WOMEN IN
AI & ROBOTICS

Hackathon Code and Concepts

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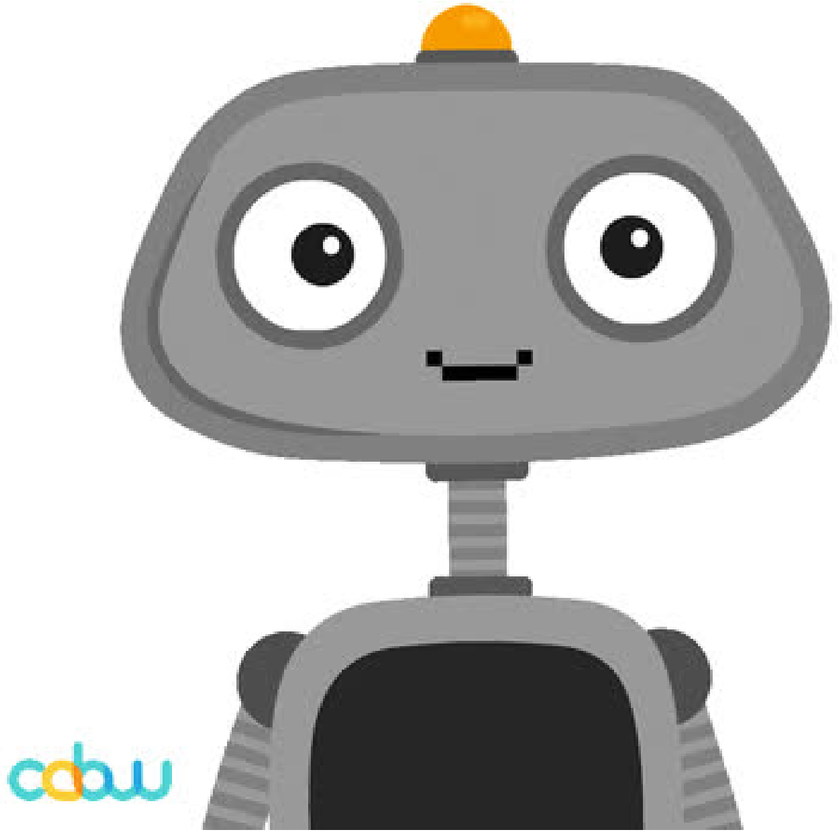
Contents

Hackathon Concepts with Koyal Bhartia



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Journey with Robotics

Masters in Robotics

2020

Kawasaki

Kawasaki Robotics (USA), Inc.

Internship - Robotics Engineer

Industrial Robots

ArcBest

More Than Logistics

Robotics Software Engineer II

Mobile Robots (AMRs)

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At Kawasaki Robotics

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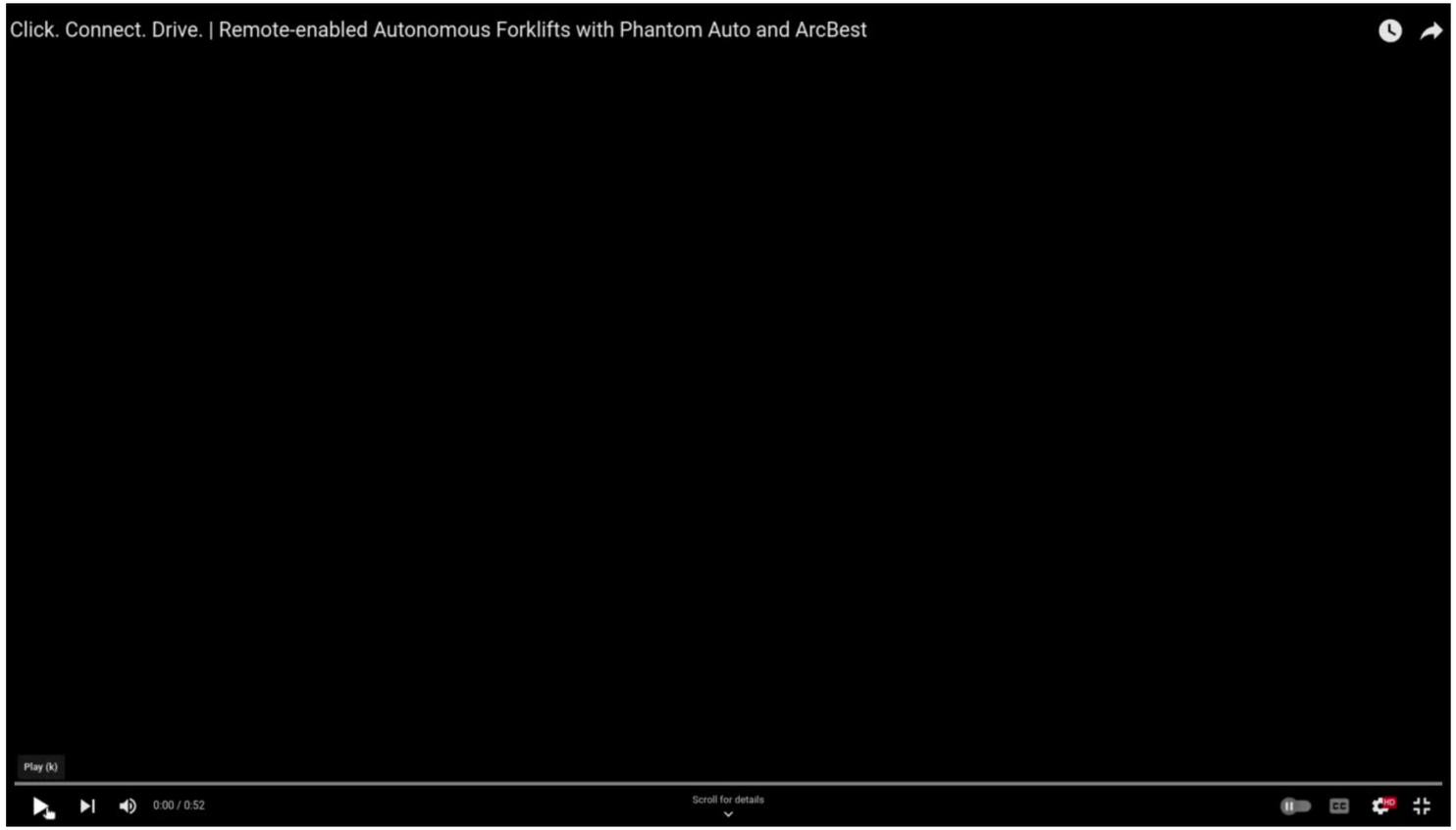
At ArcBest Technologies



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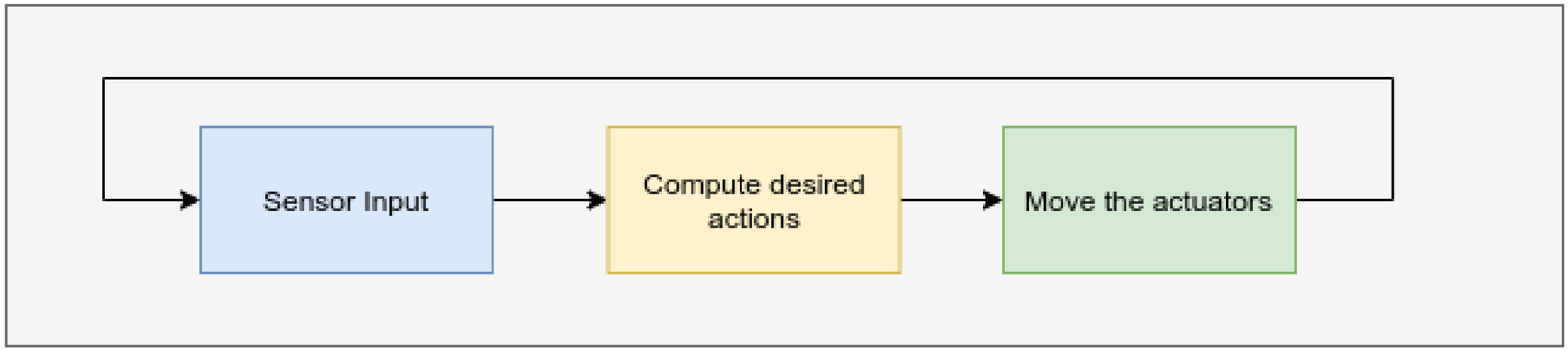
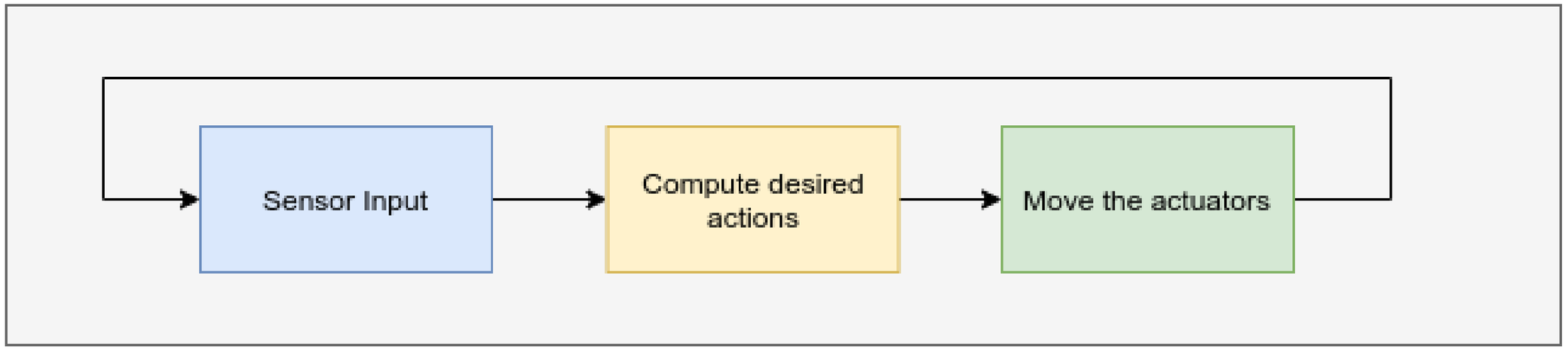
How does the magic happen in a robot !?

Basic Controller..!!!



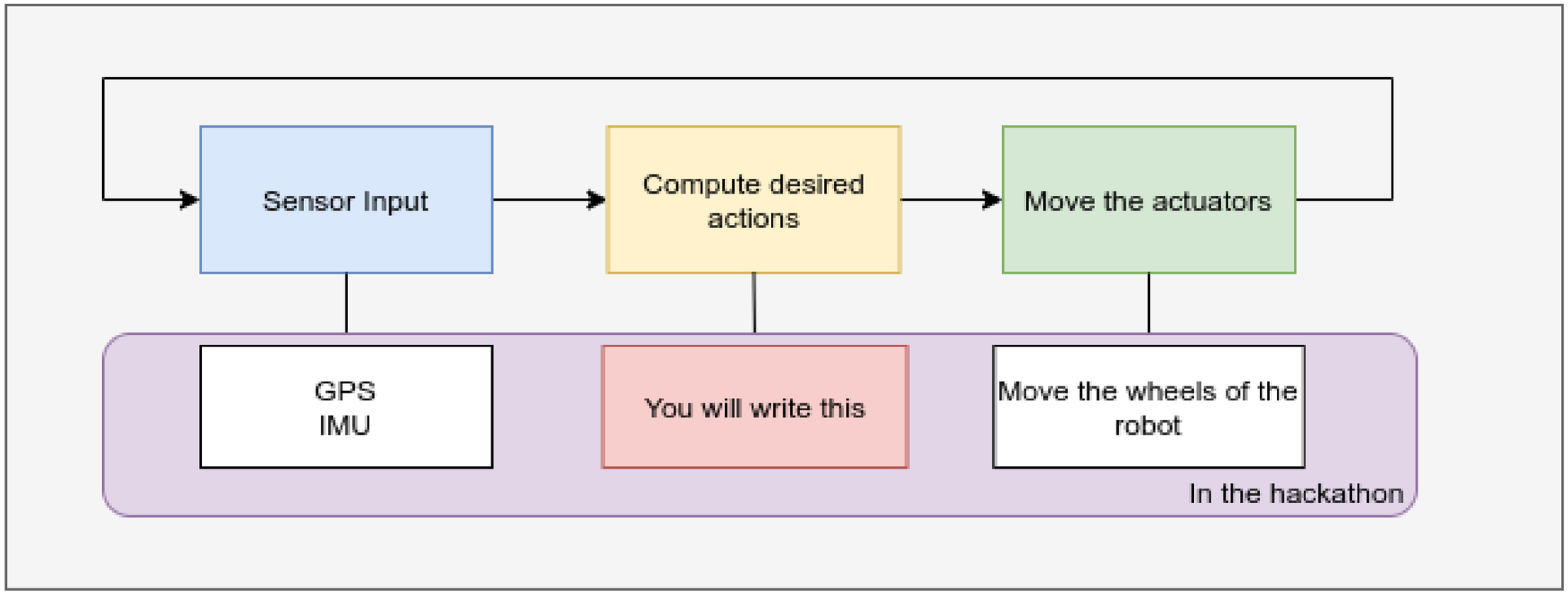
How does the magic happen in a robot !?

Basic Controller..!!!



How does the magic happen in a robot !?

Hack the Basic Controllers..!!!



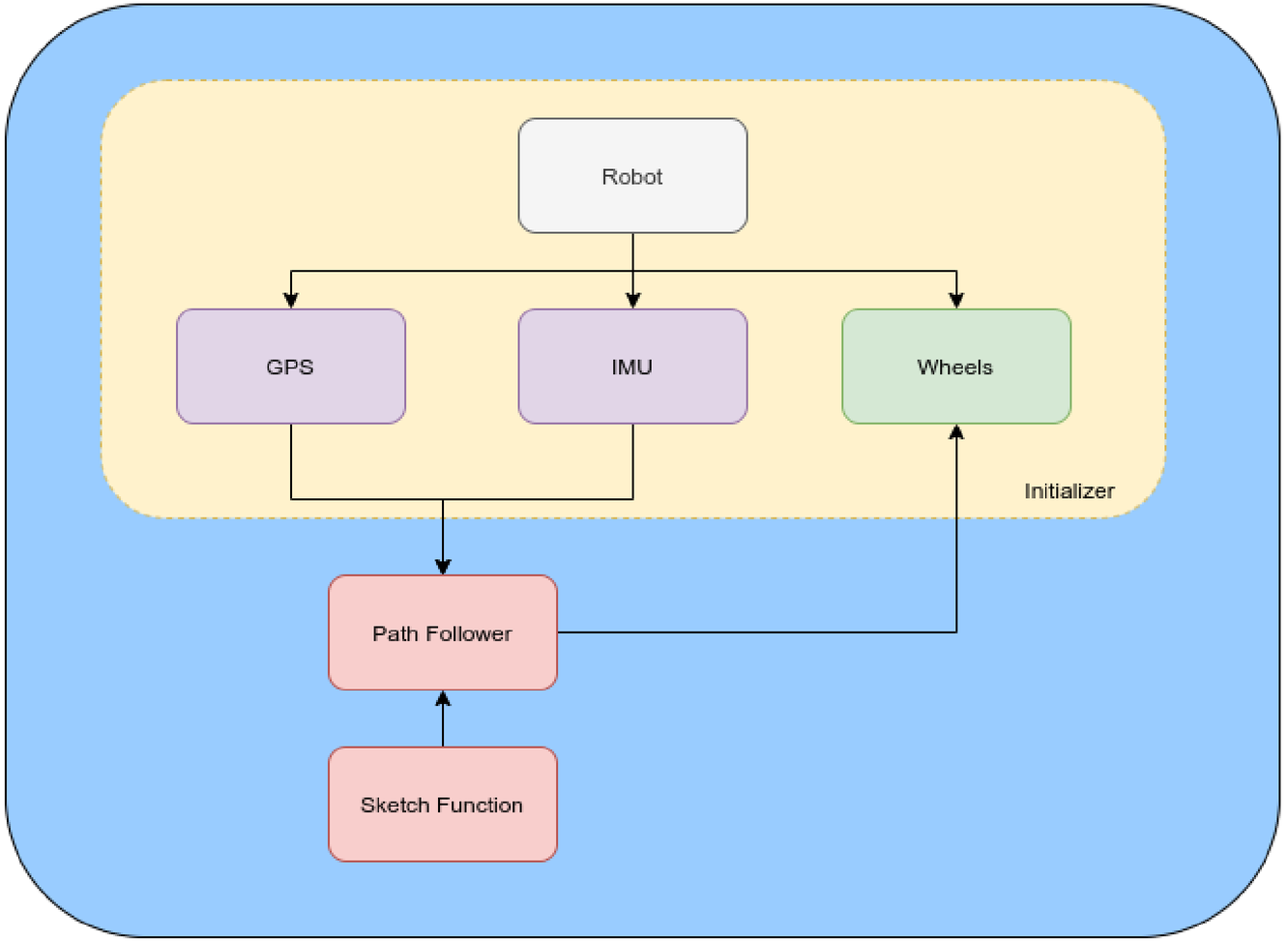
Controllers in the Hackathon

2 Python files

1. Point_follower.py - Robot controller to trace the given curve or create own art work using keyboard.
2. Ground.py - Ground Controller that colors (actually erases) the area below the robot as the robot navigates.

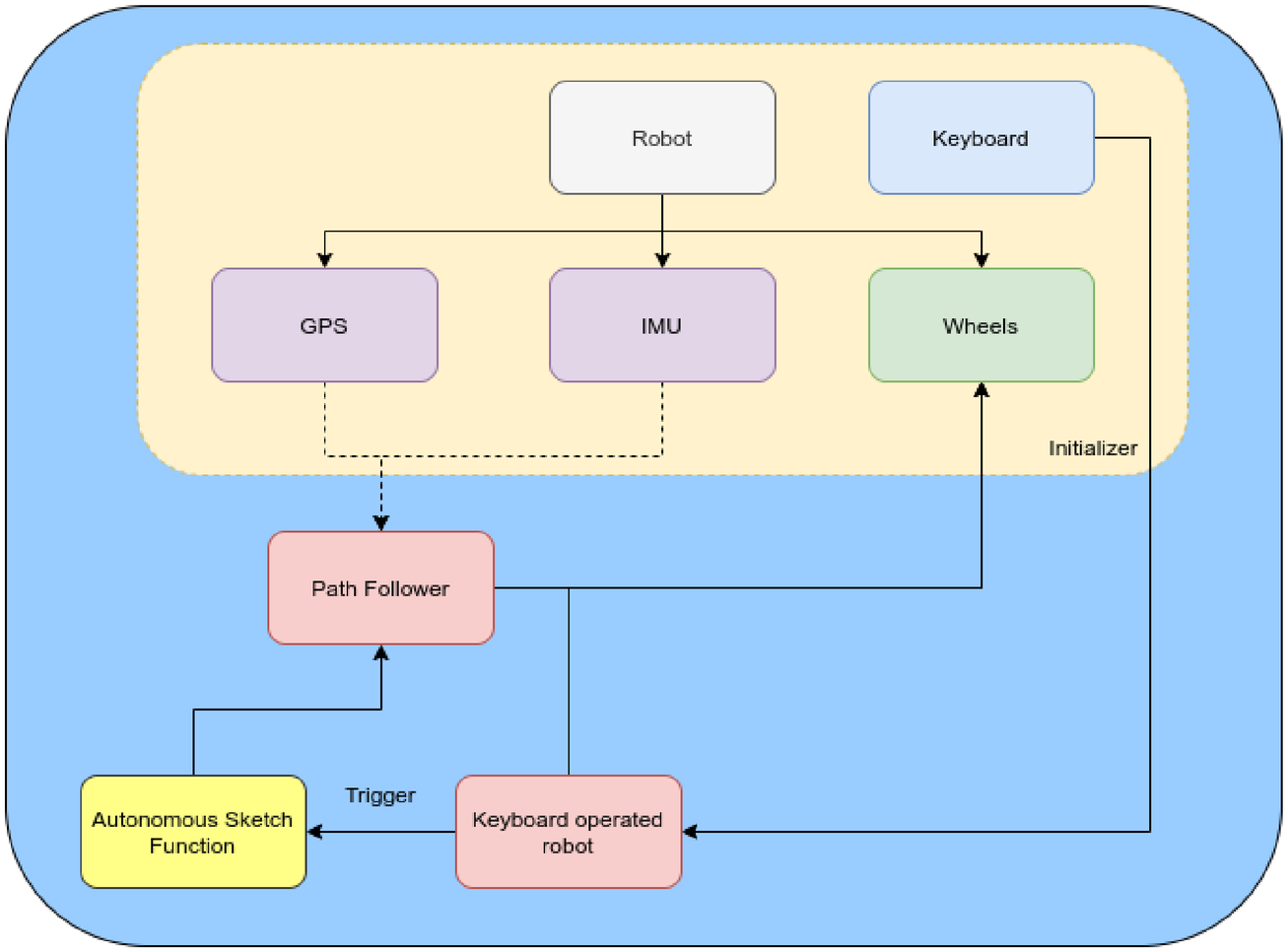
Contents

Point_Follower.py - Task 1/2/3



Contents

Point_Follower.py - Task 4



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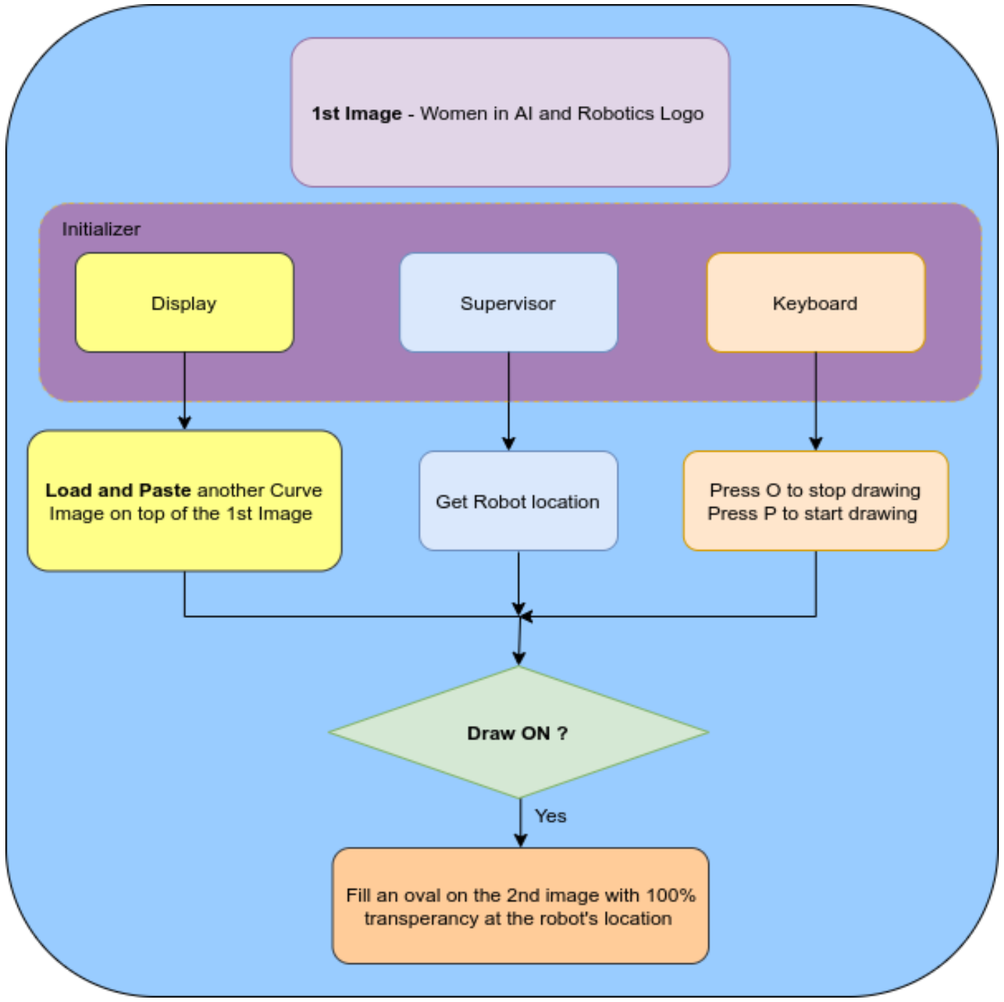
Ground.py



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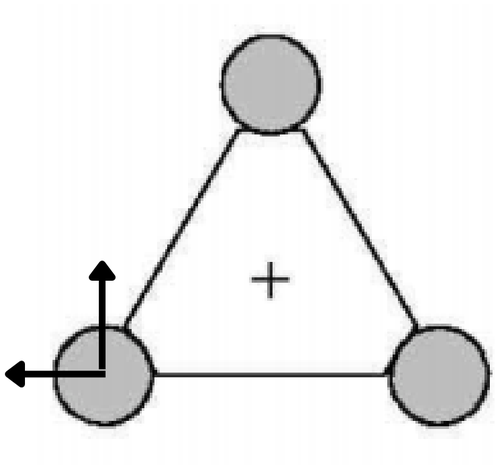
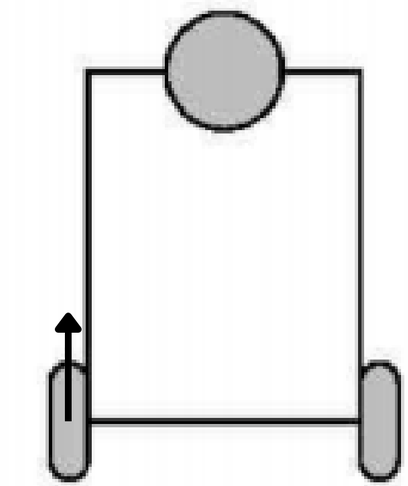
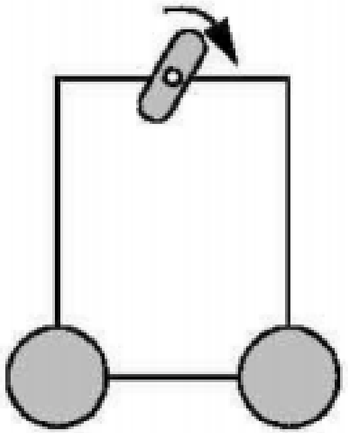
Examples of different combinations of wheels



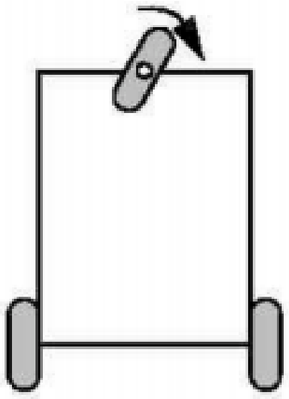
Omnidirectional



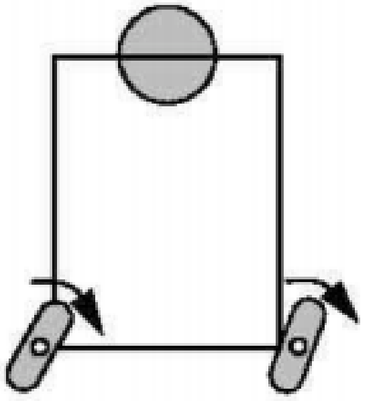
Differential



Omni-Steer



Tricycle



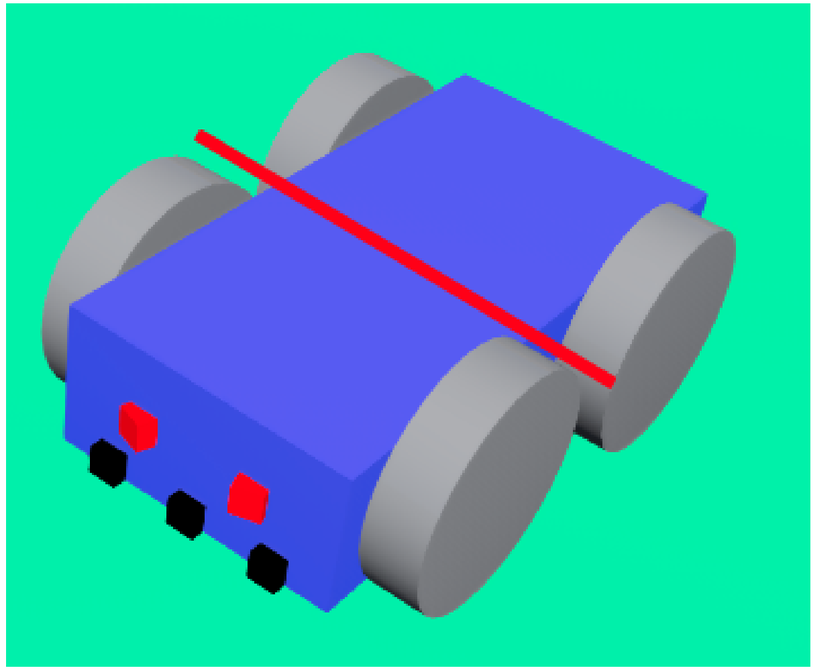
Two-Steer

Differential Drive Robots – An example

- A differential drive robot consists of 2 drive wheels mounted on a common axis
- Each wheel can be independently driven either forward or backward.
- A castor wheel is sometimes added as a passive wheel to balance and avoid tipping.

Hackathon Robot

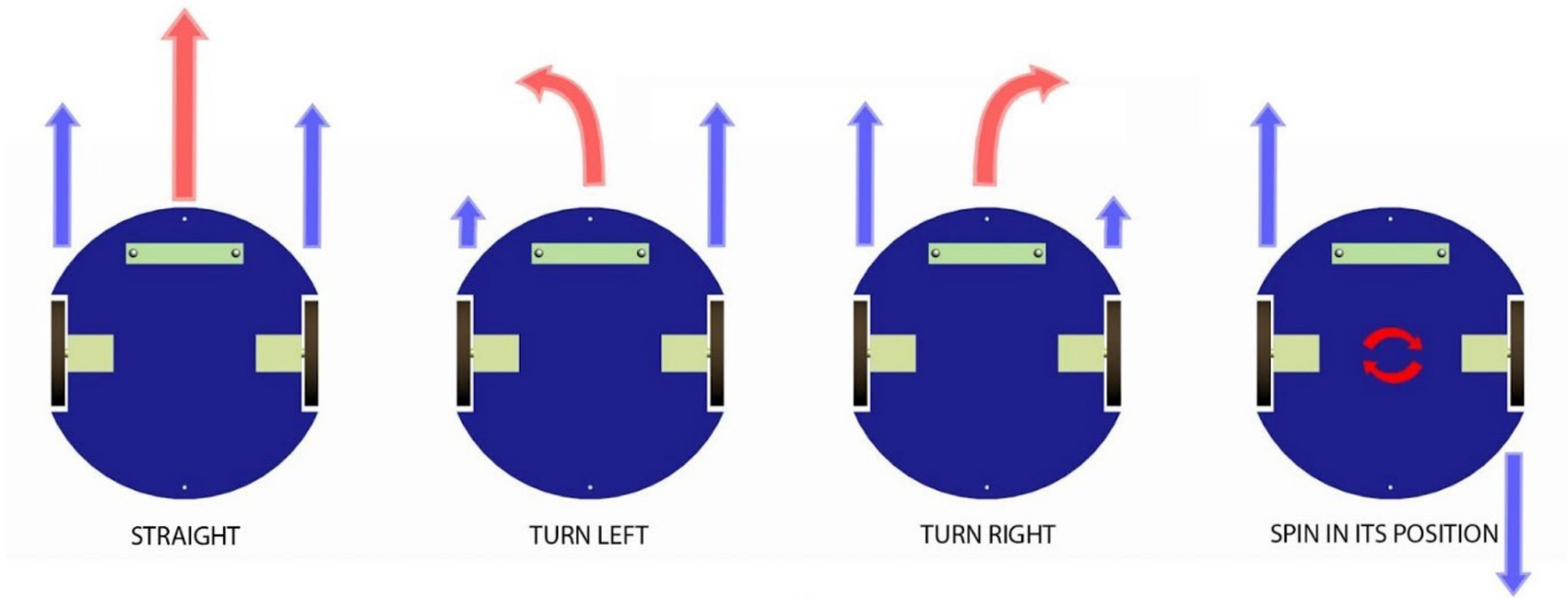
- Task Robot - 4 wheeled robot approximated as a differential drive by providing equal velocities to front and rear wheels.
- Red line - center axis



Differential Drive Robots - Possible motions

Variation of velocities in 2 wheels can result in different trajectory of robots.

Note: Length of blue arrows represent velocity of wheel and red arrow represents trajectory orientation.



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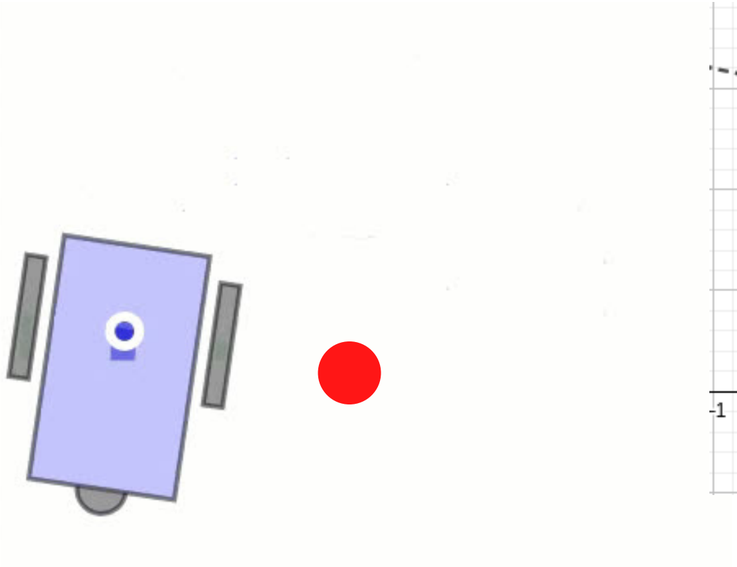
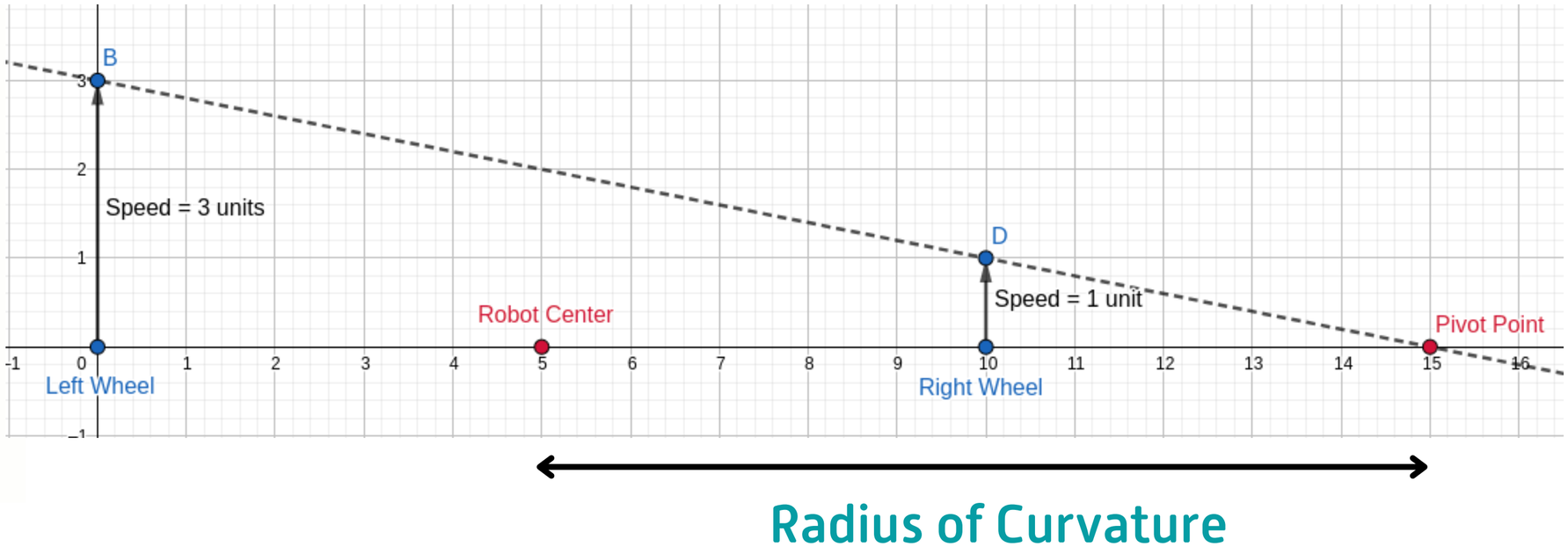
Differential Drive Robots - What is ICC (Pivot Point)

- **The point about which the robot rotates is known as the ICC - Instantaneous Center of Curvature. This point lies along the common axis of the left and right wheels.**

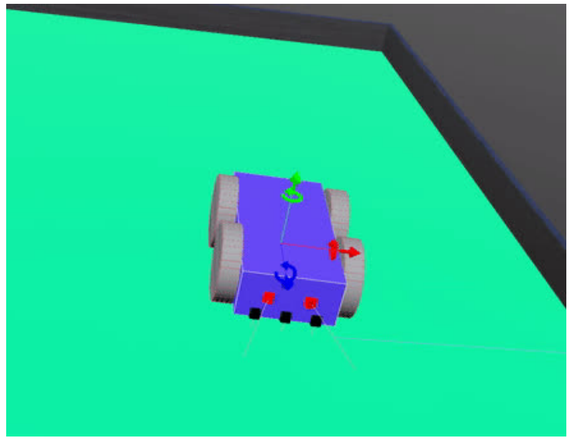




Differential Drive Robots - Trajectory examples

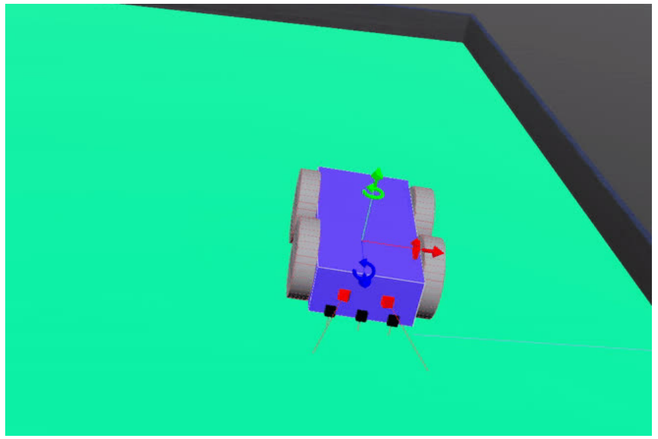
Case 1 : Left wheel -> +ve velocity, right wheel -> -ve velocity (same magnitude)

Pivot Point: Midpoint of the wheels
Behavior: Robot rotates in place



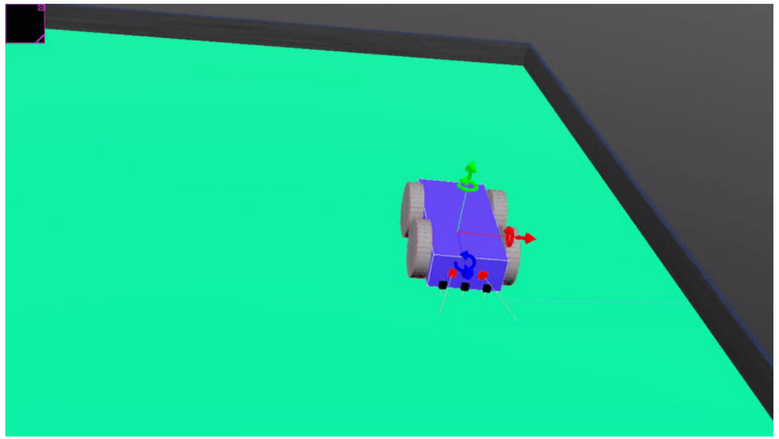
Case 2 : One of the wheels has 0 velocity

Pivot Point: On the wheel with 0 velocity
Behavior: Robot rotates about the wheel with 0 velocity, makes a shorter turn



Case 3 : Both wheels have positive velocities, magnitude of velocity of one wheel is higher

Pivot Point: Outside the robot body near the wheel having lower velocity
Behavior: Robot rotates around the wheel with lower velocity, makes a larger turn



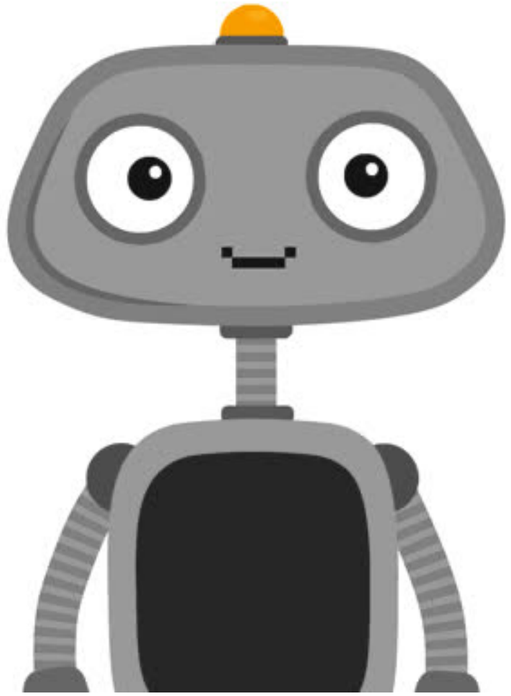
The robot's radius of curvature changes based on the distance of pivot point or ICC (Center of Curvature) from the center of the robot.

Questions to Ponder

Question:

1. How is the pivot point able to shift with changing velocities?
2. What is the relationship between the pivot point and the turning radius?

Answer:



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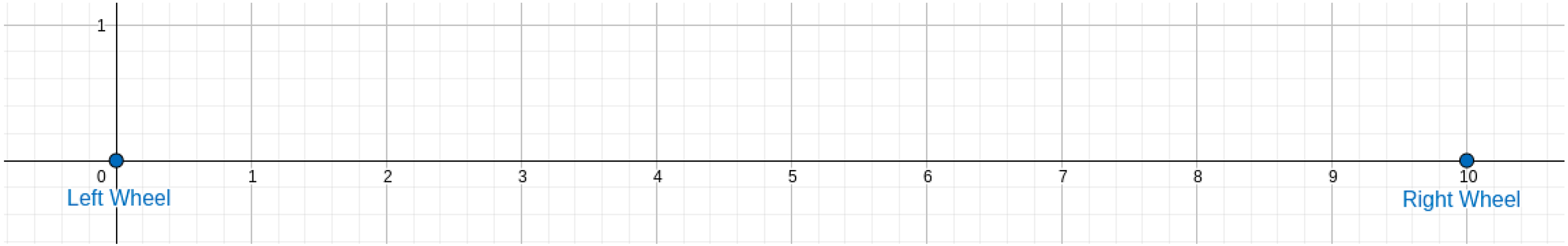
Geometric visualization of ICC

Steps to follow:

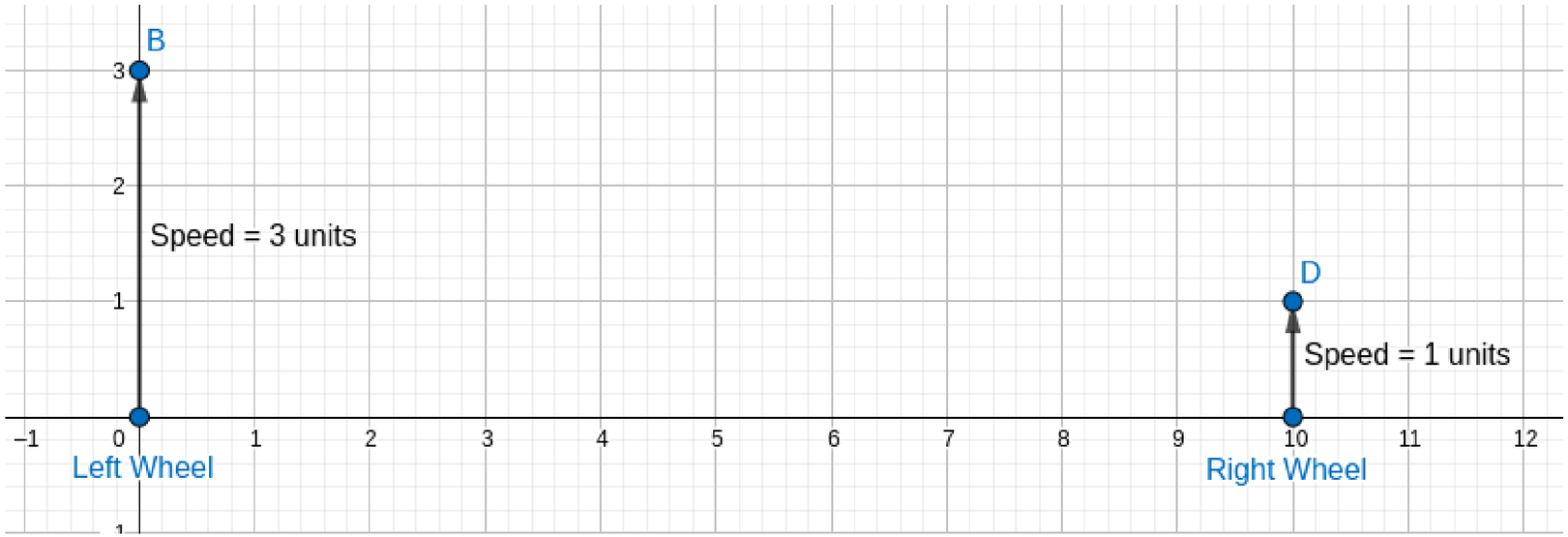
1. Draw a line segment.
2. Assume the left and right ends of the line segment as your left and right wheel spots, respectively. This is the line segment which passes through the centers of the 2 wheels.



Geometric visualization of ICC

Steps to follow - Continued:

3. Draw vector lines as shown based on the magnitude and direction of the wheel velocities.

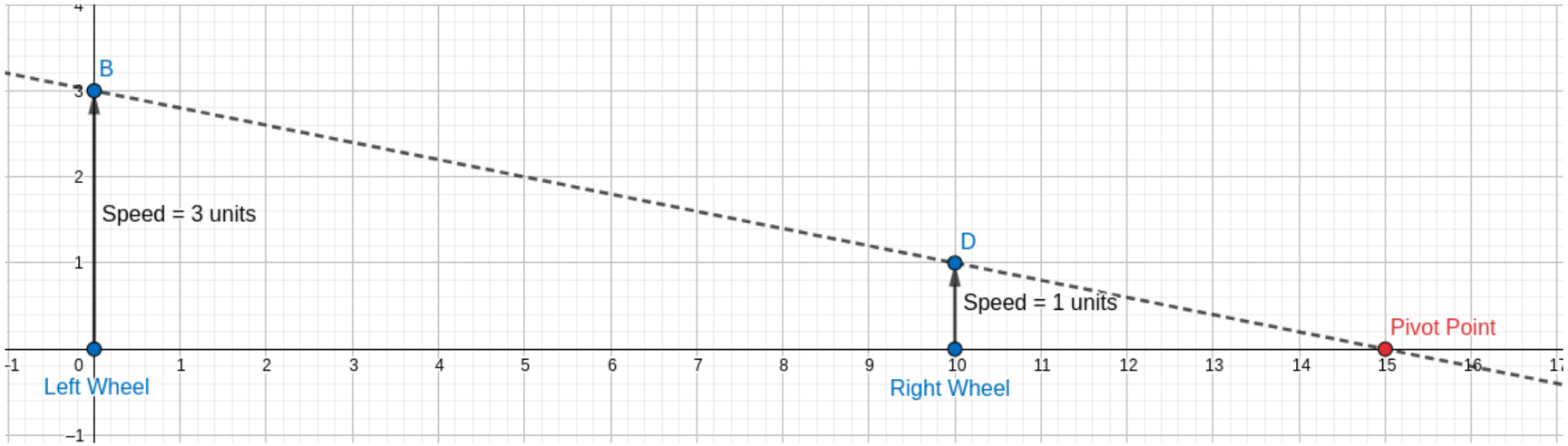


Geometric visualization of ICC

Steps to follow - Continued:

4. Join the tip of the vectors.

5. The point where this joining line meets the original line is the pivot point or center of rotation of the robot.

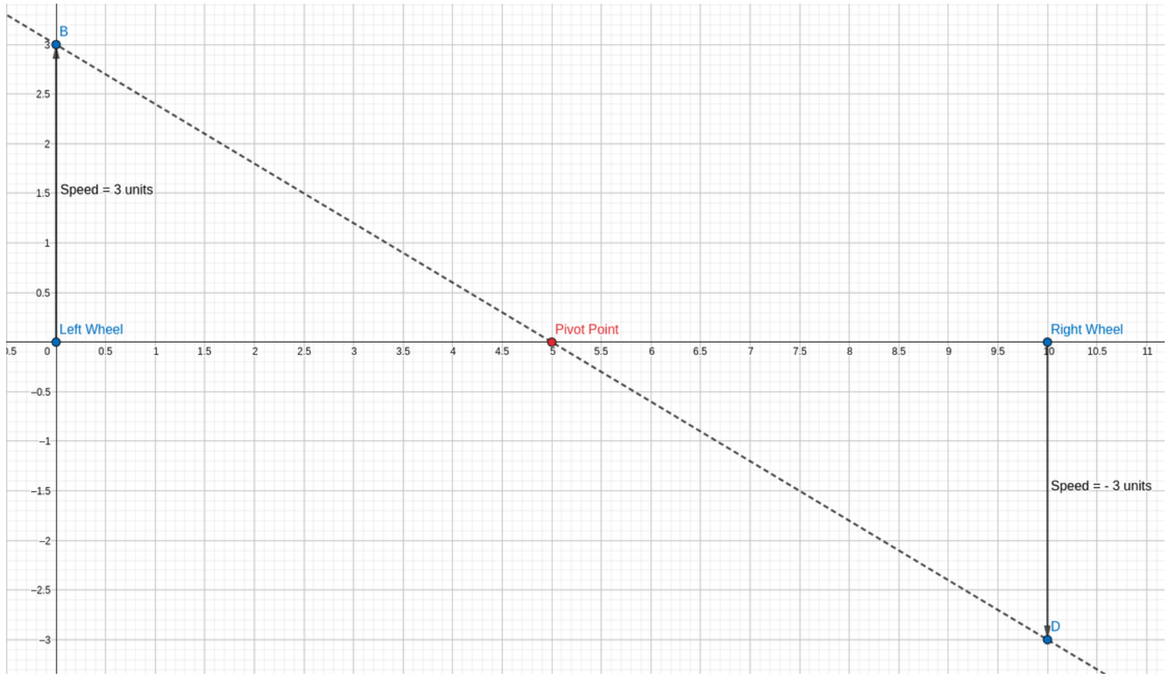


Geometric visualization of ICC - Examples

Case 1 : Left wheel has positive velocity, right wheel has negative velocity of the same magnitude

Pivot Point : Midpoint of the wheels

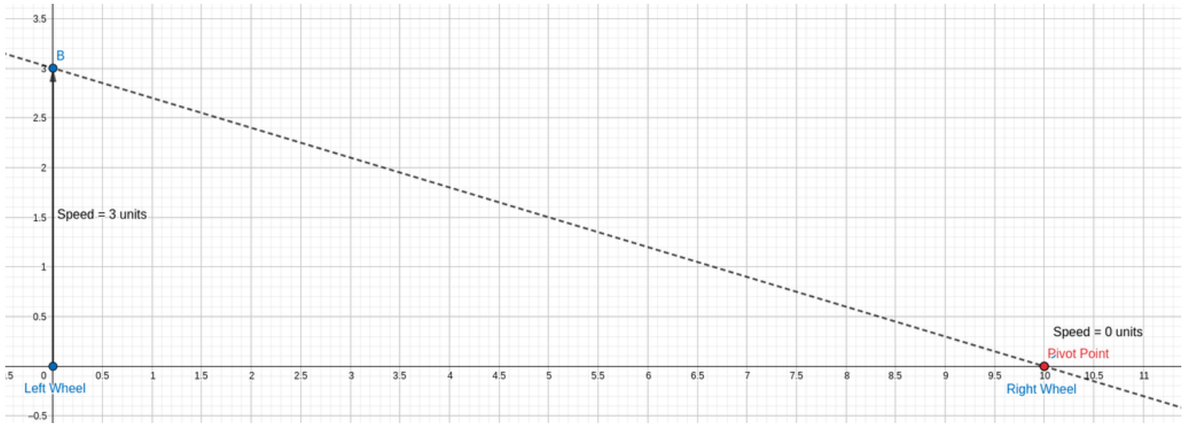
Rotation: Robot rotates in place



Case 2 : One of the wheels has 0 velocity

Pivot Point : On the wheel with 0 velocity

Rotation: Robot rotates about the wheel with 0 velocity



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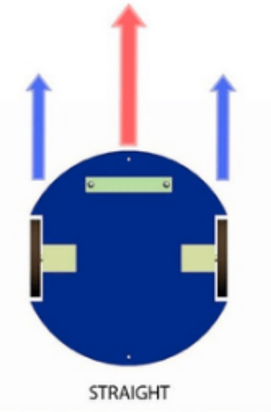
Differential Drive Robots - Conclusion

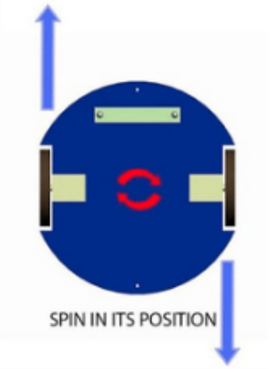
Question: How is the pivot point able to shift with changing velocities?
We saw 3 examples, however what is the relationship between the pivot point(ICC) and the turning radius?

Answer:

1. As the difference between the velocities of the left and the right wheel increases, the pivot point (Icc) comes closer and closer to the center.
2. As the pivot point moves closer to the center of the robot, the robot makes sharper turns. Further away the pivot point is from the center, wider is the turn.



ICC = Inf



ICC = 0

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Soft Illusion

Questions?

Thank you for your attention!