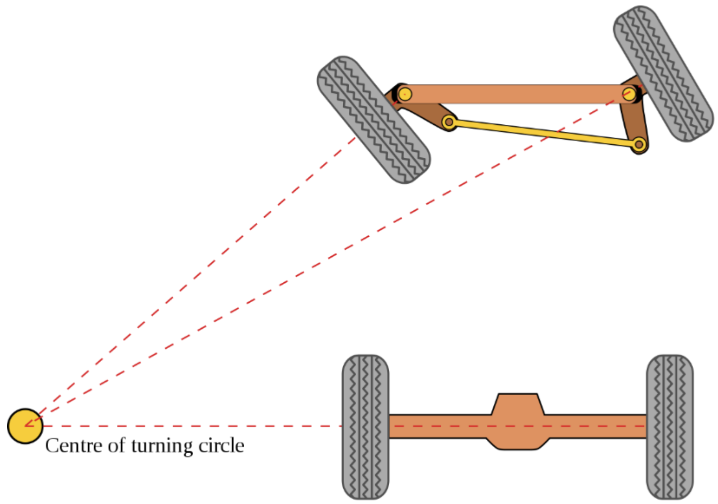
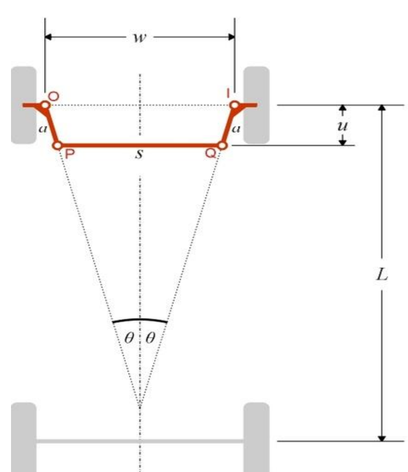
Ackerman steering geometry

It is the mechanism that makes car-like vehicles turns around a specific point. That makes the turn more efficient. The Ackerman steering depends on angular mathematics science.

You can easily notice that the inner wheel and the outer wheel are rotating different angles. See the figure [1].



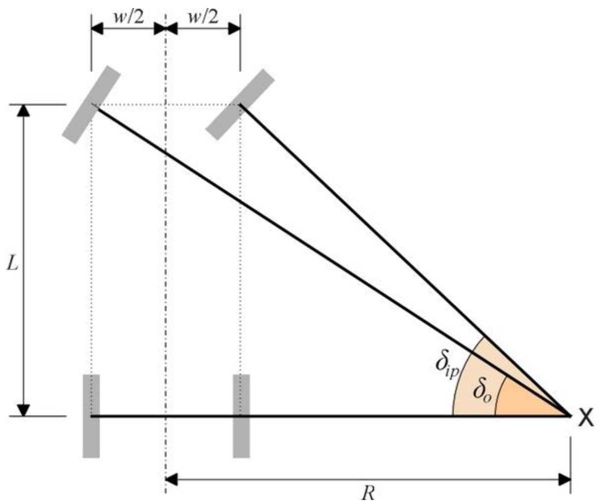
To make a start, we need to attach symbols to the various lengths and angles that define the movement of the linkage. First let's look at the fixed parameters – the ones that are built into the chassis of the car and don't change when the wheels are swiveled. There are six of them: L, w, a, θ, u, and s, as shown in figure 2. L is the distance between the front and rear axles, usually known as the wheelbase. The points O and I are the points where the pivot axes intersect the road surface, and we shall refer to the distance between them as the track width w (this is a simplification - previously we defined the track width as the distance between the wheel centerlines, and although this is not quite the same thing, each pivot axis usually intersects the road very close to the center of its corresponding contact patch, and it is convenient to assume they coincide). Attached to the wheel hubs are lever arms OP and IQ, each of length a. When the steering is in the dead-ahead position, each lever arm makes an angle θ with the car's longitudinal axis, and the track rod is spaced a distance u rearward of the front axle centerline. Finally, the two lever arms are linked by the track rod PQ, whose length is denoted by s.



$$a = u.\sec\theta \tag{1}$$

$$s = w - 2a\sin\theta = w - 2u\tan\theta \tag{2}$$

$$\tan\theta = \frac{w}{2l} \tag{3}$$



In the figure [3] it is explained how does actually Ackerman steering work!

$$\delta_{ip} = \cot^{-1}\left(\cot\delta_0 - \frac{w}{L}\right) \tag{4}$$

$$\cot\delta_0 = \frac{R+\frac{1}{2}w}{L} \tag{5}$$

$$\cot\delta_{ip} = \frac{R-\frac{1}{2}w}{L} \tag{6}$$

$$\cot\delta_{ip} = \cot\delta_0 - \frac{w}{L} \tag{7}$$

If we take our robot car for example:

$$\theta = 25°, u = 27.37mm, L = 155.12mm$$

So a becomes:

(1) $$a = 27.37 \times \sec 25° \approx 30mm$$

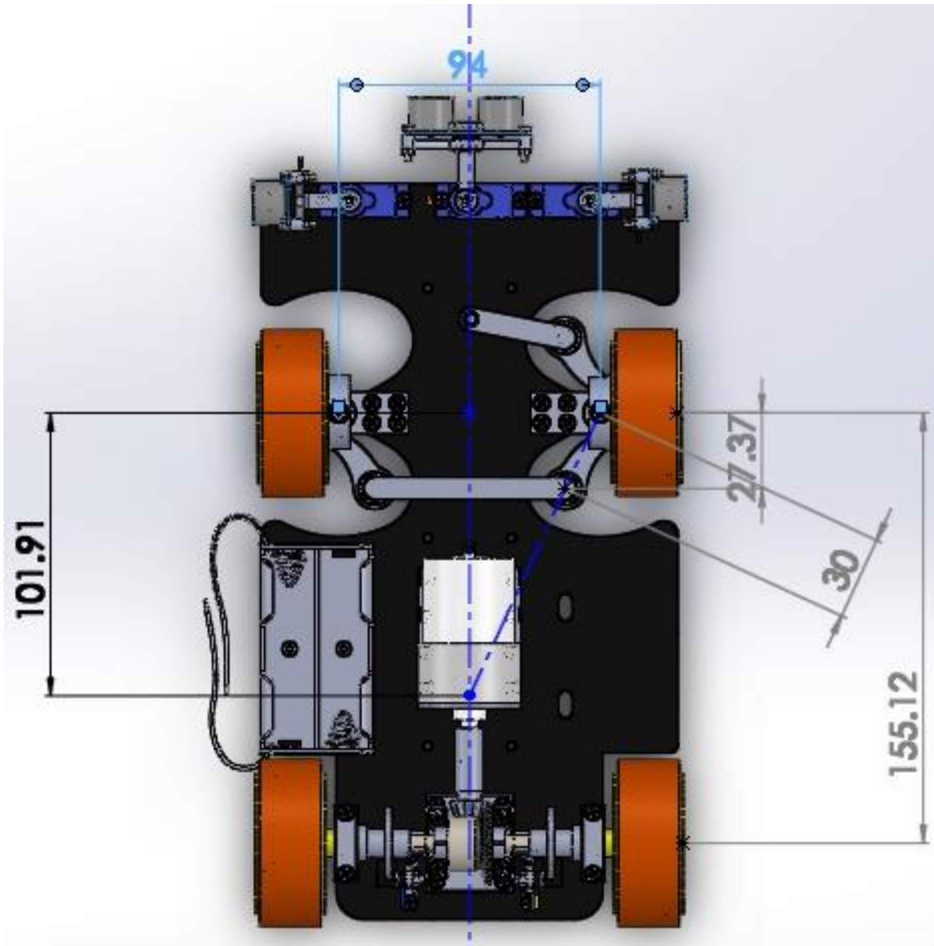
(2) $$s = w - 2a\sin\theta = 94 - 60 \times \sin 25 = 68.64mm$$

(3) $$\tan\theta = \frac{w}{2L} = \frac{94}{2\times 155.12} = 0.3$$

So if we need our robot car to turn by radius 50mm (for example):

(6) $$\cot\delta_0 = \frac{R+\frac{1}{2}w}{L} = \frac{50+\frac{1}{2}\times 94}{155.12} = 0.625$$

$$\delta_0 = 58°$$


94
27.37
30
101.91
155.12