Sensor-Actuator Functions for DE2Bot Position Control

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ECE2031
Fall 2015
DE2Bot Overview

- The DE2Bot is a two-wheeled, differential drive robot.
  - Its two drive wheels, on the left and right, allow it to move forward, backward, in arcs, or turn in place.
DE2Bot Movement

- Each drive wheel is controlled independently

- Straight forward
- Forward arc (right)
- Turn in place
• A two-sensor Braitenberg control system on the DE2Bot might look like this:
In summer 2015, the project objective was to get the DE2Bot to reach a destination. One method explored was to use a Braitenberg-like sensor-actuator conversion function, using the angular error as the “sensor”.

\[ F_L(A) \rightarrow \text{Left wheel} \]
\[ F_R(A) \rightarrow \text{Right wheel} \]
<table>
<thead>
<tr>
<th>Destination position</th>
<th>Desired Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behind robot</td>
<td>Turn in place</td>
</tr>
<tr>
<td>Left or right of robot</td>
<td>Forward curve</td>
</tr>
<tr>
<td>In front of robot</td>
<td>Full speed straight</td>
</tr>
</tbody>
</table>

![Diagram showing robot behavior examples](image)
Example Desired Wheel Speeds

- If the angular error is near 0 (i.e. the target is straight ahead), both wheels should move forward at full speed.
- If the angular error is near +/-180 (i.e. the target is behind the robot), the left and right wheels should turn in opposite directions, to spin the robot in place.
- ... etc.
Based on the desired behavior, the following function was chosen:

- **Max forward**
- **Max reverse**

The graph shows the velocity changes for different angles:
- **Right Velocity** for clockwise angles:
  - From -180° to 0°.
  - From 90° to 180°.
- **Left Velocity** for anti-clockwise angles:
  - From 0° to 90°.
  - From 0° to -90°.
Final Implemented Function

Destination is mostly behind, and slightly to the right. Left wheel forward, right wheel reverse. → **Turn in place clockwise**

Max forward

0

Max reverse

-180° (clockwise) -90° 0° 90° 180° (anti-clockwise)

Right Velocity

Left Velocity
Final Implemented Function

Destination is mostly ahead, but slightly to the left. Right wheel full forward, left wheel slightly slower. → Arc to the left

Max forward

Max reverse

Right Velocity

Left Velocity

-180°  -90°  0°  90°  180°
(clockwise)  (anti-clockwise)
Small-scale Test Results

- These are results with the DE2Bot starting at (0,0), facing right, and seeking different destinations.
Detail: Target Starts Behind Robot

- **~0°**: Nearly straight forward movement
- **~90°**: Curving to left
- **180°**: Turning in place (no forward movement)
Going the Other Way

- For the writing assignment, you are given the velocity function and asked to describe the robot’s behavior.
  - I.e. the opposite of what was done above.
- You can use any method you’d like.
  - Thought experiments, simulation, math…
- Be sure to consider what happens in different situations.
  - Target ahead, to the left, behind, etc.
  - Target very close to robot, very far away, etc.