Rack and Pinion Steering Geometry Calculator

Project Documentation

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Contents

1. Introduction

The Rack and Pinion steering geometry is shown below:

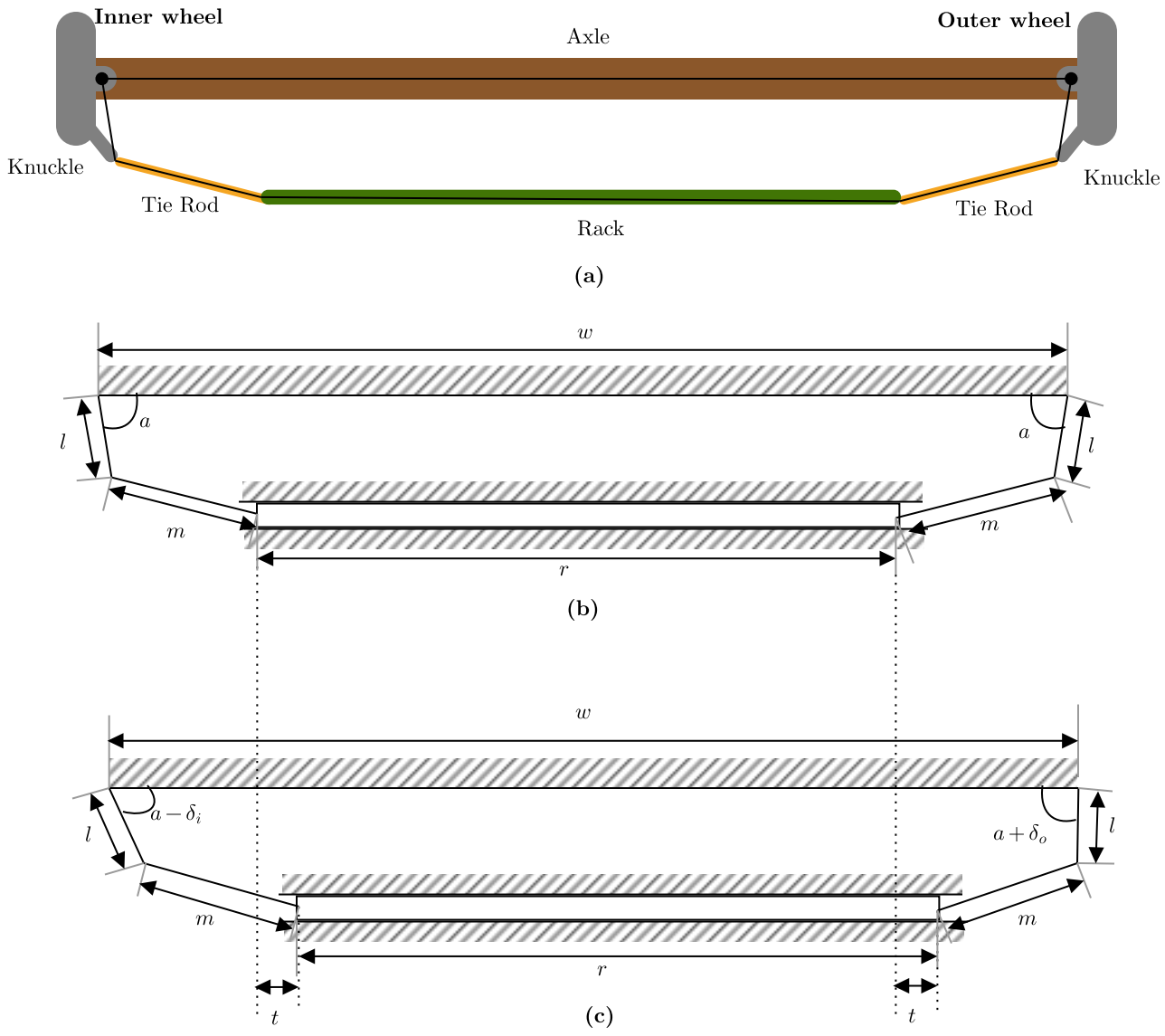

Fig. 1. (a) Illustration of the rack and pinion steering mechanism. (b) The mechanism when the vechile travels straight. (c) The mechanism when the vehicle turns left. The inner wheel turns through an angle δ_i, the outer wheel through δ_o and the rack shifts by t.

2. Using the Code

2.1. Inputs

Run the code and enter the following information in degreed (for angles) or mm (for lengths) when asked for:
(1) The initial inclination of link of length l given by a.
(2) The maximum value of the inner turning angle expected.
(3) The distance between two knuckle pins (that pivot the knuckle with the axle).
(4) The wheelbase.
(5) The distance between the two ball joints at the ends of the rack.
(6) The maximum distance the rack can travel in either directions starting from it's mean position.

2.2. Outputs

The code will calculate:
(1) The length l.
(2) The distance bewteen the two ball joints at the ends of a tie-rod.
(3) The distance between the axle and the rack.

The code will plot inner turning angle vs outer turning angle for
(1) An ideal steering mechanism that satisfies the ackerman condition.
(2) The said rack and pinion steering mechanism.

For the above calculation, the code solves equations assuming that:
(1) The ackerman condition is satisfied when the vehicle travels straight, i.e. $\delta_i = \delta_o = 0$.
(2) The ackerman condition is satisfied when the inner wheel turns by the maximum value (supplied by the user).
(3) When the inner wheel takes the maximum possible turn, the rack has travelled the maximim possible distance.

The output will end printing either "This mechanism can be used" or "This mechanism cannot be used". A condition beyond which no further turning is possible is depicted below. If this condition is reached when or before the inner wheel turns through the maximum possible angle, the code prints "This mechanism cannot be used". Else, the output says "This mechanism can be used"

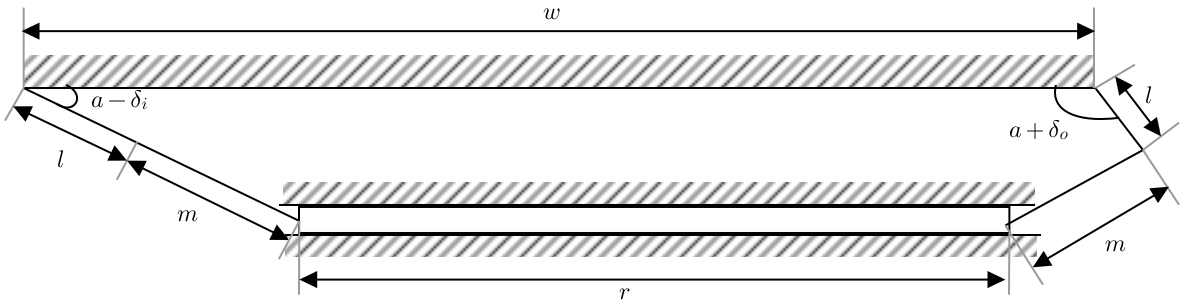

Fig 2. A tricky situation where the two links, of length l and m become paralles (see the left side above). No further turning is possible.

3. Example

An example case is shoen below

```
What is the initial inclination (degrees) of the imaginary line on the knuckle joining the pin
joints connecting to the axle and tie rods? 90
How much is max. turning angle for inner wheel (in degrees)? 40
How much is distance between two knuckle pins in mm? 3500
How much is the distance between two axles in mm? 4000
What is the rack length  (joint to joint) in mm? 1500
How much is the max. rack travel in either direction in mm? 30
Steering arm length (straight-line distance between the joints connecting to the axle and tie
rod) is 60.345671 mm
Tie rod length (joint to joint) is 1172.809684 mm
Distance between the rack and the front axle is 673.111985 mm
This mechanism can be used>>
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The plotted curves are: