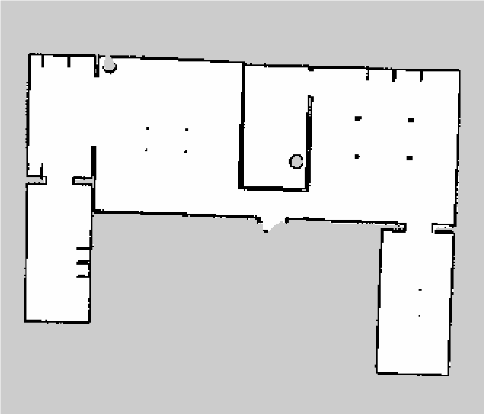
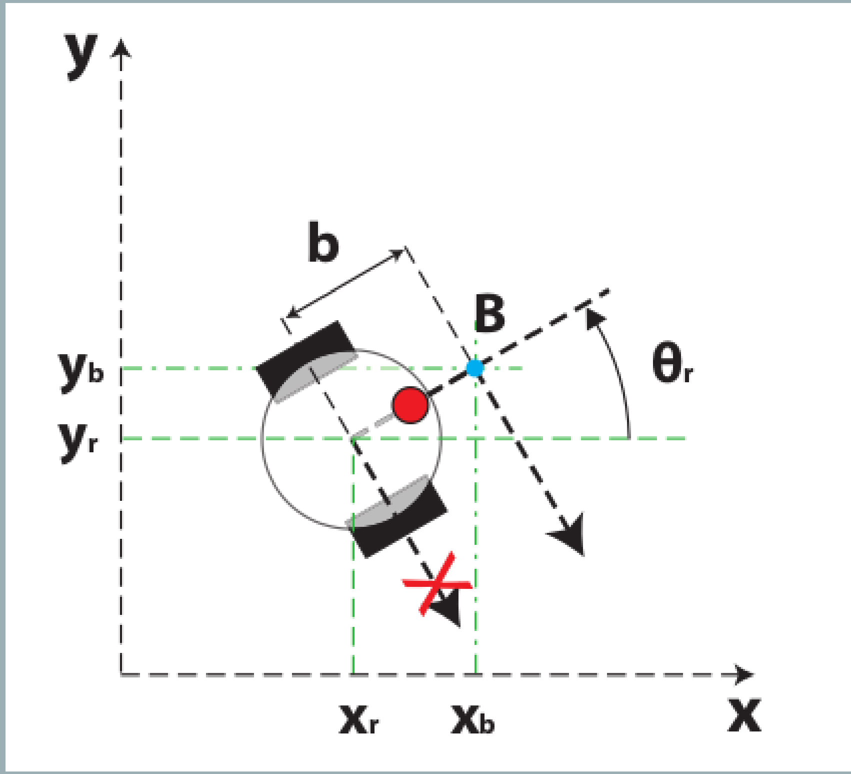
SIMULATION EXERCISES WITH ROS AND TURTLEBOT3 BURGER

SARIM MEHDI

ZARA TORABI



FOLLOWING TRAJECTORY



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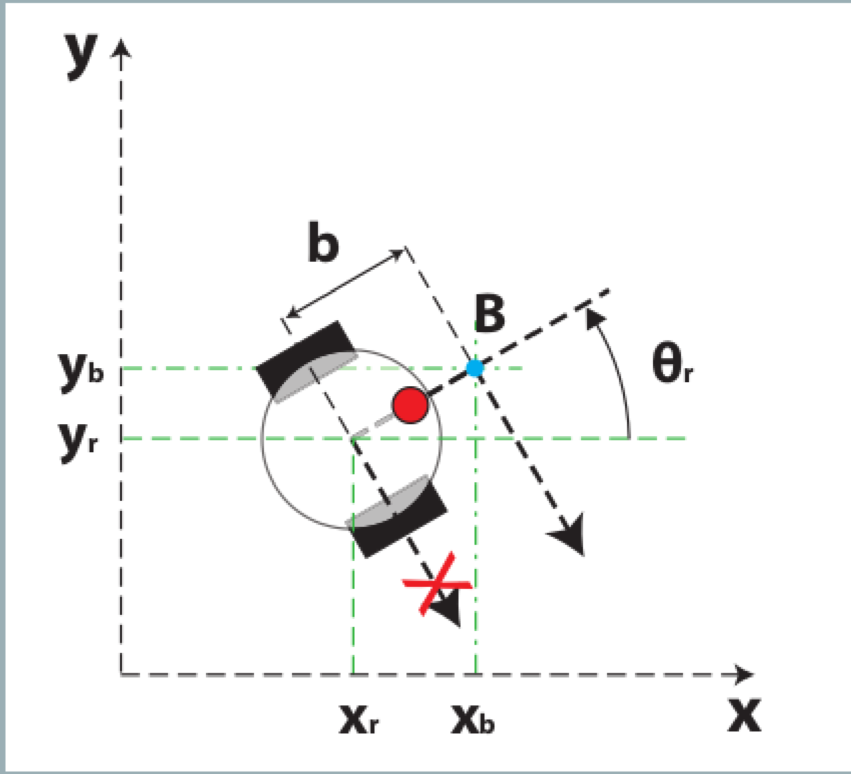

$$\begin{cases} x_b = x_r + b\cos\theta_r \\ y_b = y_r + b\sin\theta_r \end{cases}, \quad b \neq 0$$

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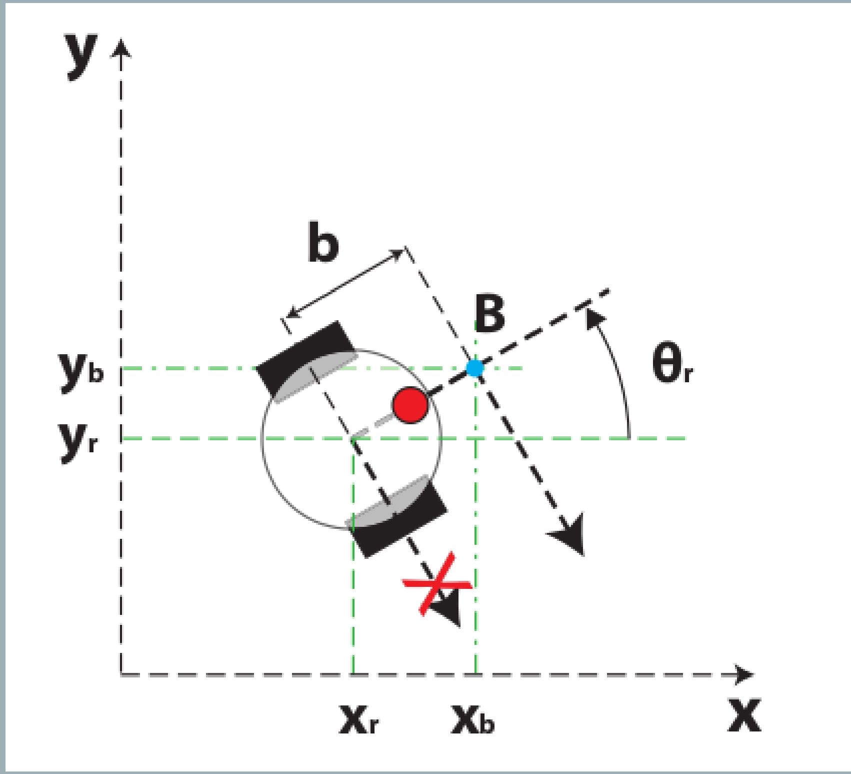

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$$\begin{aligned} \dot{x}_b &= v_{x,b} \\ \dot{y}_b &= v_{y,b} \end{aligned}$$

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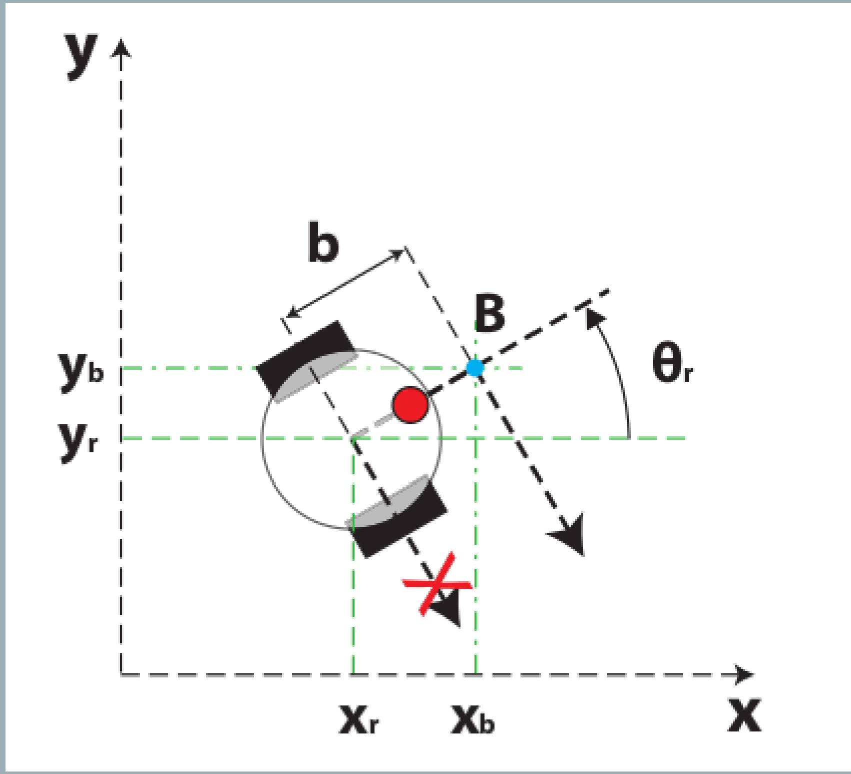

$$
\begin{aligned}
\dot{x}_b &= \dot{x}_r - b \cdot \omega \sin \theta_r \\
\dot{y}_b &= \dot{y}_r + b \cdot \omega \cos \theta_r
\end{aligned}
$$

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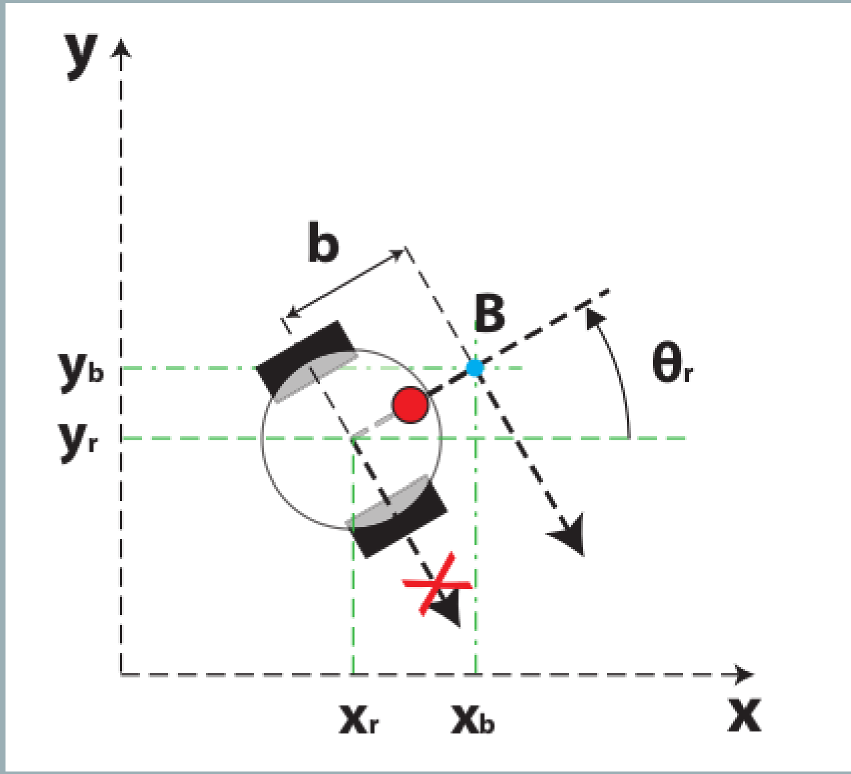

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\dot{x}_b &= v\cos\theta_r - b \cdot \omega \sin\theta_r \\
\dot{y}_b &= v\sin\theta_r + b \cdot \omega \cos\theta_r
\end{aligned}
$$

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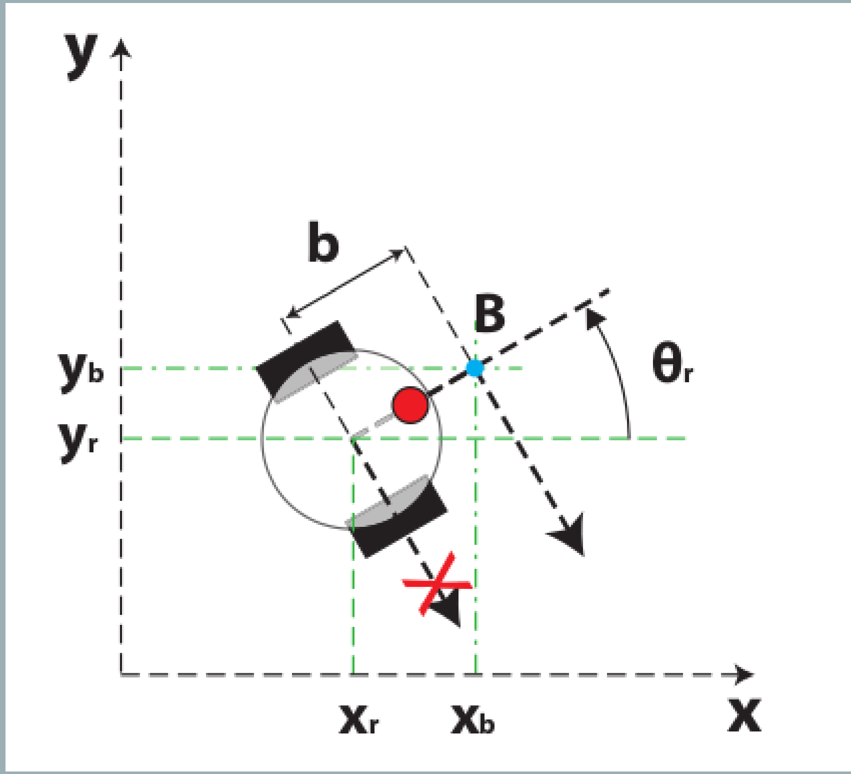

$$\begin{bmatrix} \dot{x}_b \\ \dot{y}_b \end{bmatrix} = \begin{bmatrix} \cos\theta_r & -b\sin\theta_r \\ \sin\theta_r & b\cos\theta_r \end{bmatrix} \begin{bmatrix} v \\ \omega \end{bmatrix}$$

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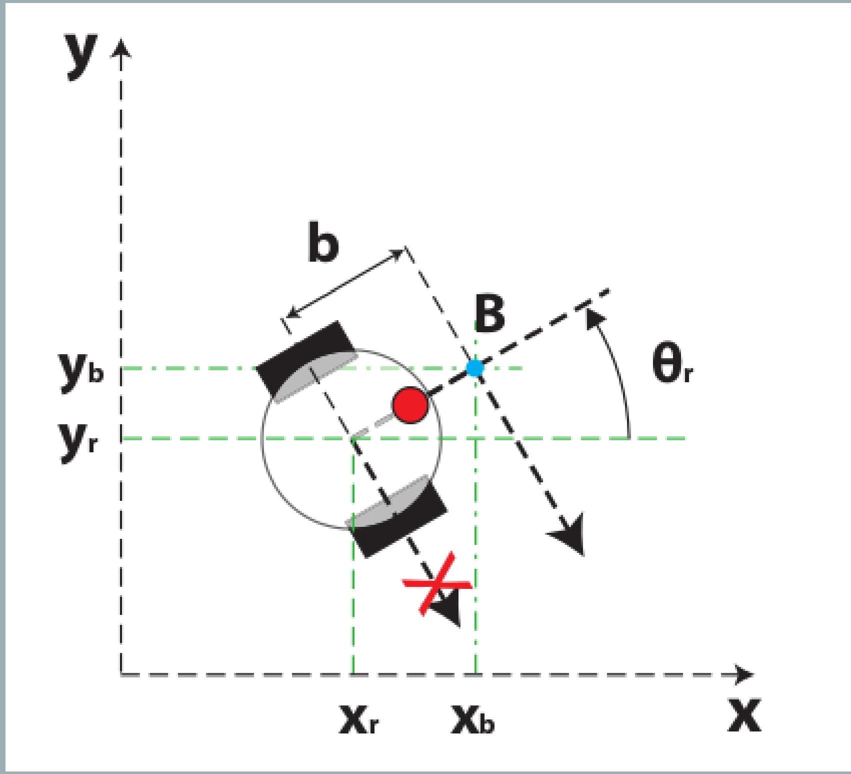

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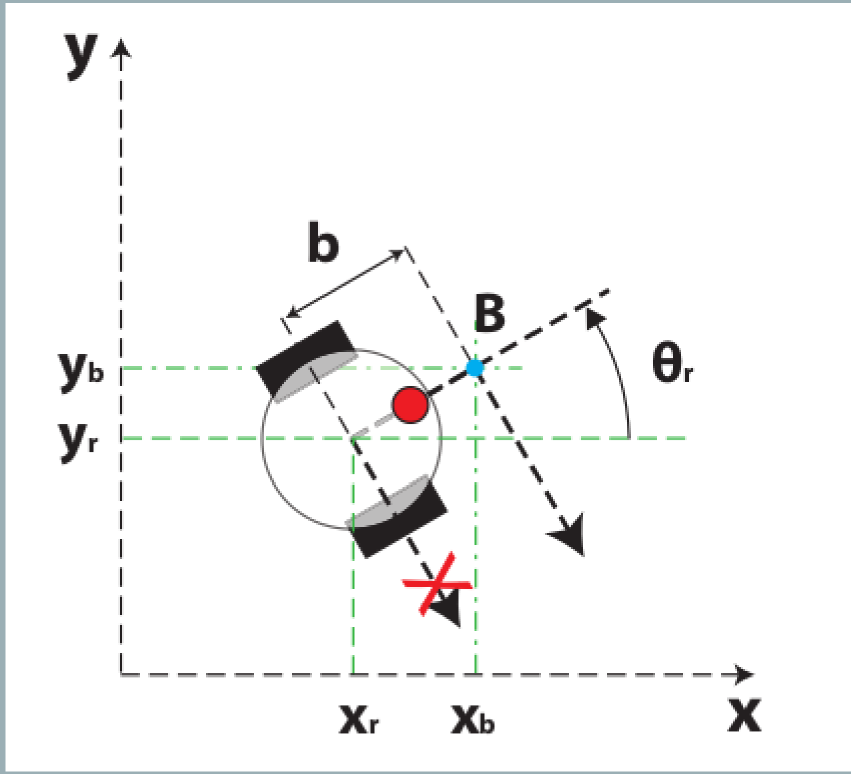

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v = linear velocity input to Turtlebot3
w = angular velocity input to Turtlebot3

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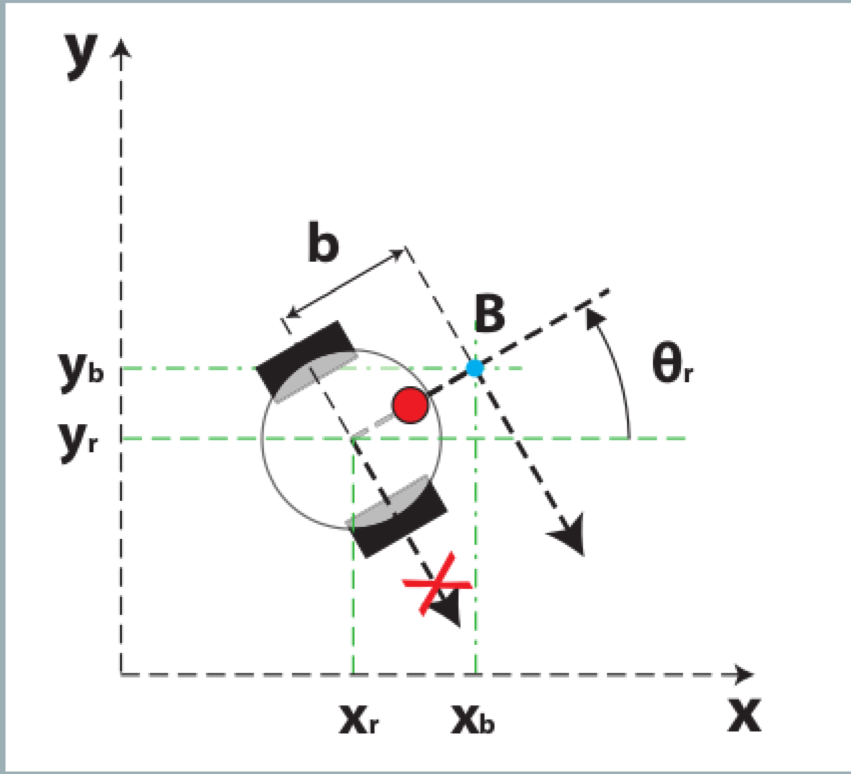

GENERATE TRAJECTORY HAS POINTS [q1*, q2*, …, qn*]

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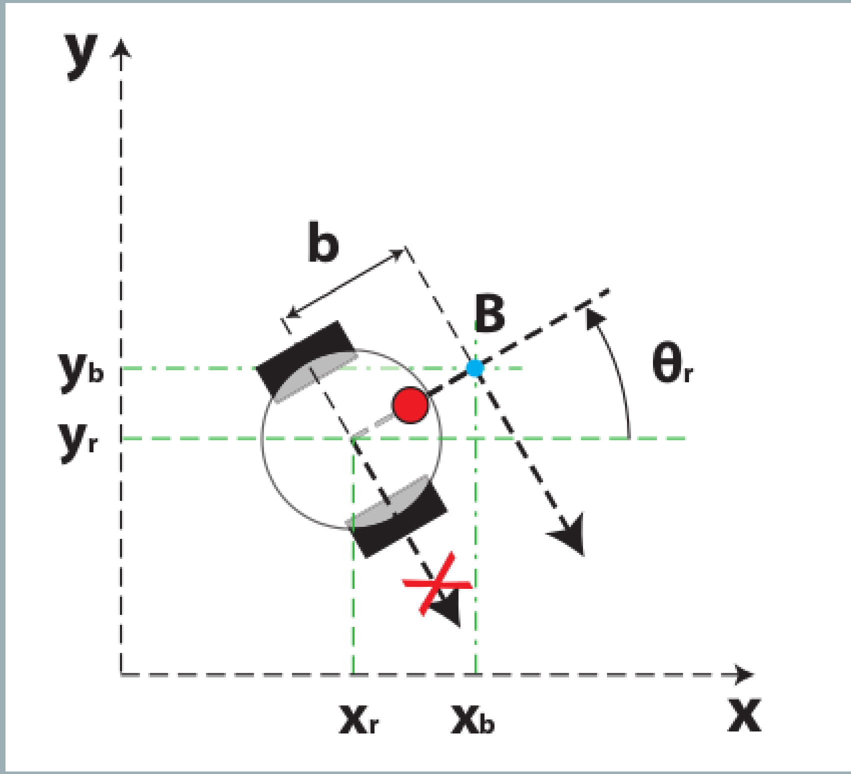

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LET q* BE A POINT FROM THIS LIST

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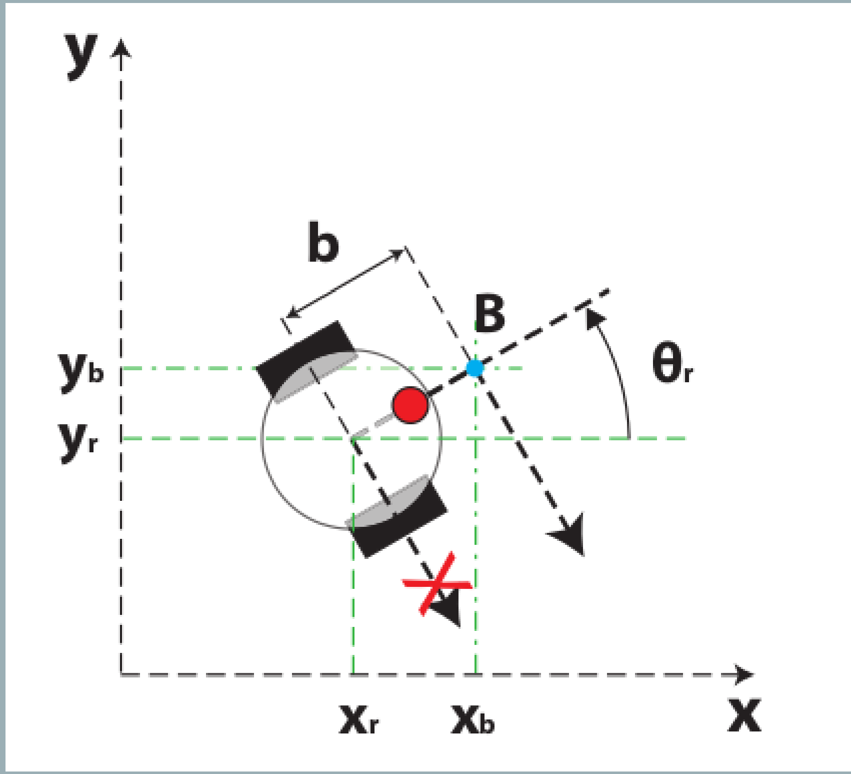

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LET q* = [x*, y*] BE A POINT FROM THIS LIST THAT ROBOT MUST GET TO

LET q = [xb, yb] BE CURRENT POSITION OF ROBOT POINT B

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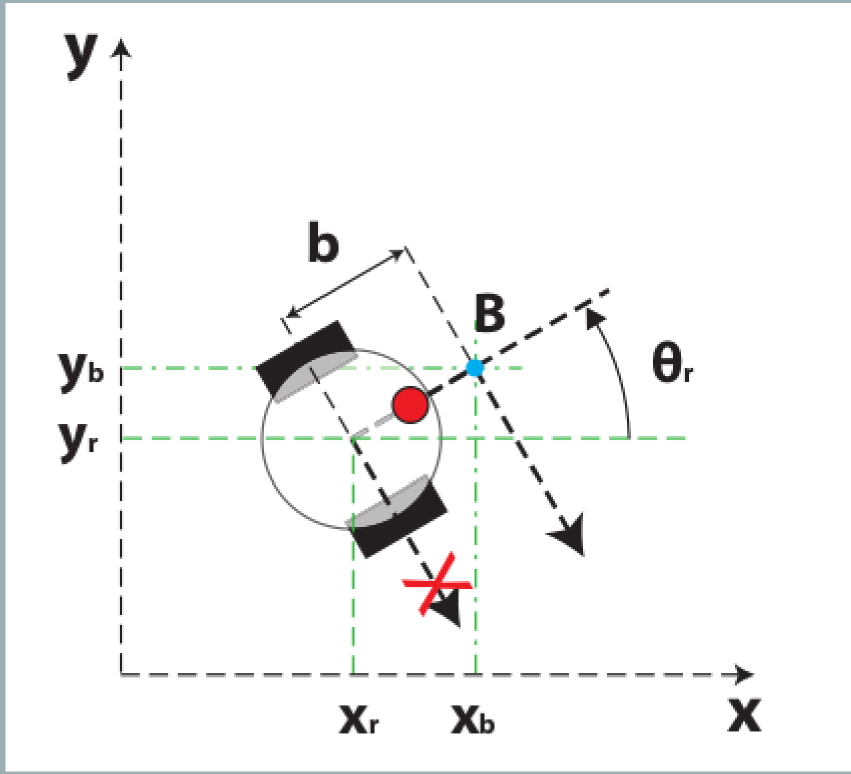

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USE POTENTIAL FIELD ALGORTHM TO GET REQUIRED vxb and vyb

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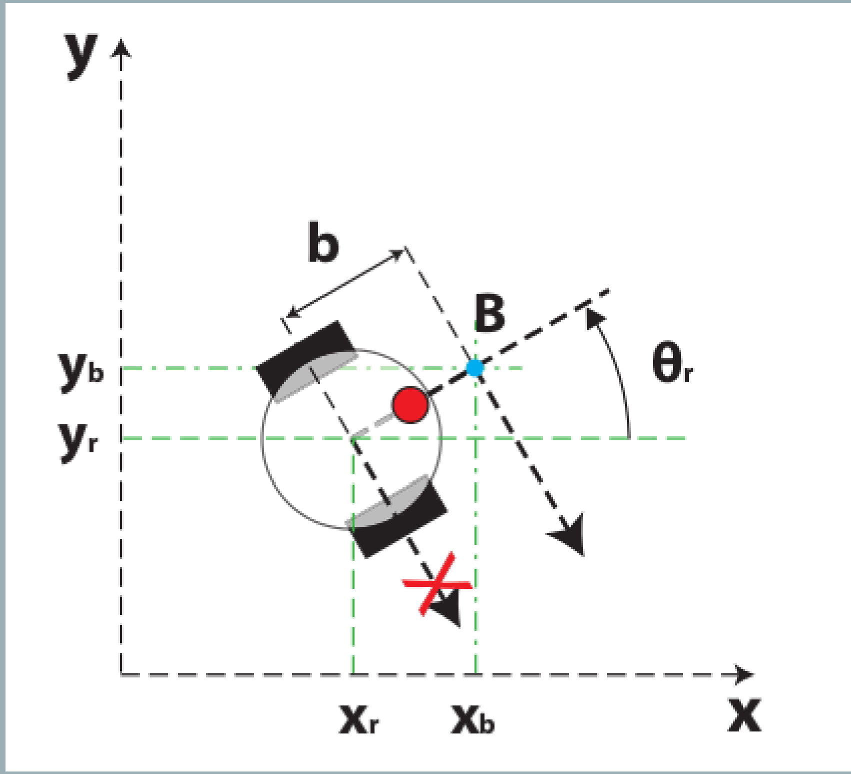

Attractive potential

$U_{att}(q)$

- It has the minimum in q_{goal}
- Its job is to attract the robot to the goal

Repulsive potential

$U_{rep} = \sum_{i=1}^{N_{obst}} U_{rep_i}(q)$

- Sum of the repulsive potentials for each obstacle
- It takes the robot away from obstacles

Control law

$$\dot{q}(t) = -\nabla U(q), \qquad \text{dove: } U(q) = U_{att}(q) + U_{rep}(q)$$

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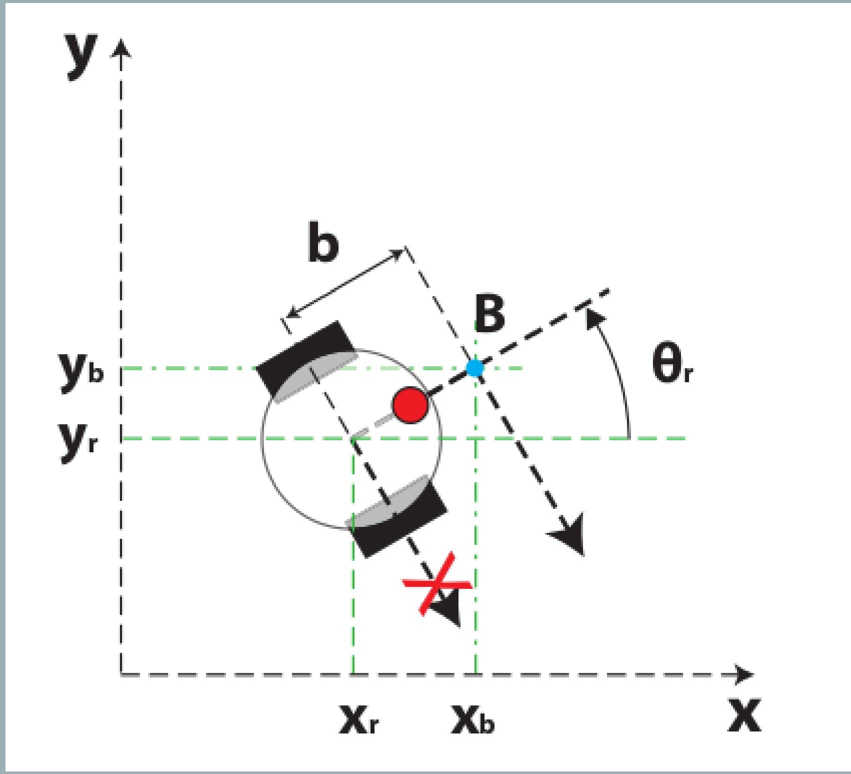


Possible choice

$$U_{att} = \frac{1}{2}K_a\Delta(q, q_{\text{goal}}) \qquad \nabla U_{att} = \frac{1}{2}K_a\nabla\Delta^2(q, q_{\text{goal}}) = K_a(q - q_{\text{goal}})$$

Possible choice

$$U_{rep_i}(q) = \begin{cases} \frac{1}{2}K_{r_i}\left(\frac{1}{d_i(q)} - \frac{1}{q^*}\right)^2 & d_i(q) \leq q^* \\ 0 & d_i(q) > q^* \end{cases}$$

$$\nabla U_{rep_i}(q) = \begin{cases} K_{r_i}\left(\frac{1}{q^*} - \frac{1}{d_i(q)}\right)^2 \nabla d_i(q) & d_i(q) \leq q^* \\ 0 & d_i(q) > q^* \end{cases}$$

OBSERVATIONS

Values set after experimentation:

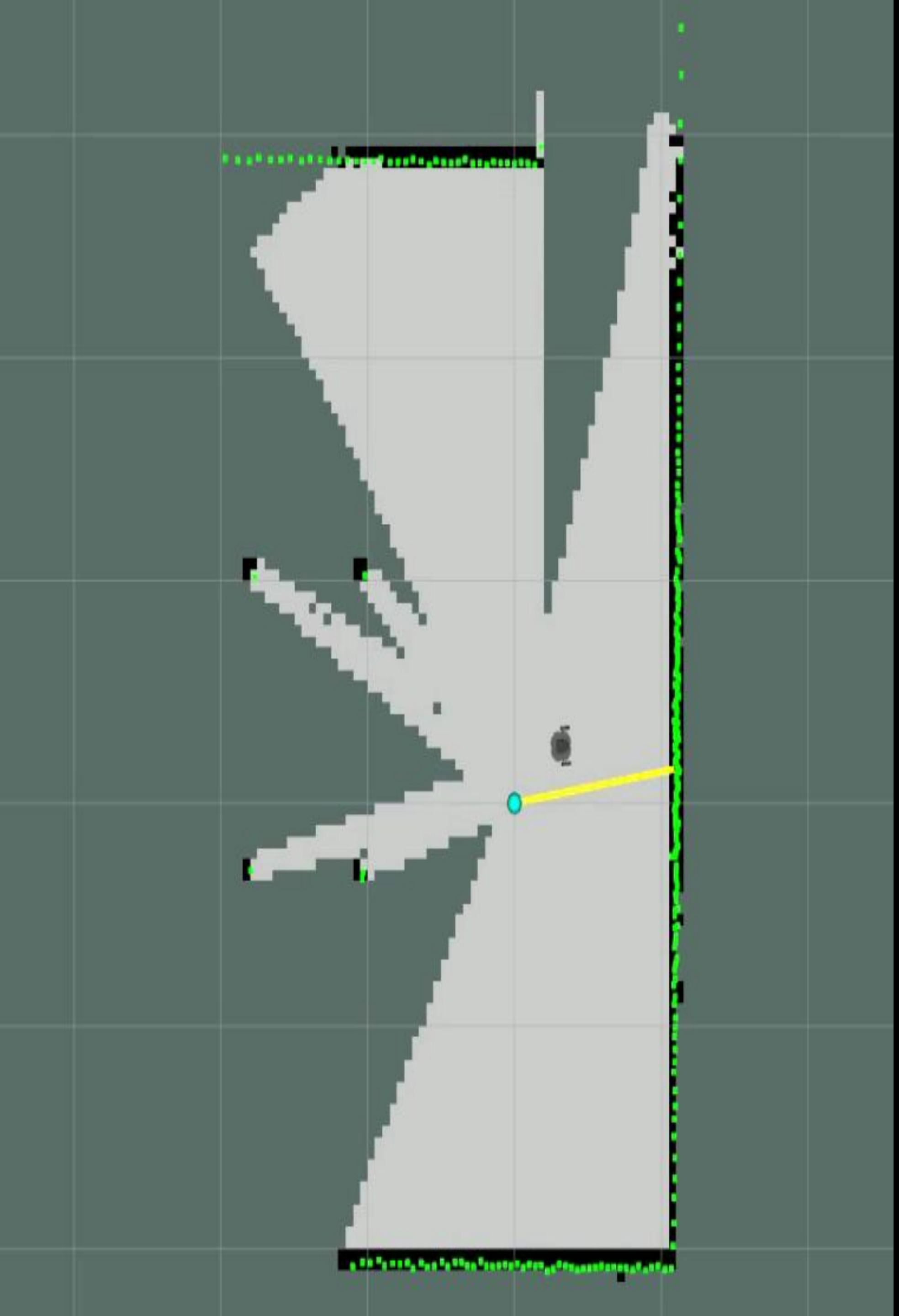
'b' = 0.1

'Ka' = 0.2

'Kr' = 0.05

'q*' = 0.5


CORNER CASES



MAPPING

- GET CLOSEST OBSTACLE IN FRONT OF TURTLEBOT AND GENERATE STRAIGHT PATH TOWARDS IT

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- WHAT IF YOU WISH TO BACKTRACK AND EXPLORE OTHER AREAS OF THE HOUSE?

EXPERIMENTS

- ROBOT SPAWNED IN EACH OF THE 6 ROOMS AND GIVEN 10 MINUTES TO EXPLORE AS MUCH OF THE HOUSE AS POSSIBLE
- ROBOT FULLY EXPLORES 4 ROOMS IN BEST ATTEMPT AND 2 ROOMS IN WORST ATTEMPT

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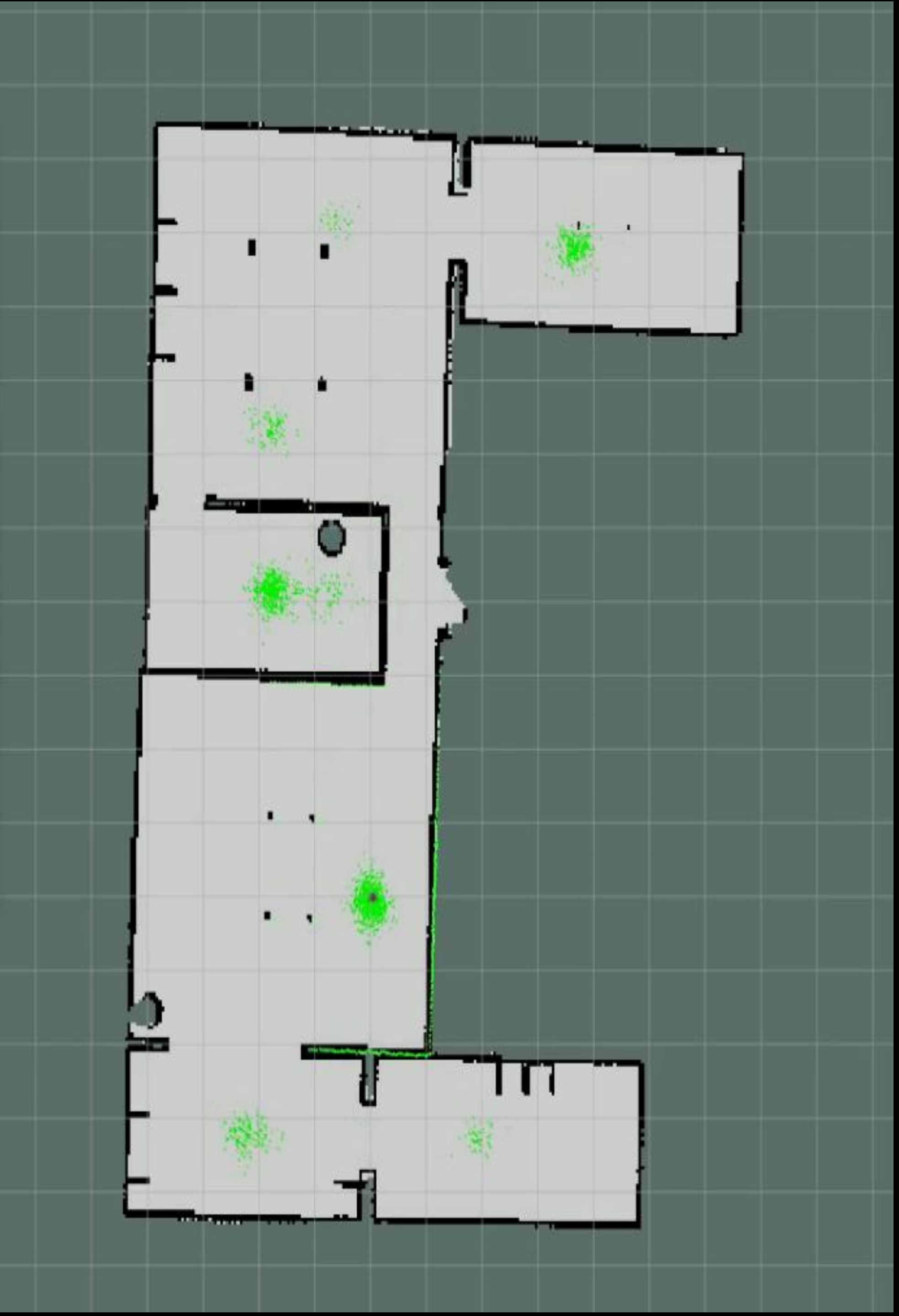
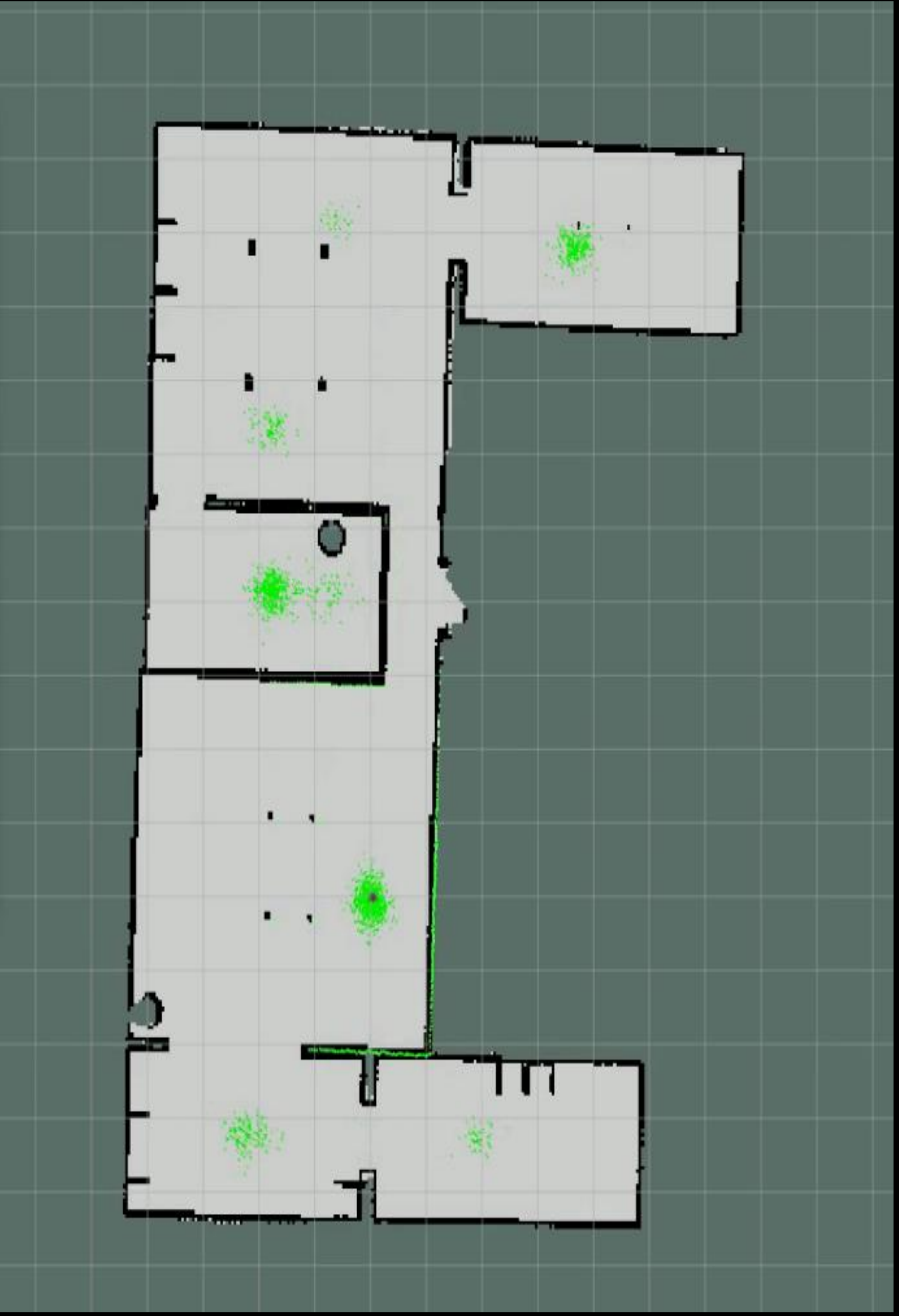
- IN CASE OF FAILURE, ALGORITHM CAN REPEAT FOR A TOTAL OF 10 TIMES BEFORE GIVING UP COMPLETELY



LOCALIZATION (DONE BEFORE NAVIGATION)

- AMCL PARTICLES EVENLY SPREAD ALL OVER THE MAP IN BEGINNING



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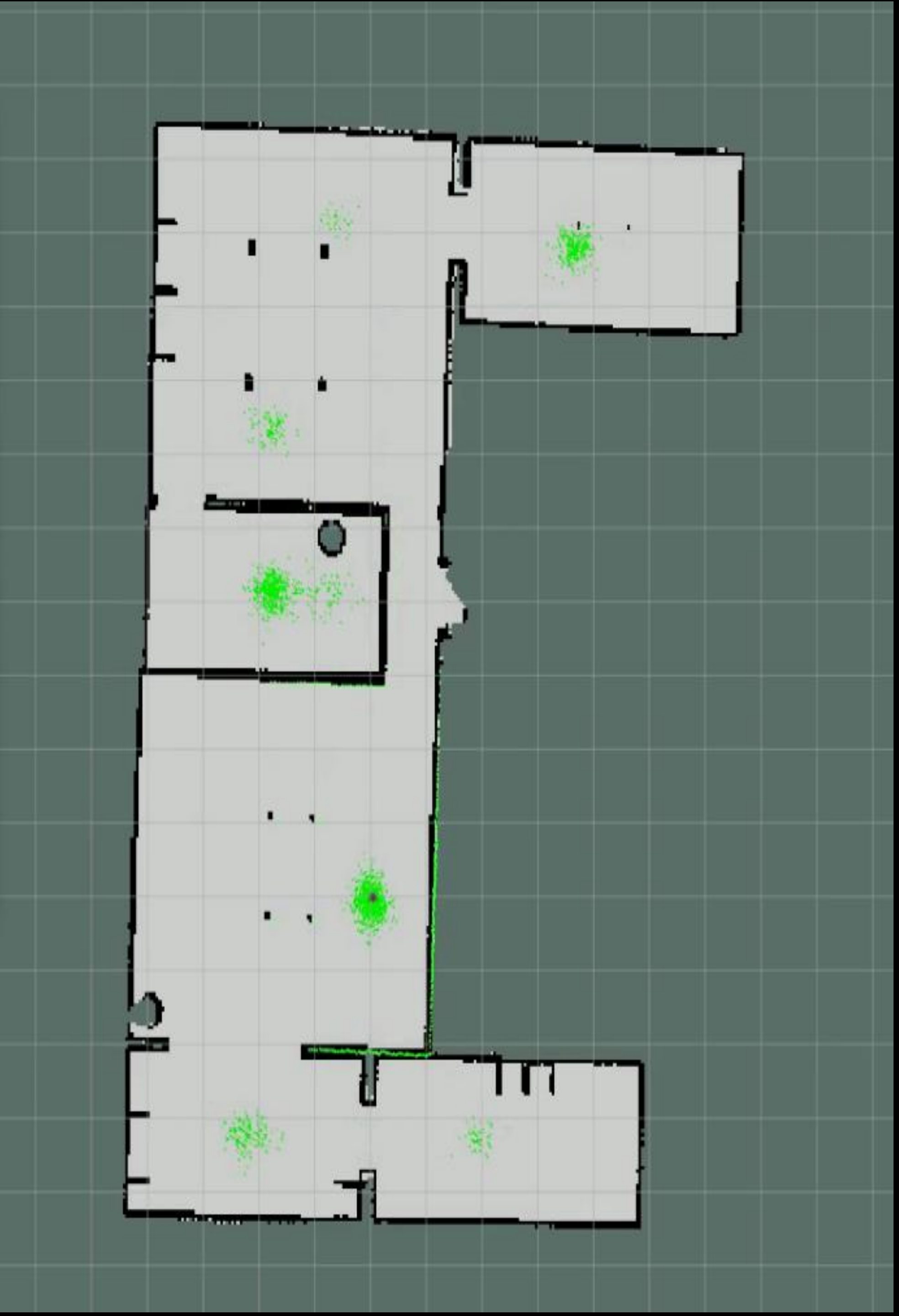

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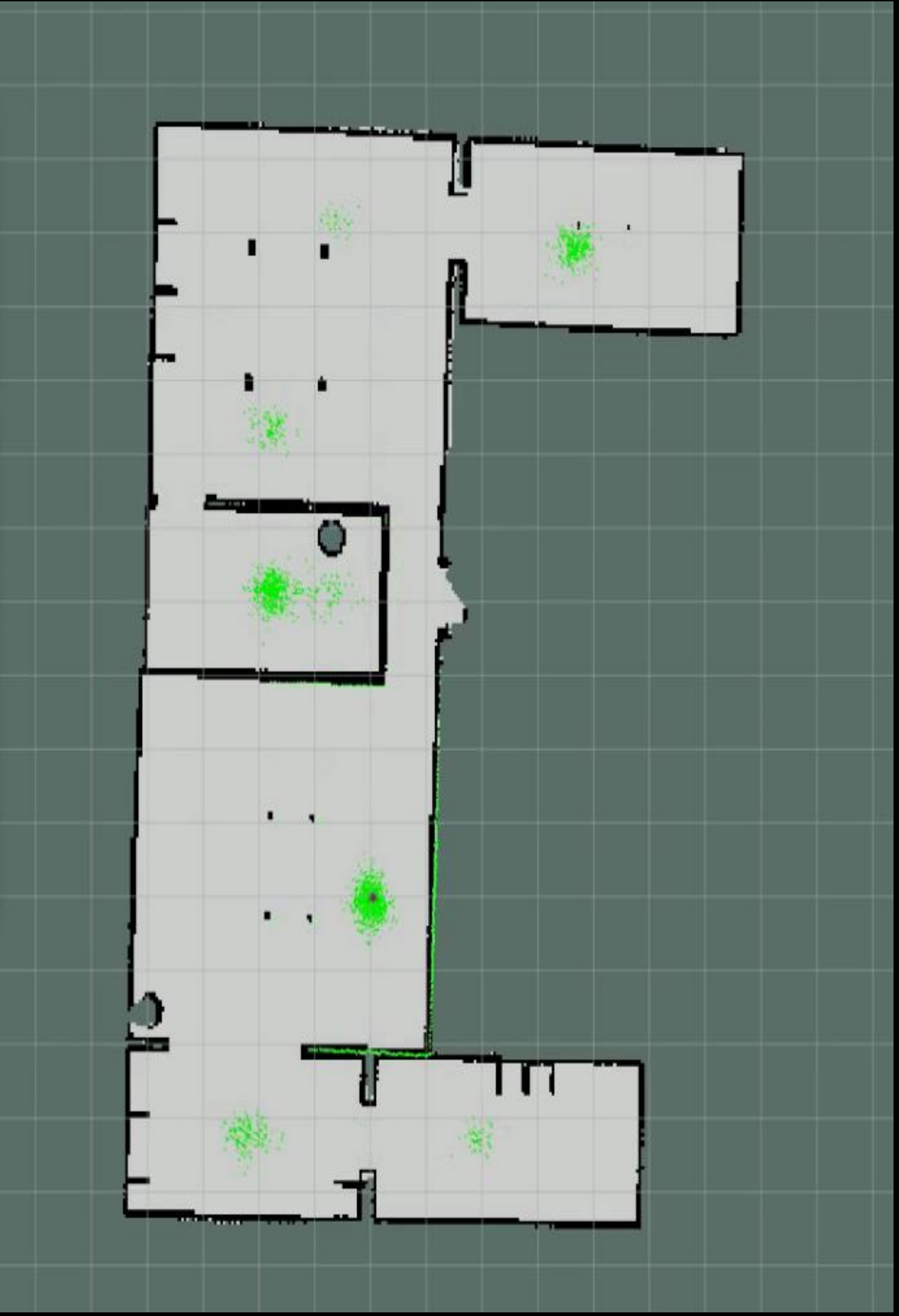

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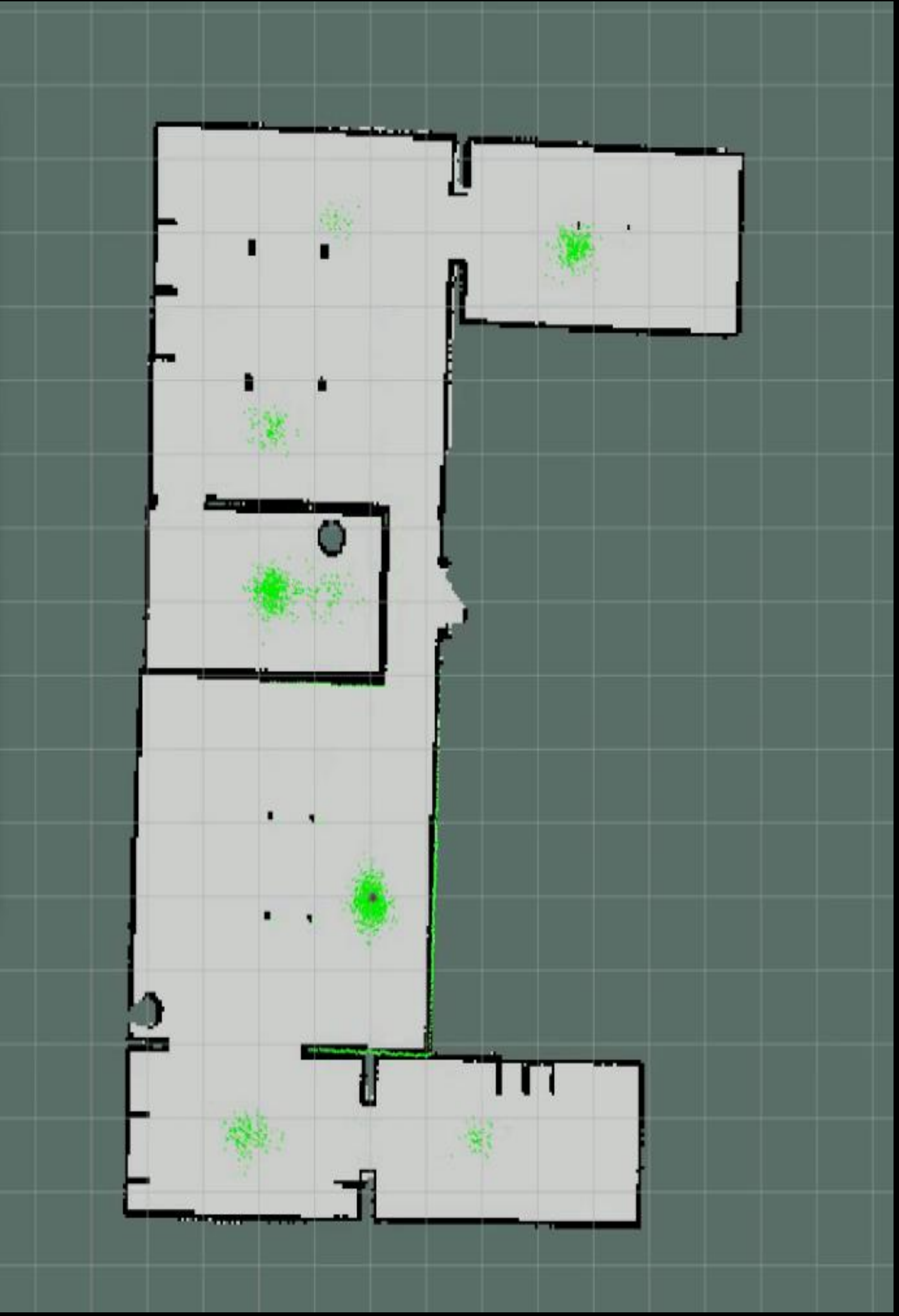

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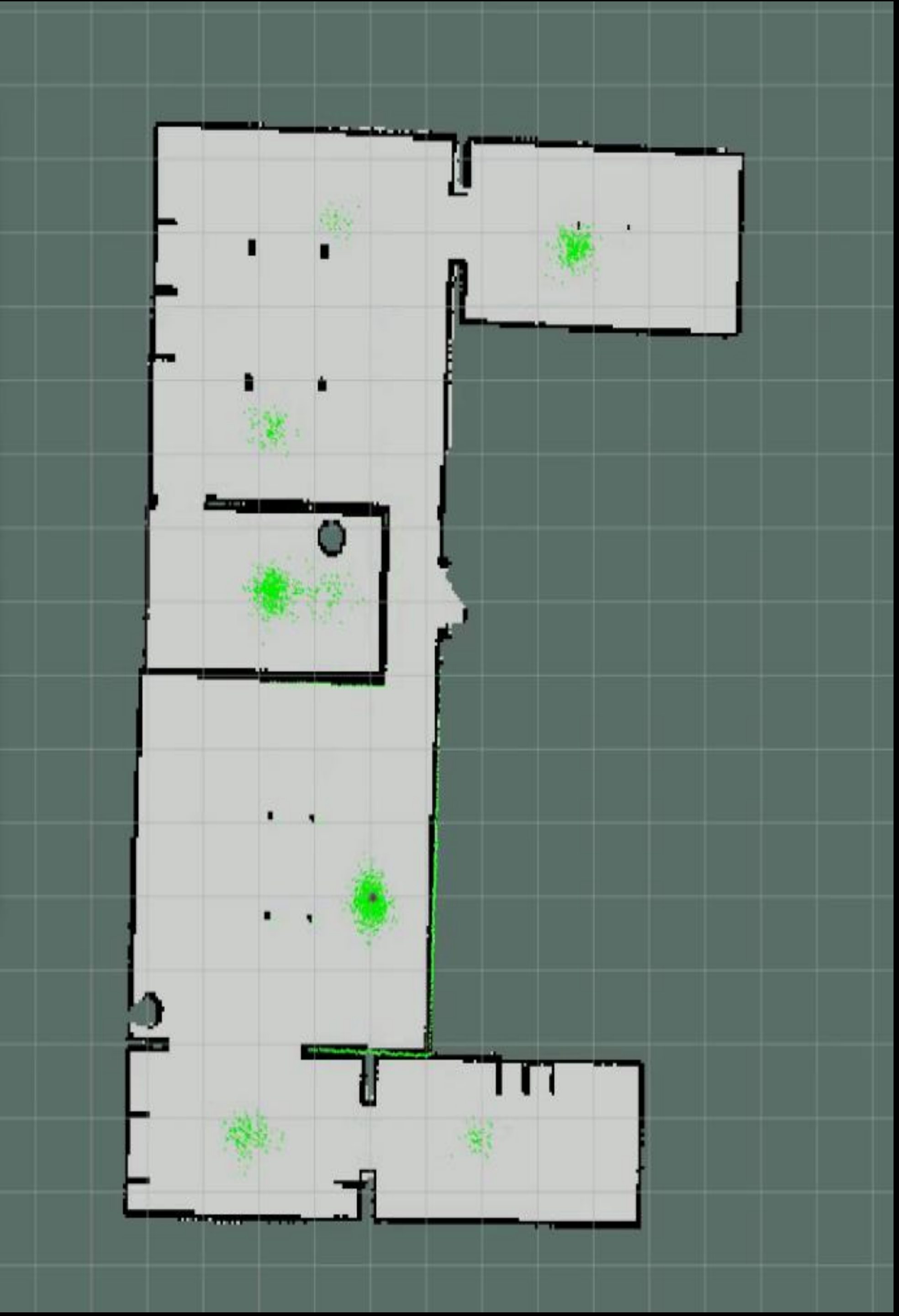

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- LOTS OF PARTICLES GATHER AROUND THE LIKELY TRUE POSITION OF THE ROBOT
- ALGORITHM GIVES EXACT LOCATION OF ROBOT IN MAP 99% OF THE TIMES