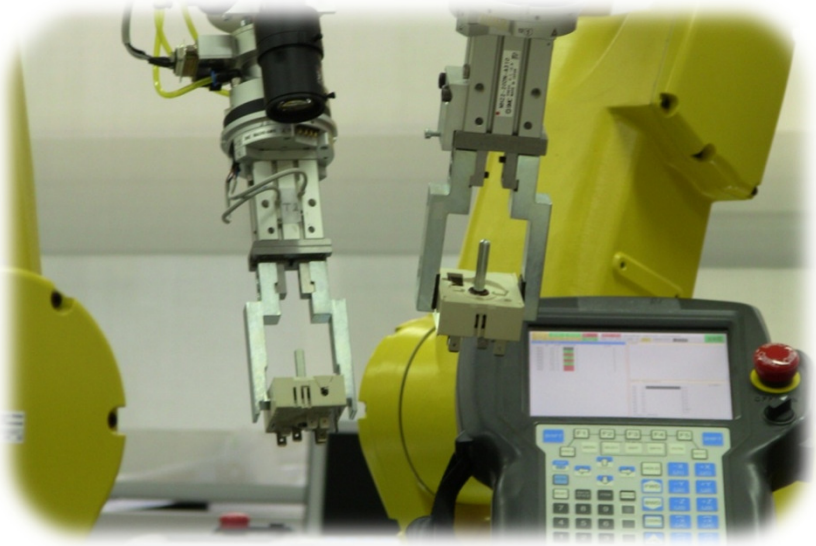
Upoznavanje sa FANUC robotskim sustavom

Programiranje automata za montažu



Marko Švaco

Fakultet strojarstva i brodogradnje

FSB *Sveučilište u Zagrebu*

Sadržaj

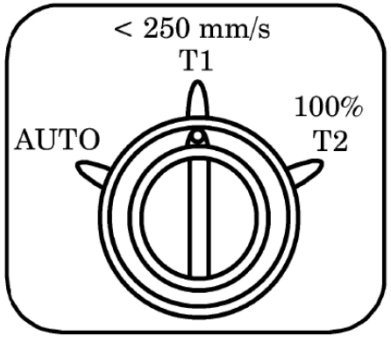
1. Sigurnost
2. FANUC robotski sustav
3. Hardver
4. Softver
5. Koordinatni sustavi robota
6. Načini kretanja
7. Struktura upravljačkih programa

Sigurnost rada na robotskom sustavu

- Rad pri malim (kontroliranim) brzinama
- Održavati siguran razmak od robota
- Nikada vizualno blokirati prostor između robota i osobe koja upravlja robotom (operater)
- Testiranje programa u koračnom (STEP) načinu rada pri kontroliranim brzinama – izvršavanje liniju po liniju koda

FANUC robotski sustav

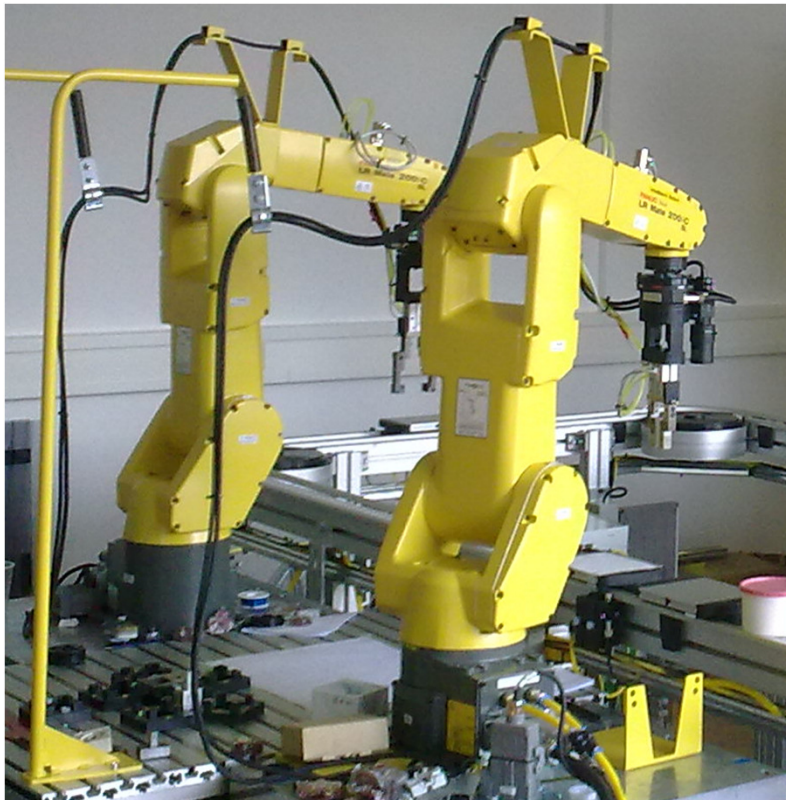
- Upravljačka jedinica
  - Načini rada robota – T1, T2, Auto

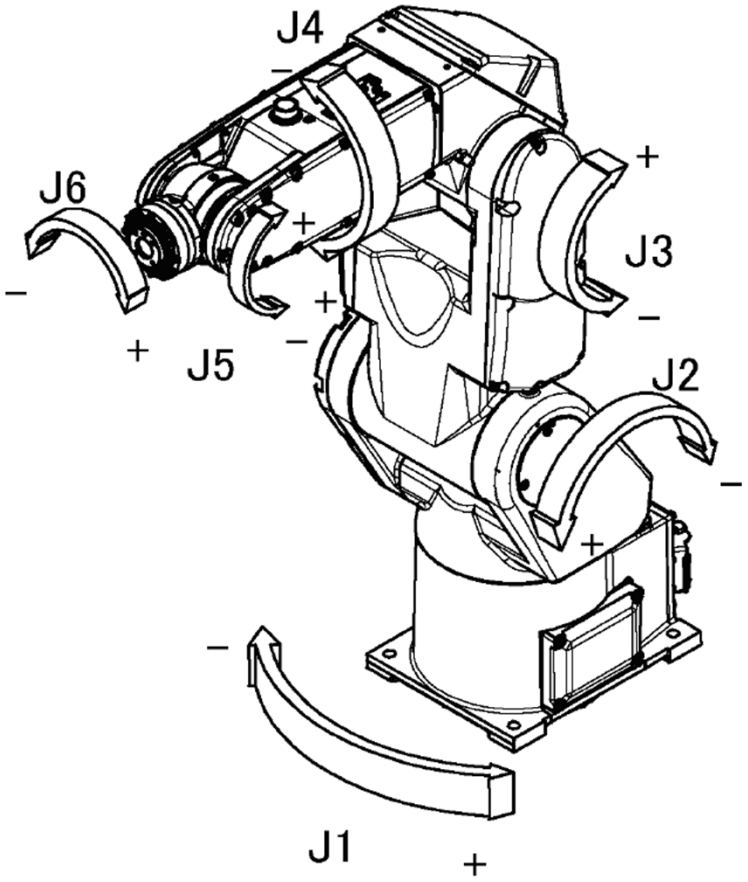


- Mehanička jedinica
- Upravljačka konzola (*Teach pendant*)
- Povezivost sa drugom opremom
  - DeviceNet, digitalni signali, analogni signali, TCP/IP – *Socket messaging*

Hardver

- LR Mate 200iC 5L – revolutan robot sa 6SSG

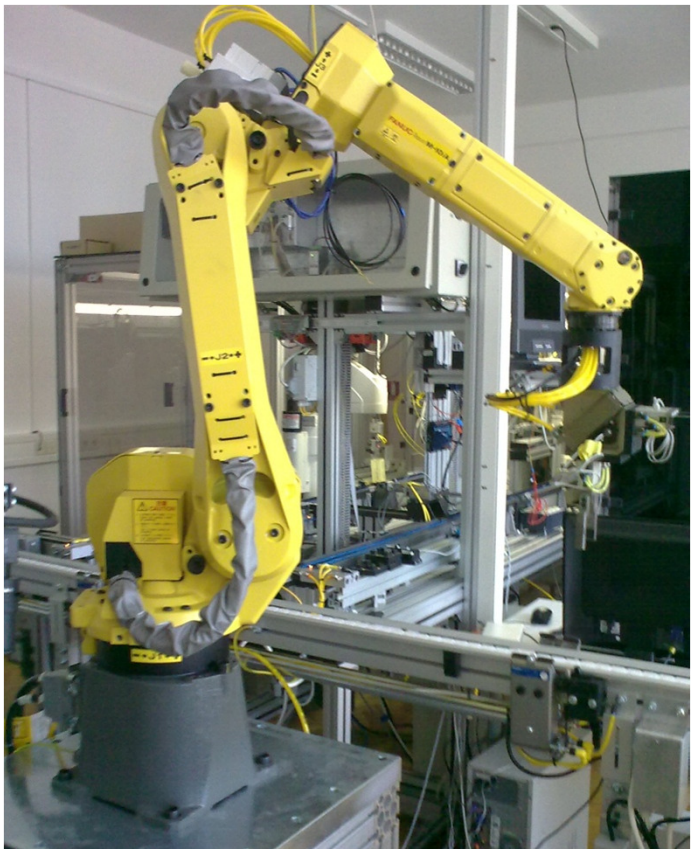




Hardver

- M10iA

Revolutan robot sa 6SSG

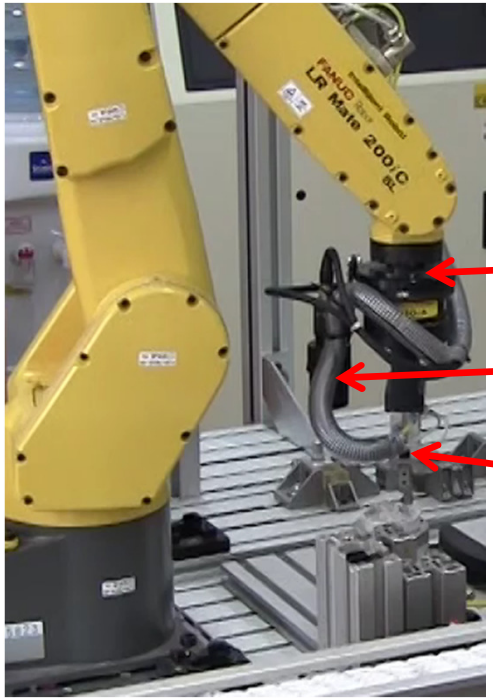


- M3iA6S

Paralelna kinematička struktura sa 6SSG

Hardver

- 3 osni senzor sile i momenata
- Vizijski sustav
  - Kamera na robotskoj ruci 2D ili 2.5D
  - Fiksna kamera



Softver

- 3 načina kreiranja upravljačkih programa

1. Na upravljačkoj konzoli – TP program (TPP)

```
                                                    1/9
    1:  UTOOL_NUM=1
    2:  UFRAME_NUM=0
    3:J @P[1] 40% FINE
    4:L  P[2] 400mm/sec FINE
    5:L  P[3] 100mm/sec CNT100
    6:  DO[5]=ON
    7:  WAIT DI[5]=ON
    8:L  P[4] 500mm/sec FINE
[End]
```

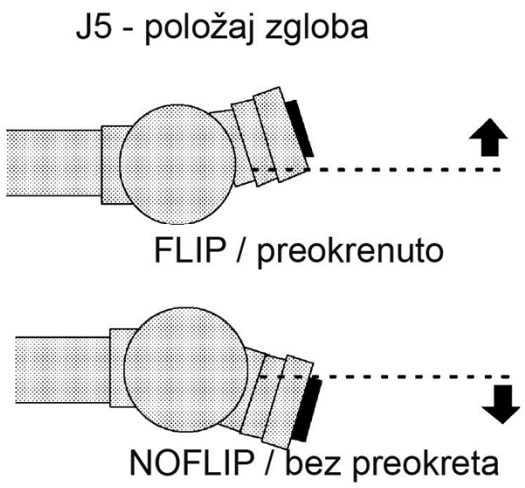
Softver

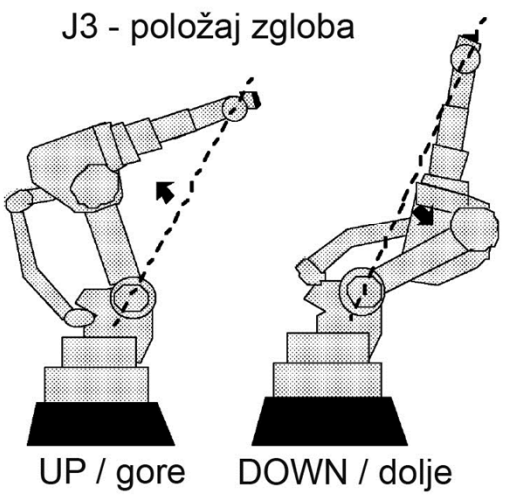
2. Na računalu – KAREL programski jezik

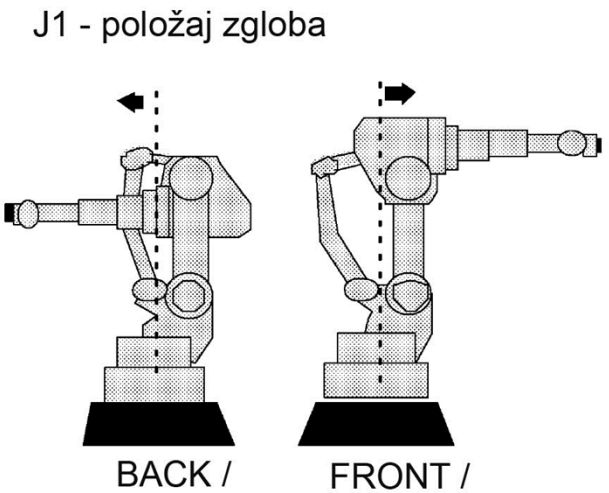
```
01 PROGRAM SR_VIZIJ
02 %NOLOCKGROUP
03 %NOPAUSE = ERROR + COMMAND + TPENABLE
04
05 VAR
06 STATUS,POC,KRAJ : INTEGER
07 visoffset : XYZWPR
08 en,M,i,ii,III,j,jj,j1,k,l,n,pom,i1,i2,i3,OB : INTEGER
09 X,Y,Z,W,P,R,real_value : REAL
10 config_var : CONFIG
11 visprocess : STRING[8]
12 KOC, KOC2, KOC3: ARRAY[30,10] OF REAL
13
14  ----------VANJSKE RUTINE----------
15  ROUTINE OPEN_FILE_(FILE_ : FILE; TAG_ : STRING) FROM LIB_FILE
16  ROUTINE CLOSE_FILE_(FILE_ : FILE; TAG_ : STRING) FROM LIB_FILE
17  ----------
18
19 BEGIN -- MAIN program
20         WHILE TRUE DO
21
22           i=0; j=0; k=0;
23           -- INICIJALIZACIJA PODATAKA ARRAY
24           FOR I=1 TO 15 DO; FOR J=1 TO 5 DO
25              KOC[I,J]=9999;KOC2[I,J]=9999; KOC3[I,J]=9999;
26           ENDFOR; ENDFOR
27           i=0; j=0; k=0;
28              V_RUN_FIND('BLOB', 0, STATUS)
29              WRITE('status run find:',STATUS,CR)
30              IF STATUS <> 0 THEN
```

3. Na računalu – simulacijski program

Konfiguracija robota







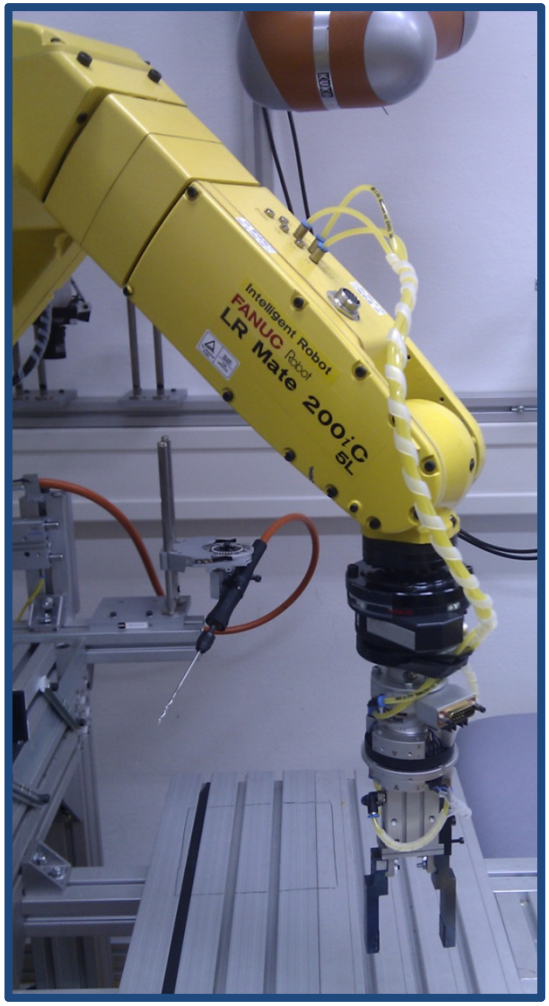
(F, U, T, 0, 0, 0)

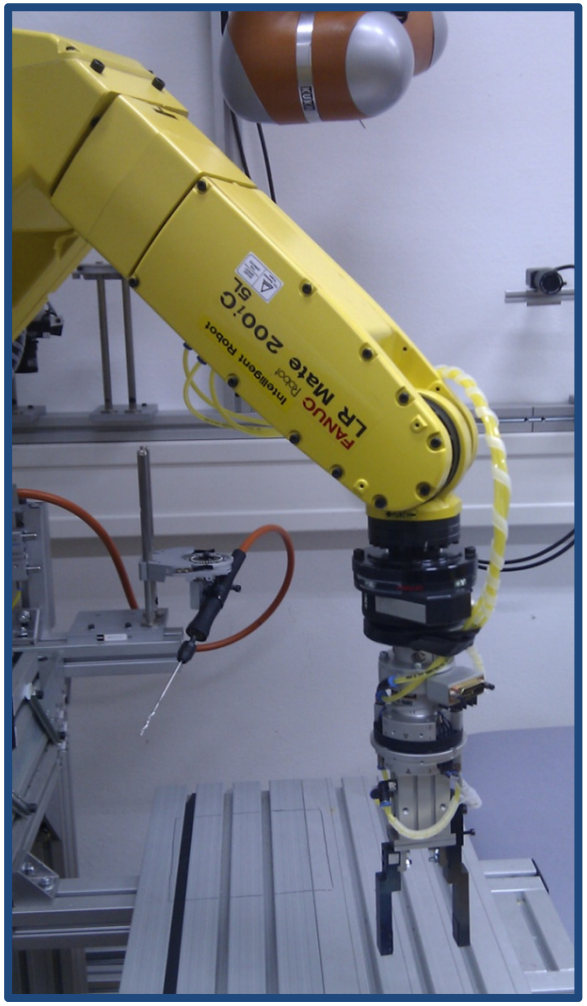
Položaji zglobova — Definiranje područja

{ FLIP / NOFLIP { UP / DOWN { FRONT / BACK

{ 1: 180° to 539°
0: –179° to 179°
–1: –539° to 180°

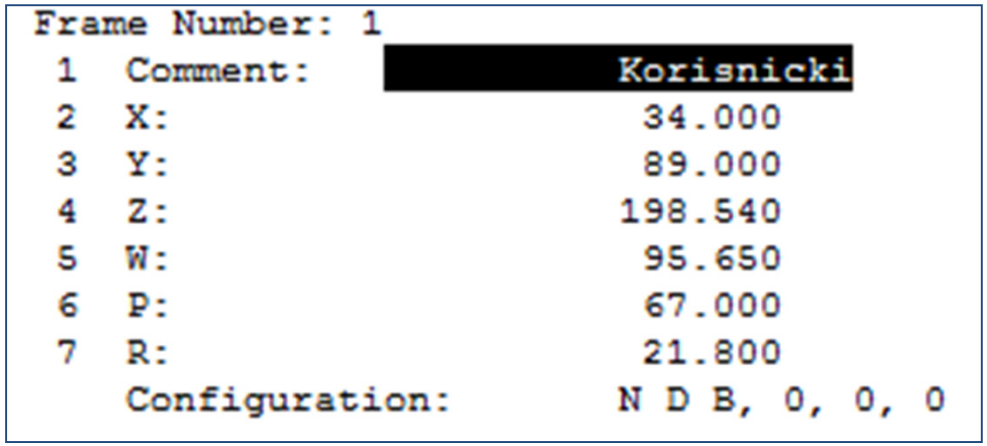
Konfiguracija robota



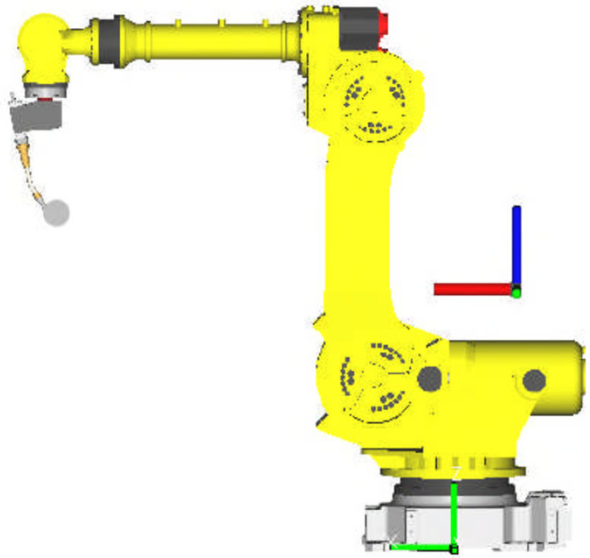


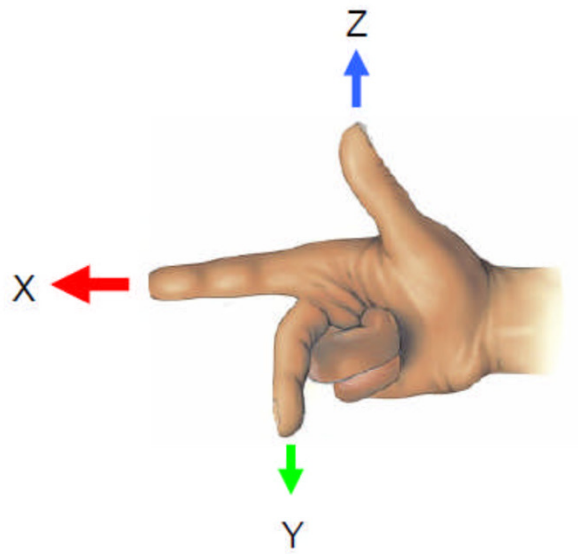
Koordinatni sustavi robota

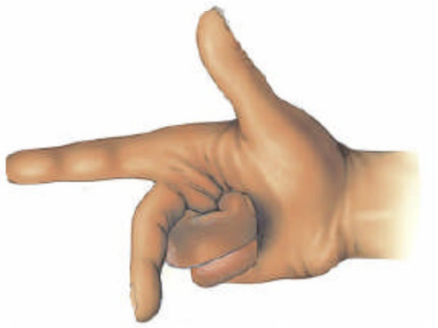
- **Korisnički i kooridnatni sustavi alata**
- Nepromjenjivi koordinatni sustavi
  - WORLD – koordinatni sustav “svijeta” (baze) robota – UFRAME[0]
  - UTOOL[0] – preddefiniran koordinatni sustav alata robota
- Svaki koordinatni sustav određen je sa 7 parametara
  - X, Y, Z, W, P, R, konfiguracija

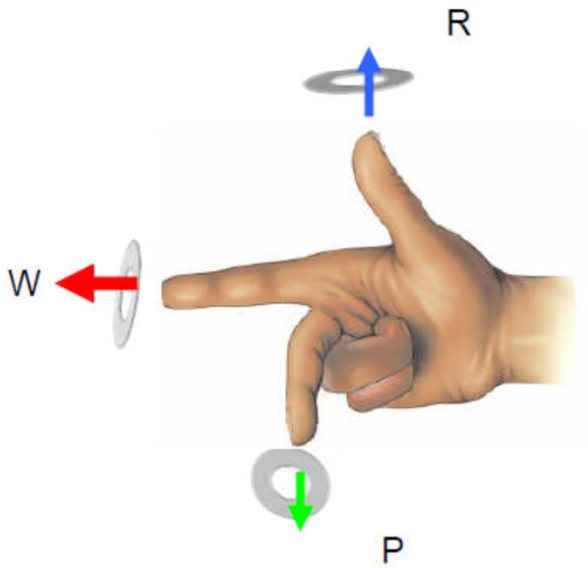


Koordinatni sustavi robota







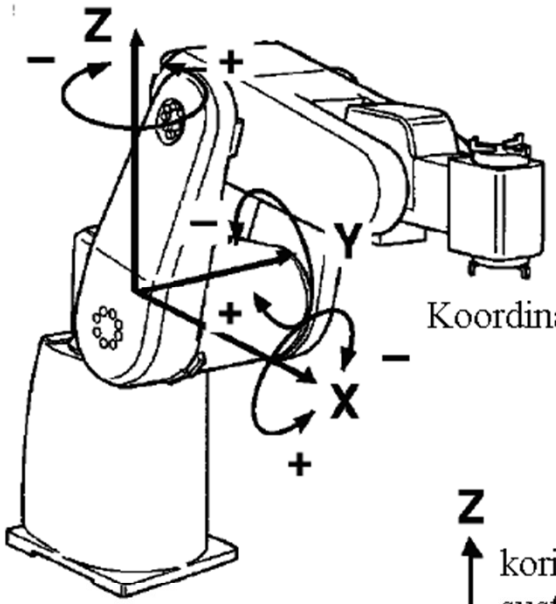


Koordinatni sustavi robota

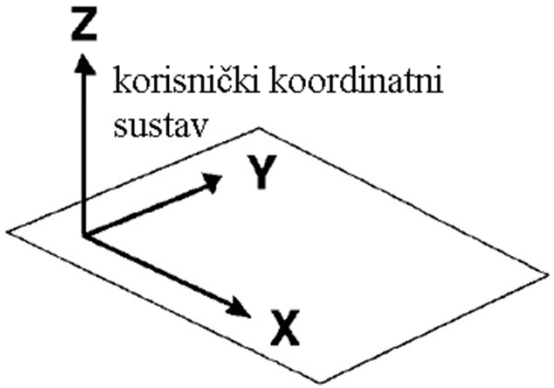
- Primjer korisničkog koordinatnog sustava

Koordinate korisničkog koordinatnog sustava

x :	500 mm
y :	0 mm
z :	–200 mm
w :	0^{o}
p :	0^{o}
r :	0^{o}



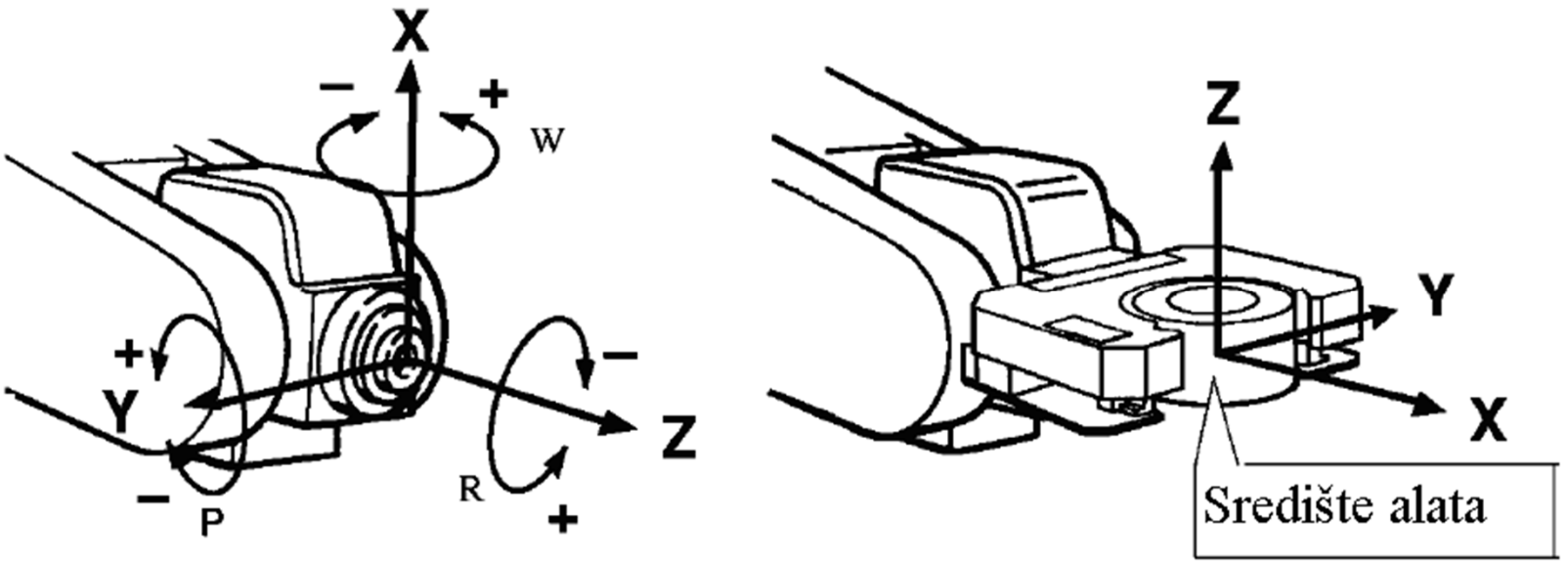
Koordinatni sustav robota



korisnički koordinatni sustav

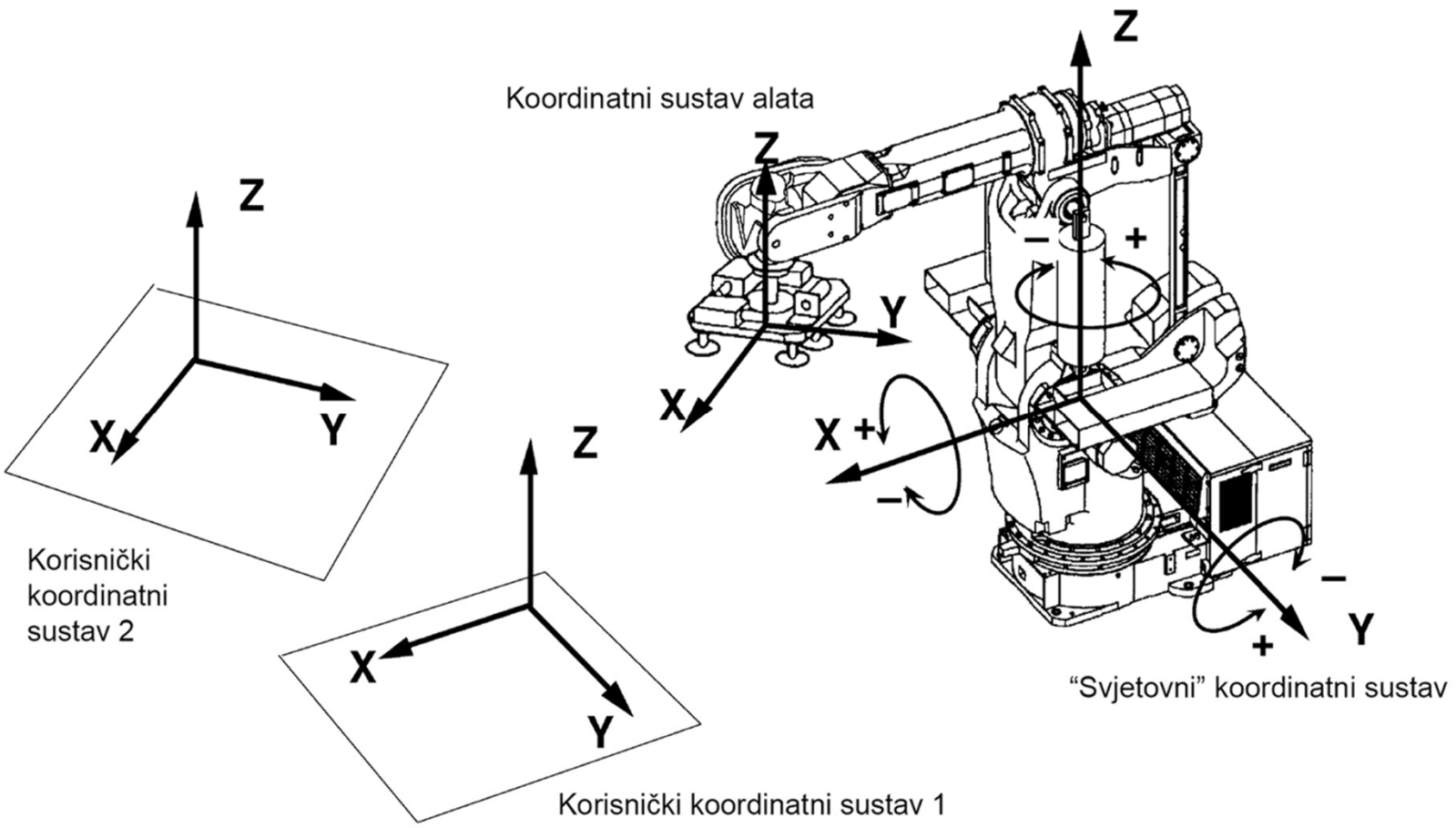
Koordinatni sustavi robota

- Primjer koordinatnog sustava alata



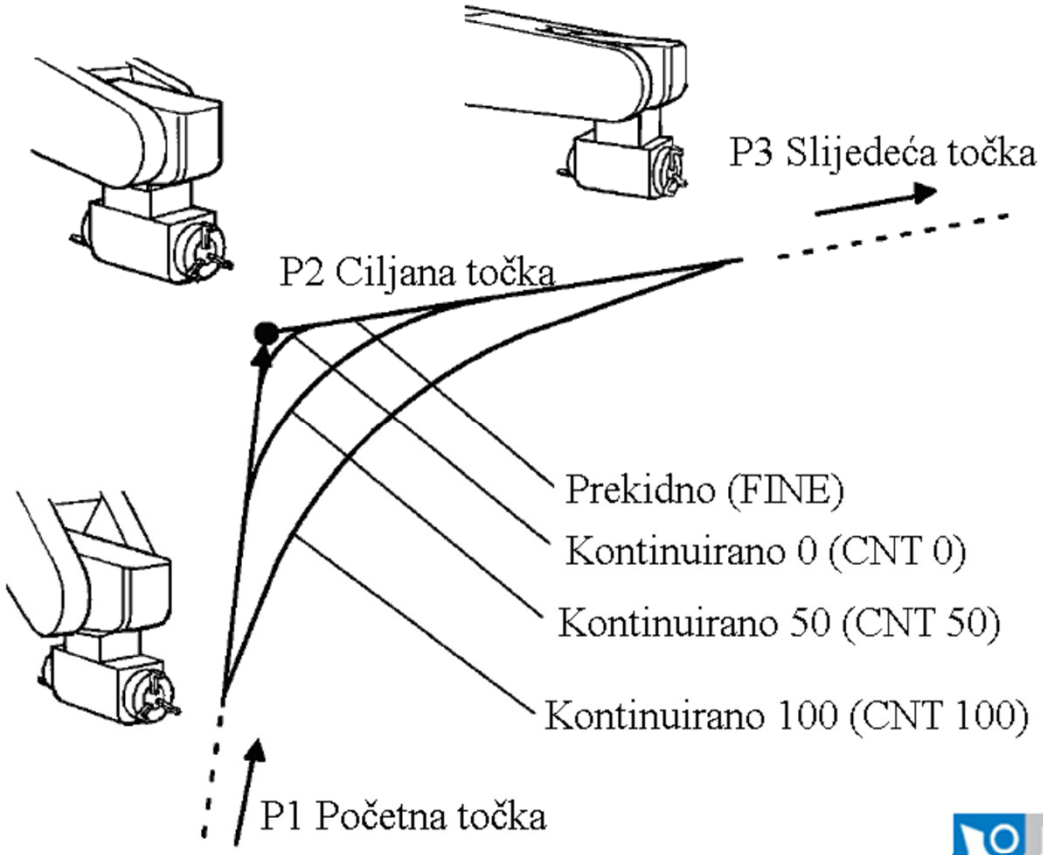
Koordinatni sustavi robota

- Prikaz svih koordinatnih sustava



Način izvršavanja gibanja

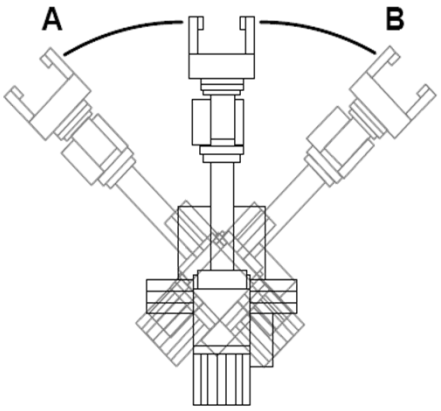
- Prekidno(intermitentno) – FINE
- Kontinuitano – CNT X X [0..100]



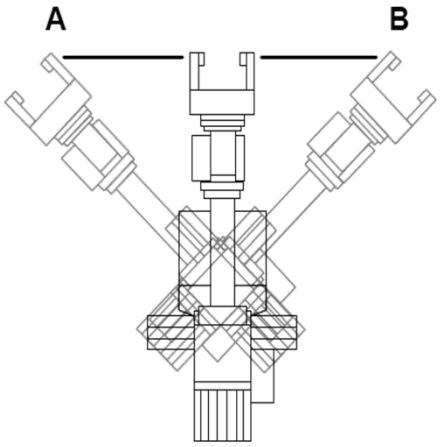
Načini kretanja robota

- Interpolacija zglobova: J P[1] 100% FINE
- Linearno: L P[2] 200mm/sec CNT 100
- Kružno: J P[1] 100% FINE
  C P[2]
  P[3] 500 mm/sec FINE

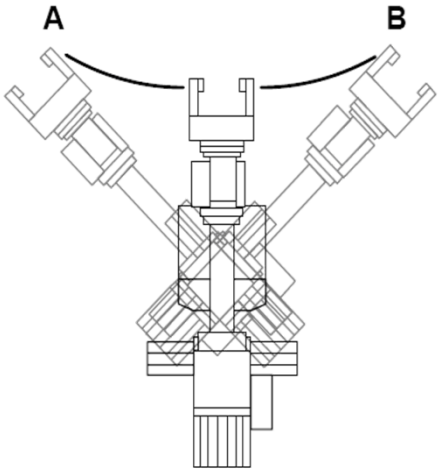
Gibanje interpolacijom zglobova



Linearno gibanje



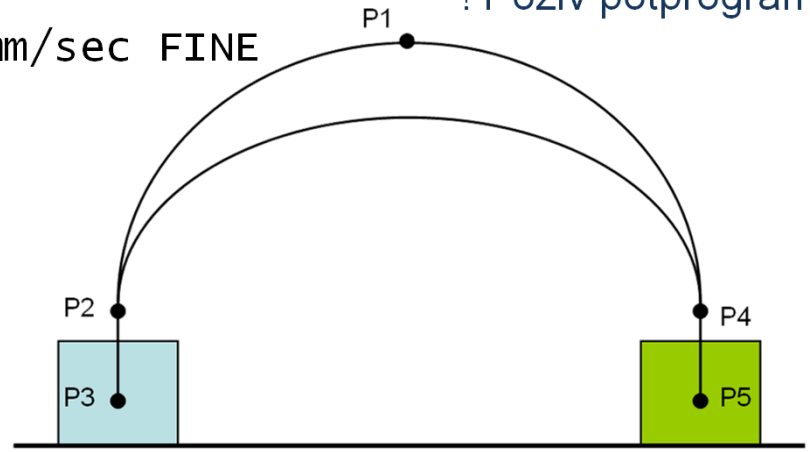
Kružno gibanje



Struktura upravljačkih programa - TPP

– Jednostavan program izuzimanja (*Pick&Place*)

```
 1: UFRAME_NUM=1                    ! Postavljanje korisničkog koord. sustava
 2: UTOOL_NUM=1                     ! Postavljanje koordinatnog sustava alata
 3: CALL GR_OP                      ! Poziv potprograma za otvaranje hvataljke
 4: J P[1] 50% FINE                 ! Početna točka programa
 5: J P[2] 50% FINE                 ! Točka prilaska
 6: L P[3] 100mm/sec FINE           ! Linearno kretanje u točku prihvata predmeta
 7: CALL GR_CL                      ! Poziv potprograma za zatvaranje hvataljke
 8: L P[2] 100mm/sec FINE           ! Linearno kretanje u točku puštanja predmeta
 9: J P[1] 50% CNT50                ! Interpolacijska točka
10: J P[4] 50% FINE                 ! Točka prilaska
11: L P[5] 100mm/sec FINE           ! Linearno kretanje u točku puštanja predmeta
12: CALL GR_OP                      ! Poziv potprograma za otvaranje hvataljke
13: L P[4] 100mm/sec FINE
```



Struktura upravljačkih programa - TPP

– Nadogradnja jednostavog program izuzimanja (*Pick&Place*)

```
 1: UFRAME_NUM=1                                  !
 2: UTOOL_NUM=1                                   !
 3: CALL GR_OP                                    !
 4: J P[1] 50% FINE                               !
 5: J P[3] 50% FINE Tool_Offset,PR[1]             ! Točka prilaska određena
 6: L P[3] 100mm/sec FINE                         ! posmakom po alatu
 7: CALL GR_CL                                    !
 8: L P[3] 100mm/sec FINE Tool_Offset,PR[1]       !
 9: J P[1] 50% CNT50                              !
10: J P[5] 50% FINE Tool_Offset,PR[1]             !
11: L P[5] 100mm/sec FINE                         !
12: CALL GR_OP                                    !
13: L P[5] 100mm/sec FINE Tool_Offset,PR[1]       !
```

Struktura upravljačkih programa - TPP

– Nadogradnja jednostavog program izuzimanja (*Pick&Place*)

```
 1: UFRAME_NUM=1                                  !
 2: UTOOL_NUM=1                                   !
 3: CALL GR_OP                                    !
 4: LBL[1]                                        ! Oznaka 1
 5: J P[1] 50% FINE                               !
 6: J P[3] 50% FINE Tool_Offset,PR[1]             !
 7: L P[3] 100mm/sec FINE                         !
 8: CALL GR_CL                                    !
 9: L P[3] 100mm/sec FINE Tool_Offset,PR[1]       !
10: J P[1] 50% CNT50                              !
11: J P[5] 50% FINE Tool_Offset,PR[1]             !
12: L P[5] 100mm/sec FINE                         !
13: CALL GR_OP                                    !
14: L P[5] 100mm/sec FINE Tool_Offset,PR[1]       !
15: JMP LBL [1]                                   ! Bezuvijetan skok na oznaku 1
```

Struktura upravljačkih programa - TPP

– Nadogradnja jednostavog program izuzimanja (*Pick&Place*)

```
 1: UFRAME_NUM=1                                  !
 2: UTOOL_NUM=1                                   !
 3: CALL GR_OP                                    !
 4: LBL[1]                                        !
 5: J P[1] 50% FINE                               !
 6: J P[3] 50% FINE Tool_Offset,PR[1]             !
 7: L P[3] 100mm/sec FINE                         !
 8: CALL GR_CL                                    !
 9: L P[3] 100mm/sec FINE Tool_Offset,PR[1]       !
10: J P[1] 50% CNT50                              !
11: J P[5] 50% FINE Tool_Offset,PR[1]             !
12: L P[5] 100mm/sec FINE                         !
13: CALL GR_OP                                    !
14: L P[5] 100mm/sec FINE Tool_Offset,PR[1]       !
15: WAIT FOR DI[1]=ON                             ! Čekanje na signal DI[1]
16: JMP LBL [1]                                   !
```

Struktura upravljačkih programa - TPP

– Nadogradnja jednostavog program izuzimanja (*Pick&Place*)

```
 1: UFRAME_NUM=1                                  !
 2: UTOOL_NUM=1                                   !
 3: CALL GR_OP                                    !
 4: R[1]=0                                        ! Inicijalizacija numeričkog registra 1
 4: LBL[1]                                        !
 5: J P[1] 50% FINE                               !
 6: J P[3] 50% FINE Tool_Offset,PR[1]             !
 7: L P[3] 100mm/sec FINE                         !
 8: CALL GR_CL                                    !
 9: L P[3] 100mm/sec FINE Tool_Offset,PR[1]       !
10: J P[1] 50% CNT50                              !
11: J P[5] 50% FINE Tool_Offset,PR[1]             !
12: L P[5] 100mm/sec FINE                         !
13: CALL GR_OP                                    !
14: L P[5] 100mm/sec FINE Tool_Offset,PR[1]       !
15: R[1]=R[1]+1                                   ! Inkrementiranje numeričkog
16: WAIT FOR DI[1]=ON                             ! registra 1
17: JMP LBL [1]                                   !
```

Hvala na pažnji!