Five Link Mechanism as a part of a Robot.

1. Introduction

We propose very interesting and simple tool to obtain two – dimensional movement using two rotary drives and five-link mechanism (FLM). We made some math model, calculate the relations between angles and the target point coordinates. Rotary drives are servos, dc, brushless or any other motors. We can use the FLM as actuators, levers, plotter arms, pusher and feets in robots and other micromechanics.

2. Mathematical Model and Calculation

Let us calculate the angles ϕ and ψ, using the Hx and Hy coordinates of an target point as arguments. Let us see the Figure1.1. Two rotary drives (situated in O_1 and O_2 points) rotate the lower levers L1. Two upper levers L2 are connected with flat joints with lower L1 levers, and is connected at a point F. One of lever is longer and it takes L2+Q total length. Let us see leftn elements of a mechanism – O1 joint with the lever L1 at the ϕ angle to the 0X axe. The distance between O1 and the target point H is, using the Pythagoras' theorem

$$L^2 = (Hx-d)^2+Hy^2 \qquad (1)$$

$$\alpha = \mathrm{arctg}\,((Hx+d)/Hy) \qquad (2)$$

or we can use usual for programmer ATAN2(a,b) operator:

$$\alpha = \mathrm{ATAN2}\,(Hx+d,Hy) \qquad (3)$$

We can use the cosine rule

$$(L2+Q)^2 = L^2+L1^2- 2L1L\cos\beta \qquad (4)$$

$$\cos\beta = (L^2+ L1^2- (L2+Q)^2)/2LL1 \qquad (5)$$

$$\beta = \arccos\,((L^2+ L1^2- (L2+Q)^2)/2LL1) \qquad (6)$$

$$\phi = \pi/2- \alpha - \beta \qquad (7)$$

For the right elements of FLM, using proportions

$$Fx = -d-L1\cos\phi + (Hx+d+L1\cos\phi)L2/(L2+Q) \qquad (8)$$

$$Fy = L1*\sin\phi + (Hy-L1\sin\phi)L2/(L2+Q) \qquad (9)$$

Here we use Fx and Fy coordinates to calculate the ψ angle, as in (1) – (7) steps:

$L'^2 = Fy^2 + (d\text{-}Fx)^2$ (10)

δ = arctg(((Fy, d- Fx) (11)

δ = ATAN2(Fy, d-Fx) (11)

using the cosine rule

$L2^2 = L'^2 + L1^2 - 2L1L'\cos\gamma$ (12)

$2LL'\cos\gamma = L12 + L'2 – L22$ (13)

$\cos\gamma = (L12 + L'2 – L22)/ 2L1L'$ (14)

$\gamma = \arccos ((L12 + L'2 – L22)/2LL')$ (15)

$\psi = \pi/2 + \gamma - \delta$ (16)

So we can use the values of ϕ and ψ to control the mechanism.