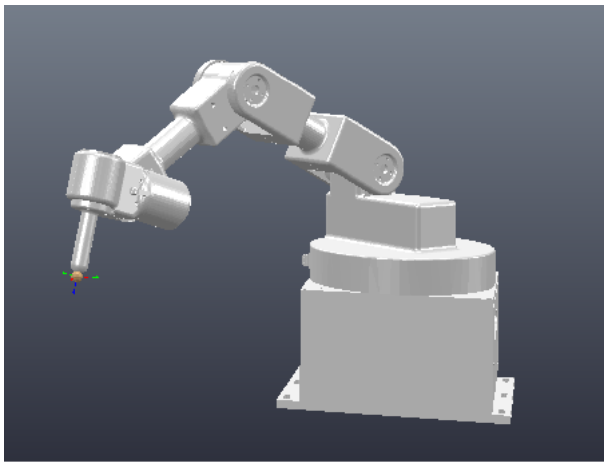
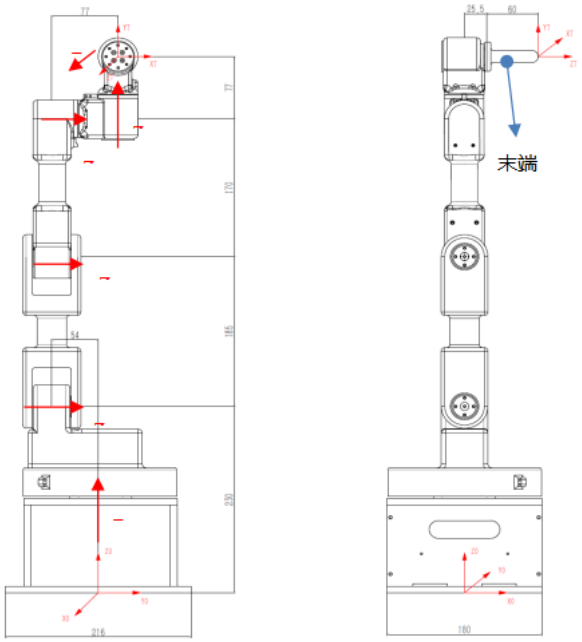
机械臂概况





机械臂DH参数

关节i	αi-1	ai-1	d	θ
1	0	0	0.23	θ1
2	-90°	0	-0.054	-90°+θ2
3	0	0.185	0	θ3
4	0	0.17	0.077	90°+θ4
5	90°	0	0.077	90°+θ5
6	90°	0	0.0855	θ6

正运动学计算

通过matlab得到初步输出，进一步化简得到：

t11 = -c6(c5s1 + c1c234s5) + c1s234s6

t12 = c5s1s6 + c1(c6s234 + c234s5s6)

t13 = c1c234c5 - s1s5

t14 = c1(0.0855c234c5 + 0.185s2 + 0.17s23 +0.077s234) +s1(-0.023-0.0855s5)

t21=c1c5c6+s1(-c234c6s5+s234s6)

t22=c6s1s234+(-c1c5+c234s1s5)s6

t23=c234c5s1+c1s5

t24=s1(0.0855c234c5+0.185s2+0.17s23+0.077s234)+c1(0.023+0.0855s5)

t31=c6s234s5+c234s6

t32=c234c6-s234s5s6

t33=-c5s234

t34=0.23+0.185c2+0.17c23+0.077c234-0.0855c5s234

t41 = t42 = t43 = 0 , t44 = 1

逆运动学推导

T = T1T2T3T4T5T6变形得T1TT6 = T2T3T4T5

设$T=\begin{bmatrix} t11 & t12 & t13 & t14 \\ t21 & t22 & t23 & t24 \\ t31 & t32 & t33 & t34 \\ t41 & t42 & t43 & t44 \end{bmatrix}$

左边等于

$$\begin{bmatrix} t11c1c6-t12c1s6+t21c6s1-t22s1s6 & -t13c1-t23s1 & t12c1c6+t11c1s6+t22c6s1+t21s1s6 & t14c1-0.0855t13c1-0.0855t23s \\ t21c1c6-t11c6s1-t22c1s6+t12s1s6 & t13s1-t23c1 & t22c1c6-t12c6s1+t21c1s6-t11s1s6 & t24c1-0.0855t23c1-0.0855t13s \\ t31c6-t32s6 & -t33 & t32c6+t31s6 & t34-0.0855t33-0.23 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

右边等于

$$\begin{bmatrix} -c234s5 & -c234c5 & s234 & 0.077s234+0.17s23+0.185s2 \\ c5 & -s5 & 0 & 0.023 \\ s234s5 & s234c5 & c234 & 0.077c234+0.17c23+0.185c2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

f_{ij}对应i行j列的元素相等带来的等式。

由f_{24}，

$$t1=-atan2(0.023,\pm\sqrt{(t24-0.0855t23)^2+(t14-0.0855t13)^2-0.023^2})+atan2(t24-0.0855t23,t14-0.0855t13)$$

由$f23$,$t6=atan2(t22c1-t12s1,-t21c1+t11s1)$ 其中计算t1时根号取正号时$t6=t6-\pi$

再由$f22,t5=asin(t23c1-t13s1)$ 其中计算t1时根号取负号时$t5=-\pi-t5$

由$f12$,$c234=\frac{t13c1+t23s1}{c5}$

由$f31$,$s234=\frac{t31c6-t32s6}{s5}$

令

$$A=0.17,B=0.185$$

$$C1=0.077s234-(t14c1-0.0855t13c1-0.0855t23s1+t24s1)$$

$$C2=0.077c234-(t34-0.0855t33-0.23)$$

则

$As23+Bs2+C1=0$

$Ac23+Bc2+C2=0$

解得$t2=atan2(-C2,C1)-atan2(\frac{C1^2+C2^2-A^2+B^2}{2B},\pm\sqrt{C1^2+C2^2-\frac{C1^2+C2^2-A^2+B^2}{2B}^2})$

$t3=atan2(-C2,C1)-atan2(\frac{C1^2+C2^2+A^2-B^2}{2A},\pm\sqrt{C1^2+C2^2-\frac{C1^2+C2^2+A^2-B^2}{2A}^2})-t2$，其中t2和t3的根号前不能同时取正号或同时取负号

$t4=atan2(s234,c234)-t2-t3$

对比IK包中的IKSolver无误，详见代码。

-----以下废---------

移动常数项后两式平方相加得$t3=\pm arccos(\frac{C1^2+C2^2-A^2-B^B}{2AB})$

$t2=atan2((Ac3+B)C1-As3C2,-[As3C1+(Ac3+B)C2])$

$t4=atan2(s234,c234)-t2-t3$