

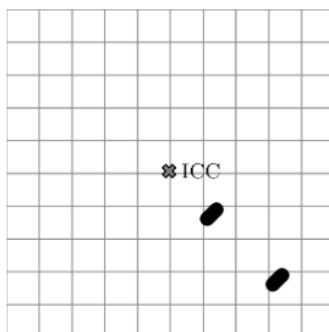
Homework 4

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1 Question 1

A certain robot that moves on three wheels. The figure below shows two of the wheels, along with the ICC of the robot's motion.



1. The third wheel (not shown) is attached to the robot so that its rolling direction is perpendicular to the rolling direction of the two wheels shown. Is this information sufficient to completely determine the position of the third wheel?
 - If you answered YES, mark the exact position and rolling direction of the third wheel on the diagram above.
 - If you answered NO, clearly mark all possible positions of the third wheel on the diagram above.

In either case, explain your answer.

2. From this position, the robot drives all three wheels so that it rolls without slipping or sliding, according to the given ICC. Draw the path followed by each of the two wheels shown. Do not draw a path for the third wheel.

1.1 Solution

1.1.1 Question 1.1

No, the information is not sufficient to determine the position of the third wheel. According to the property of the ICC, it is the intersection of the perpendicular lines to the rolling directions of all the wheels. As shown in Figure 1, we let the perpendicular line to the rolling directions of the two wheels

be l_g and assume that the perpendicular line to the third wheel's rolling direction is l_r . Since we are given that the third wheel's rolling direction is perpendicular to the two shown wheels, we have $l_g \perp l_r$ and they should intersect at the ICC. Therefore, the third wheel can be at any position along the line l_r .

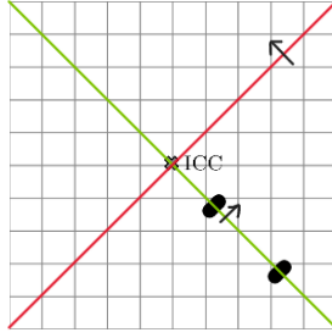


Figure 1: The green line (l_g) represents the perpendicular line to the rolling directions of the two shown wheels. Since the third wheel's rolling direction must also be perpendicular to the two shown wheels, its corresponding perpendicular line (l_r) must be perpendicular to l_g and pass through the ICC. As a result, the third wheel can be located anywhere along the red line.

1.1.2 Question 1.2

Without slipping or sliding, the robot will rotate around the ICC, causing the two wheels to follow circular paths centered at the ICC.

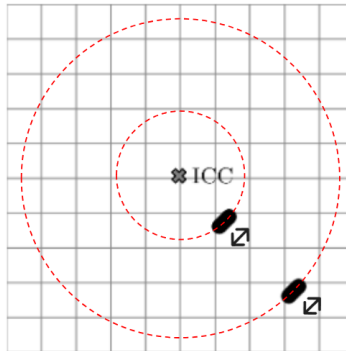


Figure 2: The robot rotates around the ICC, causing the two wheels to follow circular paths. The red dashed lines represent the circular path of the two wheels, with centered at the ICC.