Determination of the coordinates of the links of spatial mechanisms by the Alglib solver

AlgLib Solver for a system of nonlinear equations(Uno)

```
result := | for  k ∈ [1..rows(f(x))]
          |    u_k := x_k
          | Jac(x) := Jacobian(f(u), u)
          | StepMax := 0
          | Eps := 10^-14
          | X0 := al_nleqsolve(X01, StepMax, Eps, f(x), Jac(x))
```

1.The RSCR mechanism.A case where the axis of rotation are perpendicular

$L1 := 2 \quad R := 0.9 \quad A := \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}^T \quad B := \begin{bmatrix} 0 & 3 & 0 \end{bmatrix}^T$

system of nonlinear equations

$$f(x) := \begin{bmatrix} x_2 \\ (x_1 - A_1)^2 + (x_2 - A_2)^2 + (x_3 - A_3)^2 - R^2 \\ (x_1 - x_4)^2 + (x_2 - x_5)^2 + (x_3 - x_6)^2 - L1^2 \\ (x_1 - x_4)\cdot(x_4 - x_7) + (x_2 - x_5)\cdot(x_5 - x_8) + (x_3 - x_6)\cdot(x_6 - x_9) \\ x_7 - 0.1 \\ (x_7 - B_1)^2 + (x_8 - B_2)^2 + (x_9 - B_3)^2 - L1^2 \\ (x_4 - x_7)\cdot(B_1 - x_7) + (x_5 - x_8)\cdot(B_2 - x_8) + (x_6 - x_9)\cdot(B_3 - x_9) \\ x_7 - x_4 \\ x_5 - 0.7 \end{bmatrix}$$

$X01 := \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 5 & -1 \end{bmatrix}^T$ Approximation

$$result = \begin{bmatrix} 0.6576 \\ 0.0975 \\ -0.8454 \\ 0.1314 \\ 0.6109 \\ -2.7107 \\ 0.1249 \\ 3.5207 \\ -1.9234 \end{bmatrix} \qquad f(result) = \begin{bmatrix} 0.0975 \\ 0.0313 \\ 0.0202 \\ 0.0285 \\ 0.0249 \\ -0.0138 \\ -7.6448\cdot 10^{-5} \\ -0.0065 \\ -0.0891 \end{bmatrix}$$

2.Spatial four-bar (RSSR) mechanism

$CD1 := -1.74074$ $CD2 := 0.51852$ $CD3 := 0.81460$

$q1 := 5$ $q2 := 3$ $q3 := 2$ $L1 := 0.9$ $L2 := 7.2$ $L3 := 5.4$

$L4 := 8$ $L5 := 5$ $L6 := 6$ $a1 := 1$ $b1 := 2$ $c1 := 0.25$

system of nonlinear equations

$$f(x) := \begin{bmatrix} (-1 - x_4)^2 + (2 - x_5)^2 + (1 - x_6)^2 - 1.9^2 \\ x_1 - 5 \\ a1 \cdot x_4 + b1 \cdot x_5 + c1 \cdot x_6 + 0.5 \\ (q1 - x_1)^2 + (q2 - x_2)^2 + (q3 - x_3)^2 - 2.4^2 \\ (x_4 - x_1)^2 + (x_5 - x_2)^2 + (x_6 - x_3)^2 - 7.7^2 \\ x_5 - 0.1 \end{bmatrix}$$

$X01 := [5\ 5\ 1\ -1\ 0.25\ 0.25]^T$ Approximation

$$result = \begin{bmatrix} 5 \\ 4.9677 \\ 0.6258 \\ -0.9542 \\ 0.1006 \\ 1.0122 \end{bmatrix} \qquad f(result) = \begin{bmatrix} 0.0001 \\ -2.7847 \cdot 10^{-7} \\ -1.2597 \cdot 10^{-5} \\ 1.4759 \cdot 10^{-6} \\ 8.1132 \cdot 10^{-6} \\ 0.0006 \end{bmatrix}$$

3.System of 12 equations

$D1 := 3$ $D2 := 2$ $D3 := 2$

$G1 := 2$ $G2 := 2$ $G3 := -1$

$A1 := 3.6$ $A2 := 1.2$ $A3 := 1.2$

$L1 := 0.9$ $L2 := 0.5$ $L3 := 2.2$ $L4 := 2.7$ $L5 := 1$

system of nonlinear equations

$$f(x) := \begin{bmatrix} (D1 - x_4)^2 + (D2 - x_5)^2 + (D3 - x_6)^2 - L3^2 \\ (D1 - x_7)^2 + (D2 - x_8)^2 + (D3 - x_9)^2 - L2^2 \\ x_4 - x_5 + 0.5 \cdot x_6 - 2 \\ x_7 - x_8 + 0.5 \cdot x_9 - 2 \\ (x_4 - x_7)^2 + (x_5 - x_8)^2 + (x_6 - x_9)^2 - L2^2 - L3^2 \\ x_1 + x_2 - 0.5 \cdot x_3 - 4 \\ (G1 - x_1)^2 + (G2 - x_2)^2 + (G3 - x_3)^2 - L5^2 \\ (x_4 - x_1)^2 + (x_5 - x_2)^2 + (x_6 - x_3)^2 - L4^2 \\ (x_7 - x_{10})^2 + (x_8 - x_{11})^2 + (x_9 - x_{12})^2 - L1^2 \\ x_{12} - 1 \\ x_{10} - 3.5 \\ x_1 + x_3 \end{bmatrix}$$

Approximation

$$X01 := \begin{bmatrix} 1 & 1 & -1 & 1 & 1 & 1 & 2 & 3 & 1 & 1 & 5 & 1 \end{bmatrix}^T$$

$$result = \begin{bmatrix} 1.7445 \\ 1.3832 \\ -1.7445 \\ 2.0579 \\ 0.441 \\ 0.7663 \\ 3.305 \\ 2.1156 \\ 1.6211 \\ 3.5 \\ 2.7371 \\ 1 \end{bmatrix} \qquad f(result) = \begin{bmatrix} -2.3768 \cdot 10^{-15} \\ 1.4198 \cdot 10^{-15} \\ -2.9711 \cdot 10^{-15} \\ -4.9518 \cdot 10^{-15} \\ -9.6559 \cdot 10^{-15} \\ -5.416 \cdot 10^{-15} \\ -5.8312 \cdot 10^{-15} \\ -1.5846 \cdot 10^{-14} \\ -2.5353 \cdot 10^{-15} \\ 0 \\ 0 \\ 0 \end{bmatrix}$$