computer architecture robot

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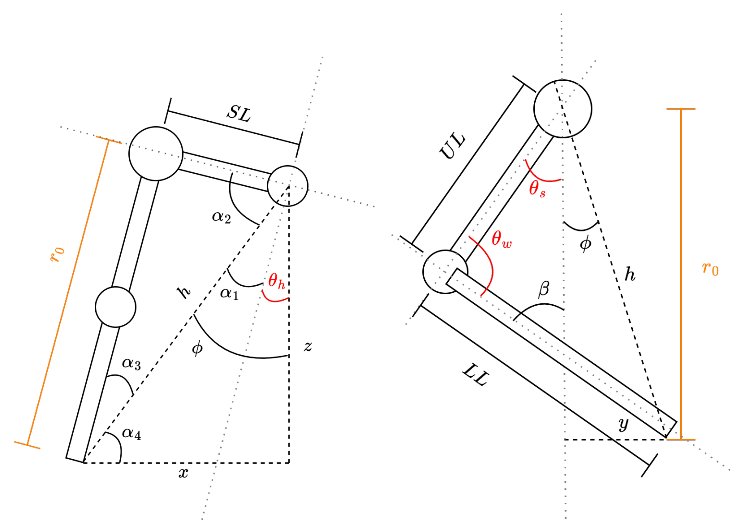
1 Introduction



(a) Front view of leg (b) Side view of leg

Calculation for θ_h. We know x, z (starting positions) and SL, the shoulder length. First we calculate r_0.

$$h = \sqrt{x^2 + z^2} \Rightarrow r_0 = \sqrt{h^2 - SL^2} = \sqrt{x^2 + z^2 - SL^2}$$

The different angles are then given as

$$\alpha_2 = \arcsin\left(\frac{r_0}{h}\right)$$
$$\alpha_1 = \frac{\pi}{2} - \alpha_2$$
$$\phi = \arctan\left(\frac{z}{x}\right)$$

Which then gives

$$
\begin{aligned}
\Rightarrow \theta_h &= \phi - \alpha_1 \\
&= \arctan\left(\frac{z}{x}\right) - \frac{\pi}{2} + \arcsin\left(\frac{r_0}{h}\right) \\
&= \arctan\left(\frac{z}{x}\right) - \frac{\pi}{2} + \arcsin\left(\frac{x^2+z^2-SL^2}{x^2+z^2}\right) \\
&= \arctan\left(\frac{z}{x}\right) - \frac{\pi}{2} + \arcsin\left(1-\frac{SL^2}{x^2+z^2}\right)
\end{aligned}
$$

Now for the different side view we have

$$
\begin{aligned}
\phi &= \arctan\left(\frac{x}{r_0}\right) \\
h &= \sqrt{r_0^2+y^2}
\end{aligned}
$$

For θ_s using the cosine law we get

$$
\begin{aligned}
\cos(\theta_s+\phi) = \frac{UL^2+h^2-LL^2}{2UL\cdot h} \Leftrightarrow \theta_s &= \arccos\left(\frac{UL^2+h^2-LL^2}{2UL\cdot h}\right) - \phi \\
&= \arccos\left(\frac{UL^2+h^2-LL^2}{2UL\cdot\sqrt{x^2+y^2+z^2-SL^2}}\right) - \arctan\left(\frac{x}{\sqrt{x^2+z^2-SL^2}}\right)
\end{aligned}
$$

For θ_w using then again the cosine law

$$
\begin{aligned}
\cos(\theta_w) = \frac{UL^2+LL^2-h^2}{2UL\cdot LL} \Leftrightarrow \theta_w &= \arccos\left(\frac{UL^2+LL^2-h^2}{2UL\cdot LL}\right) \\
&= \arccos\left(\frac{UL^2+LL^2-(x^2+y^2+z^2-SL^2)}{2UL\cdot LL}\right)
\end{aligned}
$$

2 Movement

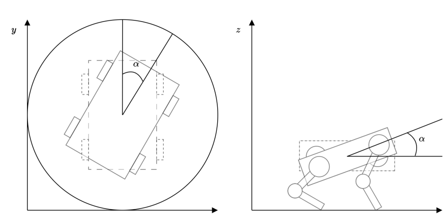


Figure 2: Above and side view of movement of the robot

To move the robot at an angle α in the side view (second image) we need to calculate the wanted of x, y, z values and then the changes to the angles of

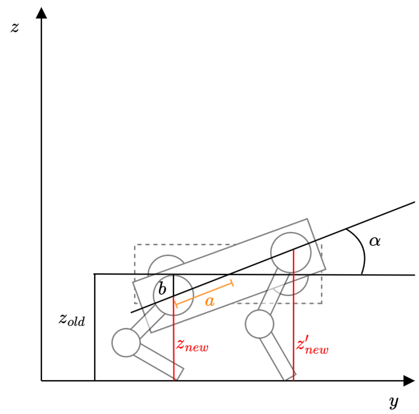


Figure 3: Side view of body rotation

the different joints. The only coordinate that changes in this movement is the z coordinate.

$$
\begin{aligned}
b &= a\sin(\alpha) \\
\Rightarrow z_{new} &= z_{old} - b \\
\Rightarrow z'_{new} &= z_{old} + b
\end{aligned}
$$

We can then calculate the angle change ψ_{change} by calculating the difference between the two configurations

$$\psi_{change} = \theta_{new} - \theta_{old}$$