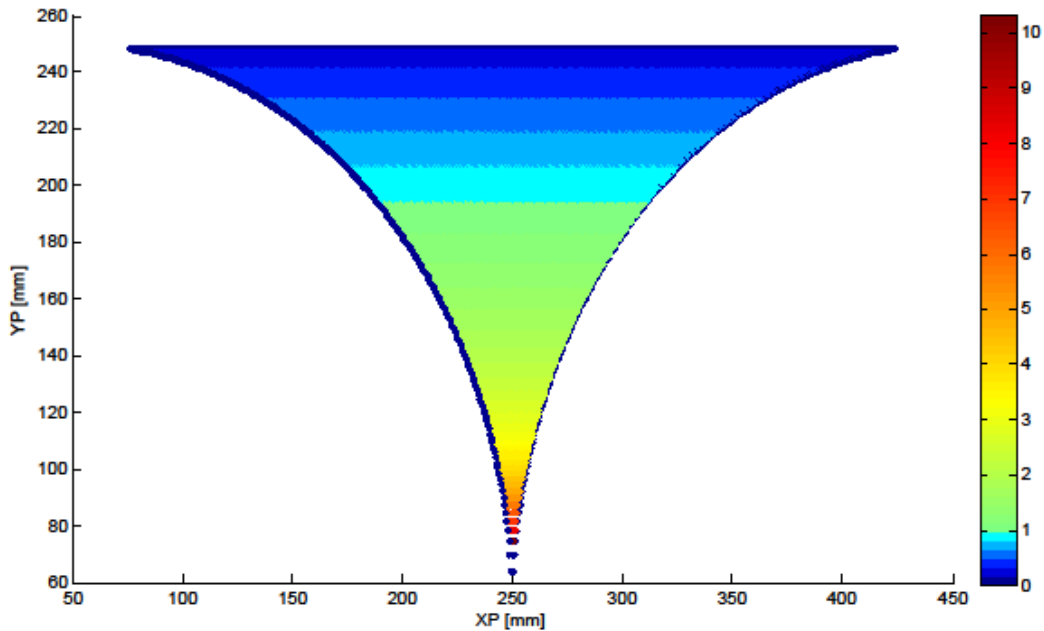
$$c\varphi = \frac{q_2 - q_1}{a}; s\varphi = \frac{1}{a}\sqrt{a^2 - (q_2 - q_1)^2} \quad \varphi = \text{atan2}\left(\sqrt{a^2 - (q_2 - q_1)^2}, q_2 - q_1\right)$$

$$\begin{cases} X_p = q_1 \\ Y_p = b + \sqrt{a^2 - (q_2 - q_1)^2} \end{cases} \quad \begin{cases} f_1(X_P, Y_P, q_1, q_2) \equiv X_P - q_1 = 0 \\ f_2(X_P, Y_P, q_1, q_2) \equiv Y_P - b - \sqrt{a^2 - (q_2 - q_1)^2} = 0 \end{cases}$$

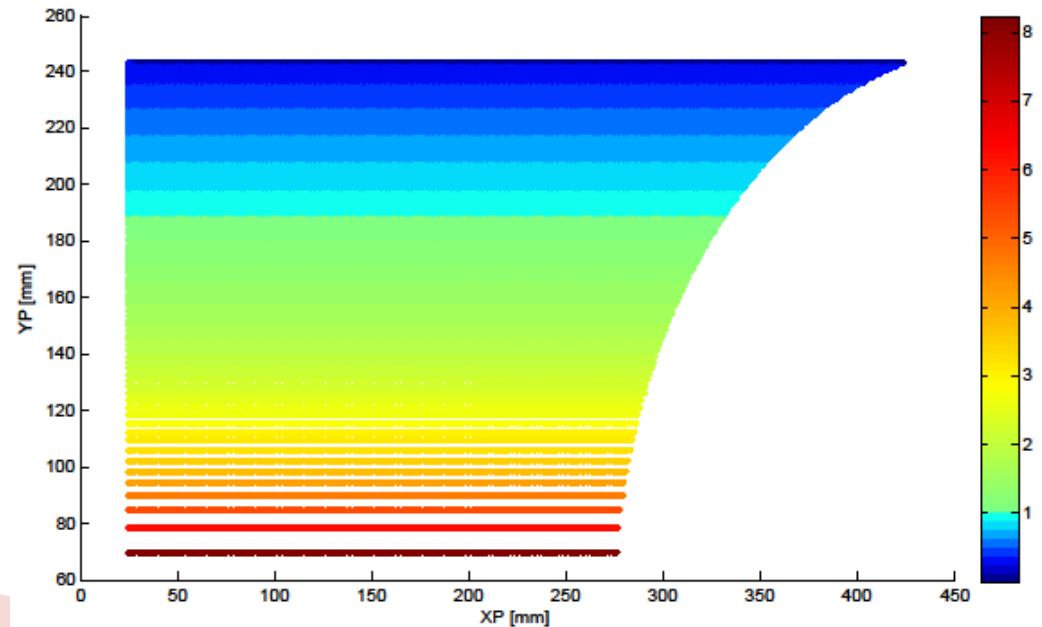
$$\begin{cases} q_1 = X_p \\ q_2 = Y_1 + \sqrt{a^2 - (X_p - b)^2} \end{cases}$$

Solutie analitica!

Precizia robotului

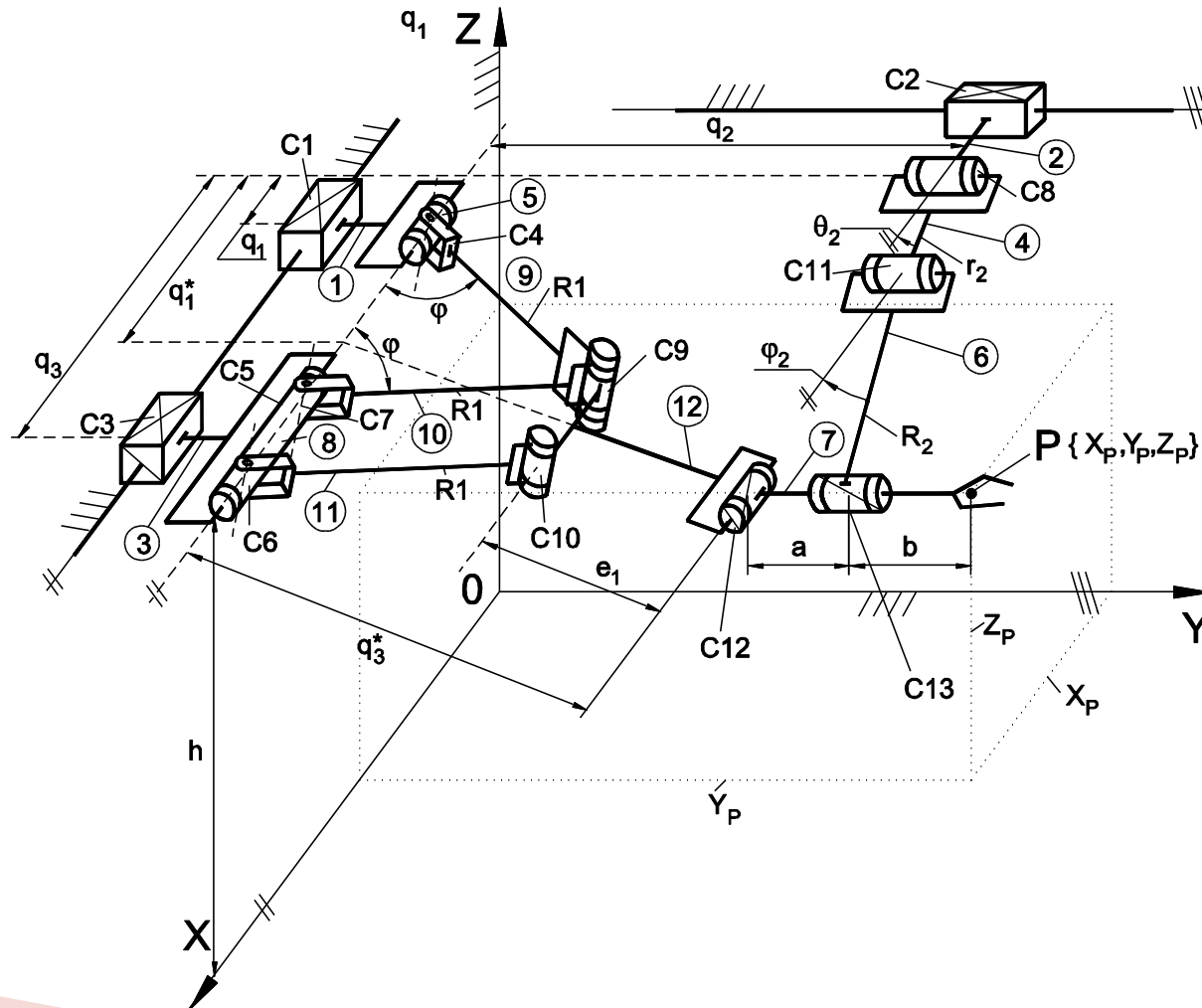


Modelarea spatiului de lucru cu
maparea preciziei de pozitionare
Valorile **subunitare** reprezinta
precizie ff buna, cele **supraunitare**
zone de precizie mai mica.



Modelul cinematic al robotului plan paralel. Spatiul de lucru.

Mecanism paralel cu orientare constanta a platformei folosind modulul plan



Modelul geometric

$$\begin{cases} X_P = q_1^* \\ Y_P = q_3^* \cdot c\theta_1 + a + b \\ Z_P = h - q_3^* \cdot s\theta_1 \end{cases}$$

$$\begin{cases} X_P = r_2 \cdot c\theta_2 + R_2 \cdot c\varphi_2 \\ Y_P = q_2 + b \\ Z_P = h - r_2 \cdot s\theta_2 - R_2 \cdot s\varphi_2 \end{cases}$$

$$q_3^* = \frac{1}{2} \sqrt{(2R_1)^2 - (q_3 - q_1)^2} + e_1$$

$$q_1^* = \frac{1}{2} (q_1 + q_3) + \frac{d}{2}$$

$$\begin{cases} q_3^* \cdot c\theta_1 = Y_P - a - b \\ q_3^* \cdot s\theta_1 = h - Z_P \end{cases}$$

DGM:

$$\begin{cases} X_P = q_1^* = \frac{1}{2} (q_1 + q_3) + \frac{d}{2} \\ Y_P = q_2 + b \\ Z_P = h - \sqrt{(q_3^*)^2 - (Y_P - a - b)^2} \end{cases}$$

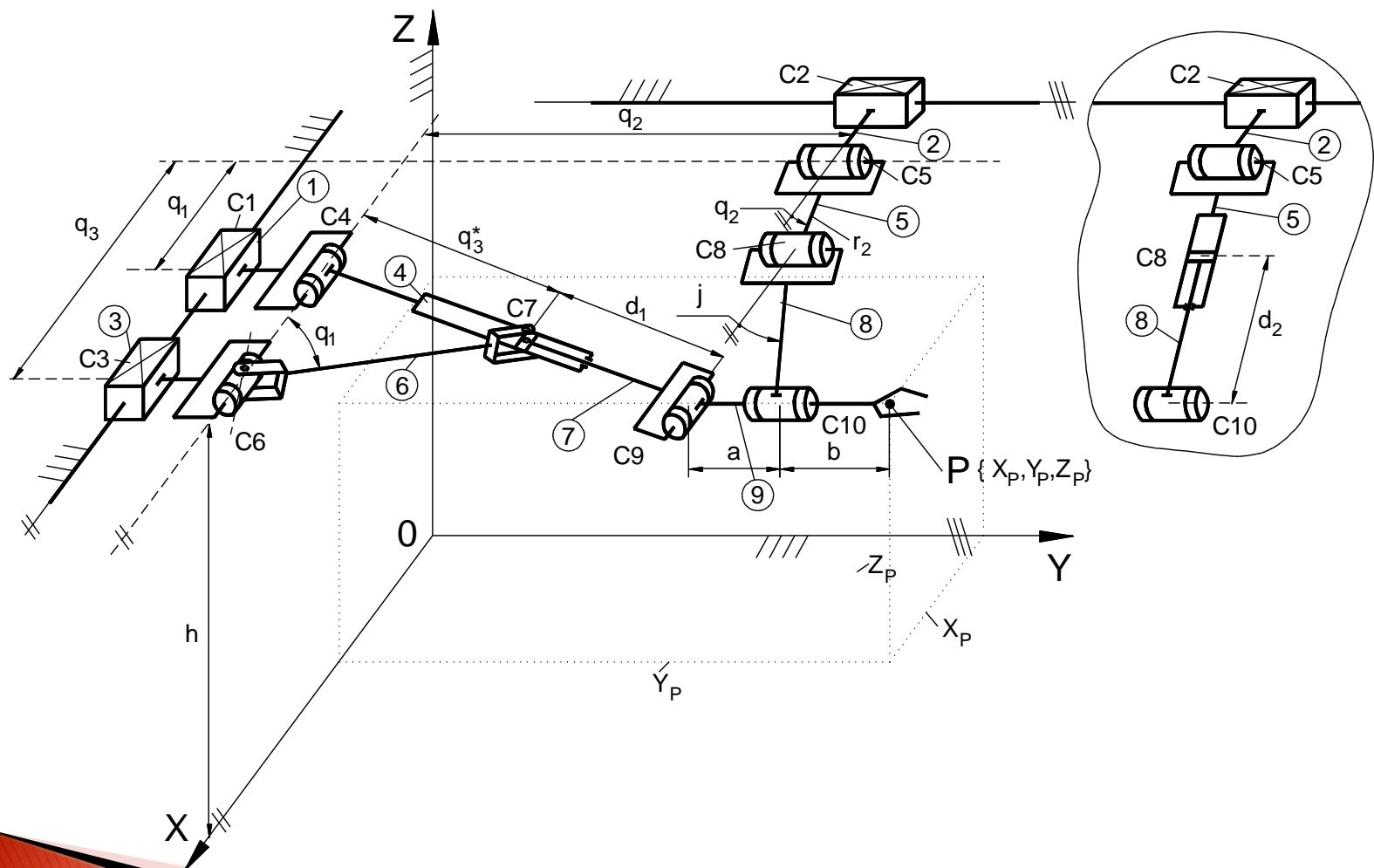
IGM:

$$\begin{cases} q_1 = X_P - \frac{d}{2} - \sqrt{R_1^2 - (q_3^* - y_P)^2} \\ q_2 = Y_P - b \\ q_3 = q_1 + 2\sqrt{R_1^2 - (q_3^* - y_P)^2} \end{cases}$$

Unde: $q_3^* = \sqrt{(Y_P - a - b)^2 + (h - Z_P)^2}$, $y_P = e_1$

$$\begin{cases} f_1(X_P, Y_P, Z_P, q_1, q_2, q_3) \equiv X_P - \frac{1}{2} (q_1 + q_3) - \frac{d}{2} = 0 \\ f_2(X_P, Y_P, Z_P, q_1, q_2, q_3) \equiv Y_P - q_2 - b = 0 \\ f_3(X_P, Y_P, Z_P, q_1, q_2, q_3) \equiv (Z_P - h)^2 - \left[\frac{1}{2} \sqrt{(2R_1)^2 - (q_3 - q_1)^2} + e_1 \right]^2 + (Y_P - a - b)^2 = 0 \end{cases}$$

Mecanism paralel cu orientare constanta a platformei folosind al doilea modulul plan



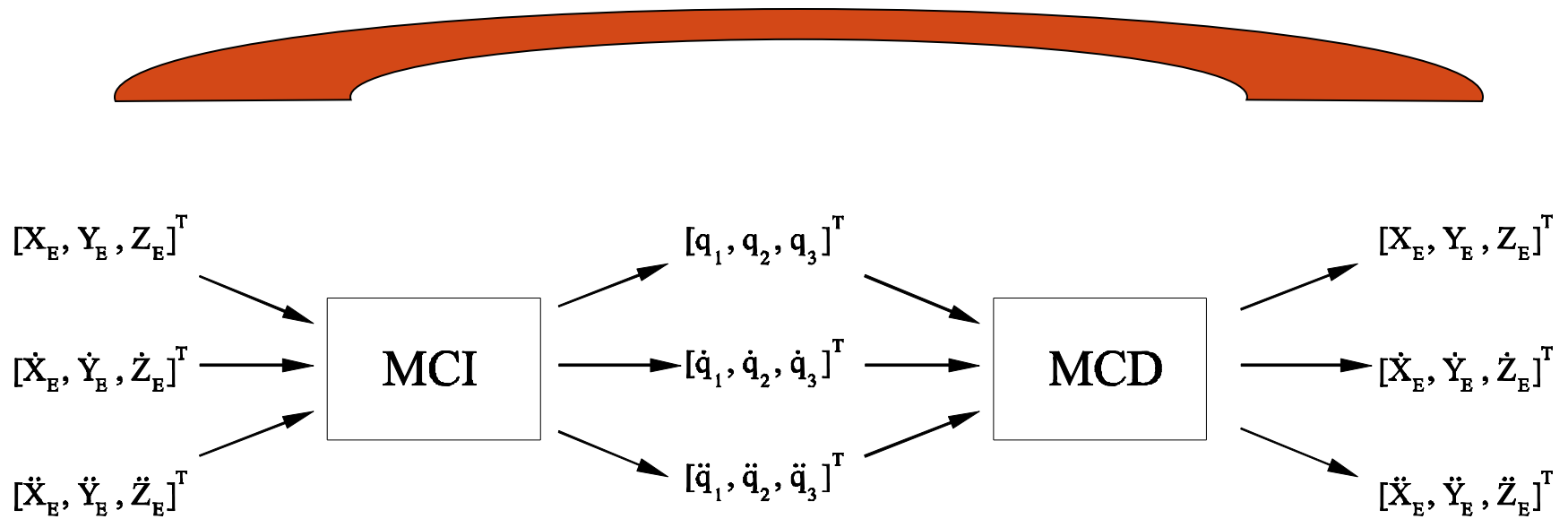
Functiile implicite

$$\begin{cases} X_P = q_1 \\ Y_P = (q_3^* + d_1) \cdot C\theta_1 + a + b \\ Z_P = h - (q_3^* + d_1) \cdot S\theta_1 \end{cases} \quad \begin{cases} X_P = r_2 C\theta_2 + R_2 C\varphi \\ Y_P = q_2 + b \\ Z_P = h - r_2 S\theta_2 - R_2 S\varphi \end{cases} \quad \text{unde} \quad q_3^* = \sqrt{R_1^2 - (q_3 - q_1)^2}$$

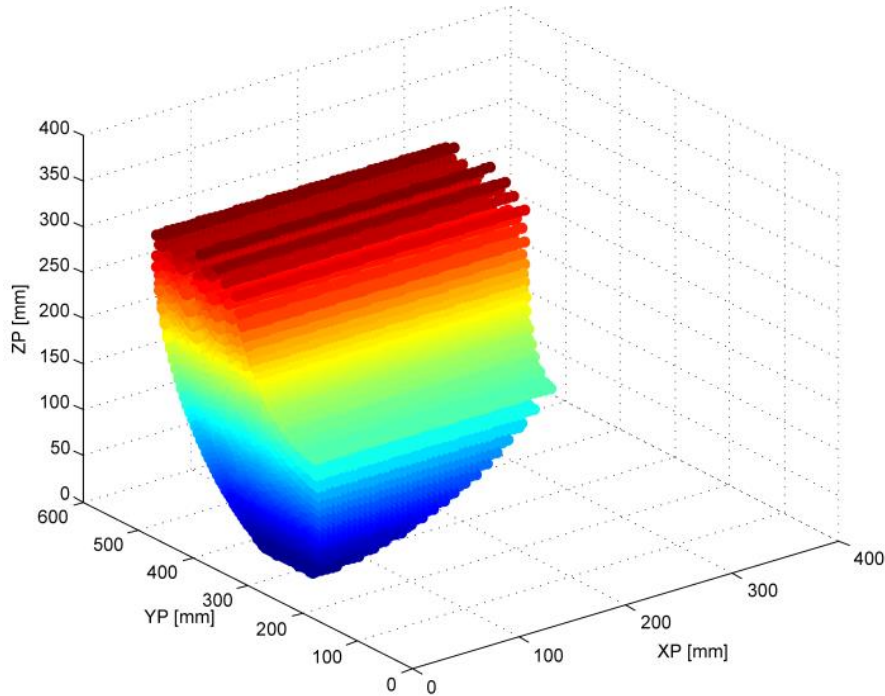
$$\text{DGM:} \quad \begin{cases} X_P = q_1 \\ Y_P = q_2 + b \\ Z_P = h - \sqrt{(q_3^* + d_1)^2 - (q_2 - a)^2} \end{cases} \quad \text{IGM:} \quad \begin{cases} q_1 = X_P \\ q_2 = Y_P - b \\ q_3 = X_P + \sqrt{R_1^2 - \left[\sqrt{(Y_P - a - b)^2 + (h - Z_P)^2} - d_1 \right]^2} \end{cases}$$

$$\begin{cases} f_1(q_1, q_2, q_3, X_P, Y_P, Z_P) \equiv q_1 - X_P = 0 \\ f_2(q_1, q_2, q_3, X_P, Y_P, Z_P) \equiv q_2 - Y_P + b = 0 \\ f_3(q_1, q_2, q_3, X_P, Y_P, Z_P) \equiv (q_3 - q_1)^2 - R_1^2 + \left[\sqrt{(Y_P - a - b)^2 + (h - Z_P)^2} - d_1 \right]^2 = 0 \end{cases}$$

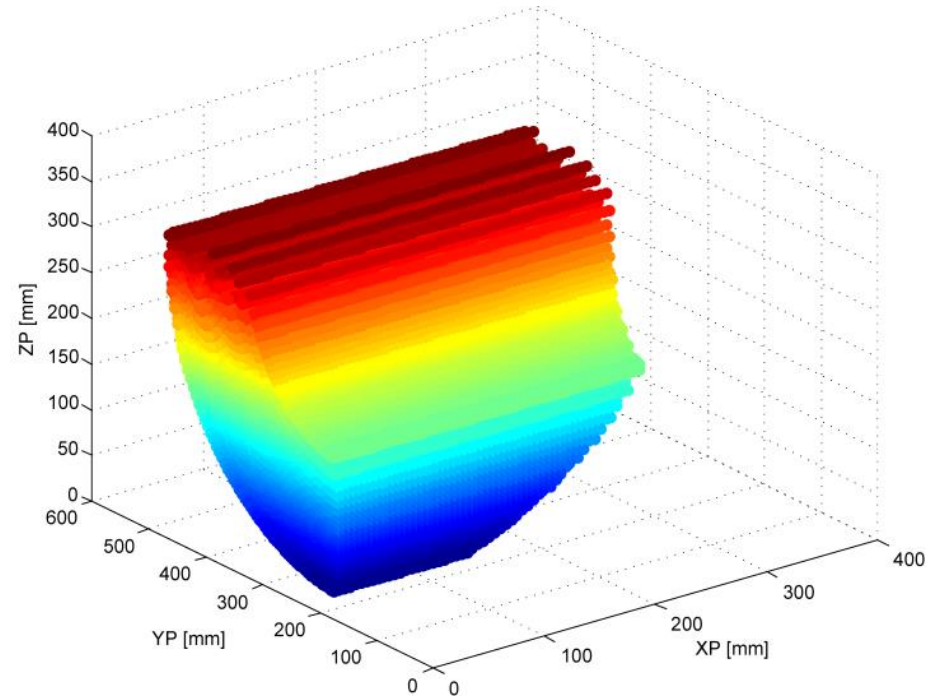
Validarea modelului matematic



Determinarea analitica a spatiului de lucru

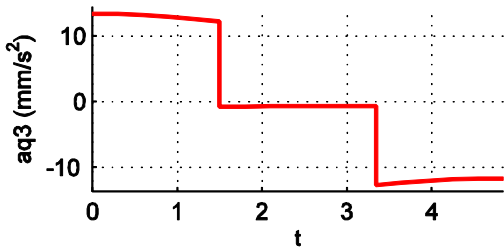
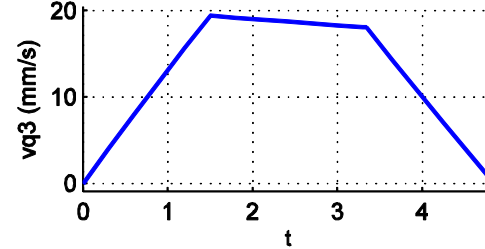
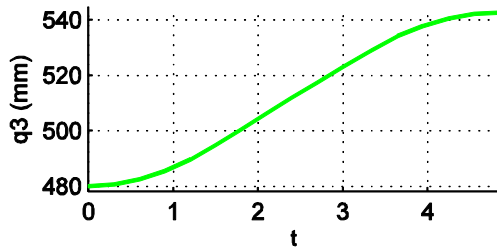
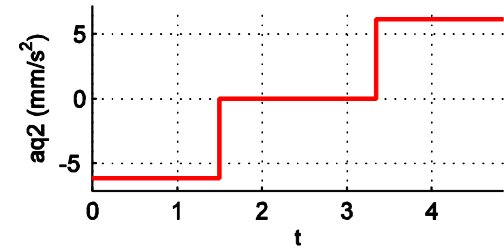
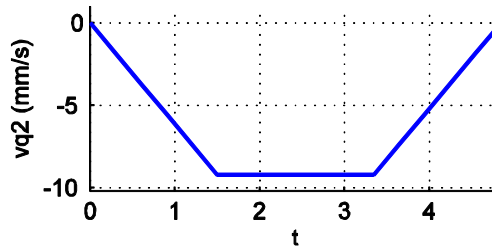
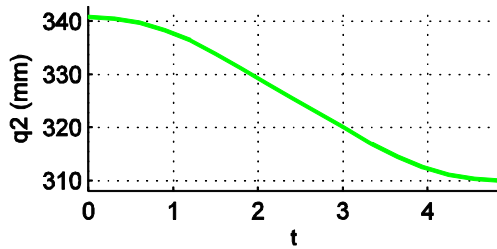
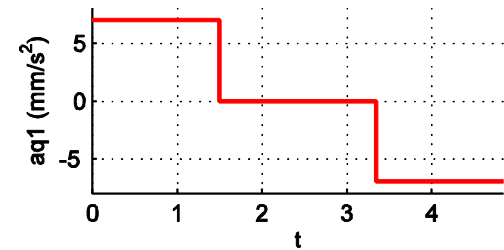
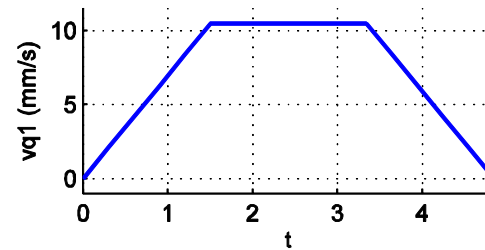
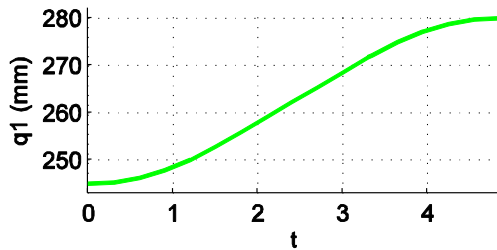


Spatiul de lucru folosind o cupla de rotatie pentru C8



Spatiul de lucru folosind o cupla de translatie pentru C8

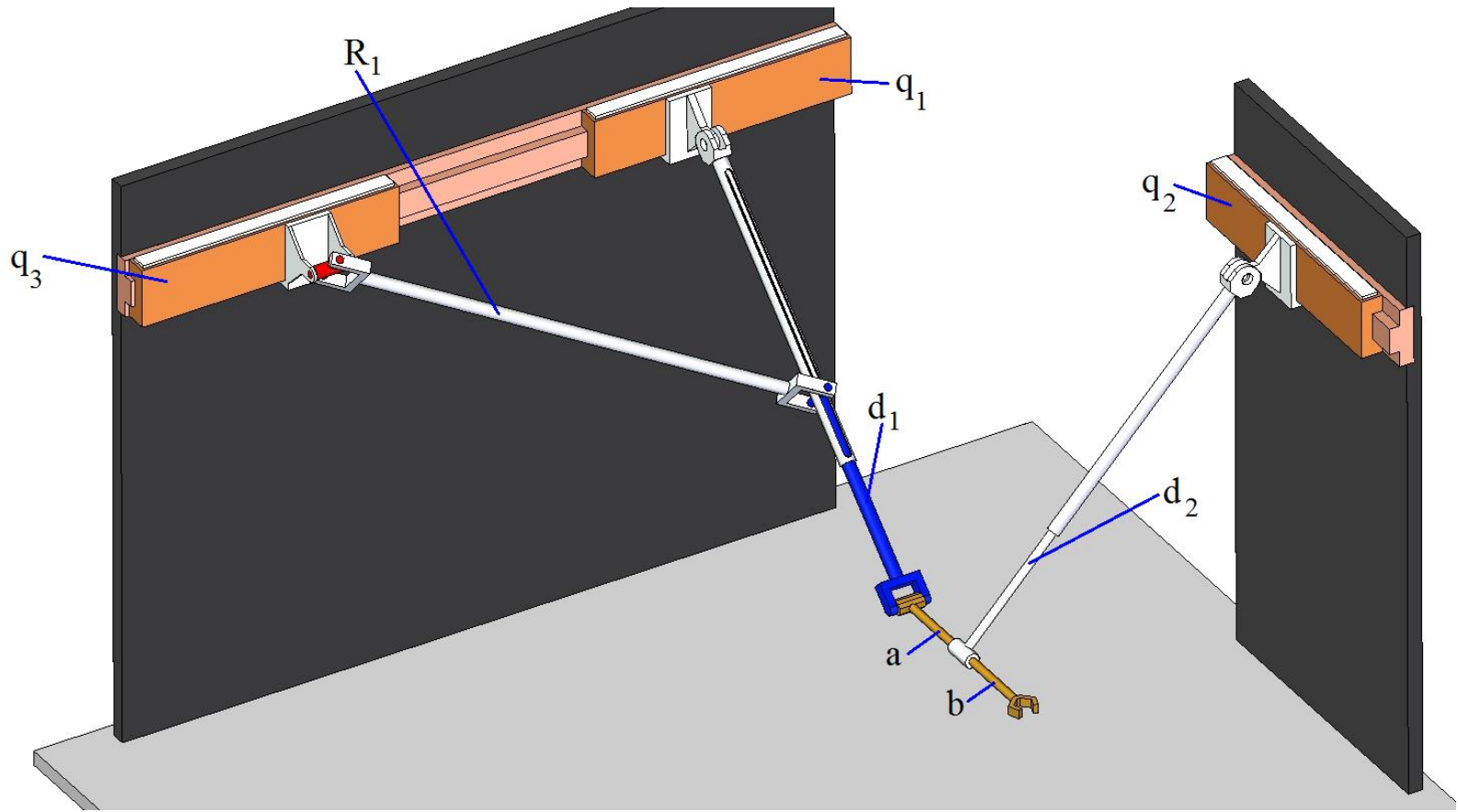
Traietorii de miscare



Deplasarea robotului, pe o traiectorie liniară între două puncte în spațiul de lucru cu orientare constantă
 $X_i = 245 \text{ mm}$, $X_f = 280 \text{ mm}$, $Y_i = 400.84 \text{ mm}$, $Y_f = 370 \text{ mm}$, $Z_i = 121.49 \text{ mm}$, $Z_f = 140 \text{ mm}$

Proiectarea constructiva a robotului spatial cu orientare constanta

Modelul CAD



Intrebari

