Assignment1 – Amit Cohen 322330010

Question1 (Some definitions relies on Wikipedia)

• Euler Angels & Quaternions - Euler angles are a way of specifying the angular relation between two coordinate systems. They describe the orientation of a rigid body with respect to a fixed coordinate system. They are often presented as (x, y, z, roll, pitch, yaw) which defines the location (x, y, z) and the rotation around each axis (roll, pitch, yaw).

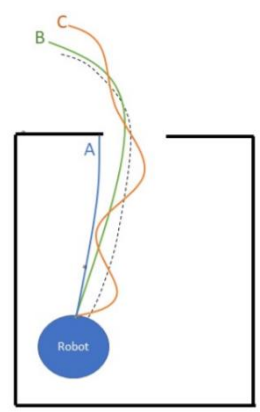
A quaternion is a 3d vector combined with an angle, according to Euler's rotation theorem, any sequence of rotations around several axes is equivalent to a single rotation by a given angle about a fixed axis. So, a quaternion is a 4d vector (w, x, y, z), where w is the rotation and (x, y, z) are the axes.

• Sensor Fusion - Combining information from multiple readouts into a single percept. For example, combining results from the camera and the laser scanner to detect certain objects.

• Deliberative Paradigm – A robotic paradigm which relies heavily on planning. The robot senses the world, plans the next action, and only then acts. At each step the robot explicitly plans the next move. All the sensing data tends to be gathered into one global world model.

• Reactive Paradigm – A robotic paradigm which is Sense – Act based. The robot has multiple instances of Sense-Act couplings. These couplings run concurrently and independently one from another.

Question2



Values for each line: A – 0.9m, B - 0.6m, C- 0.3m.

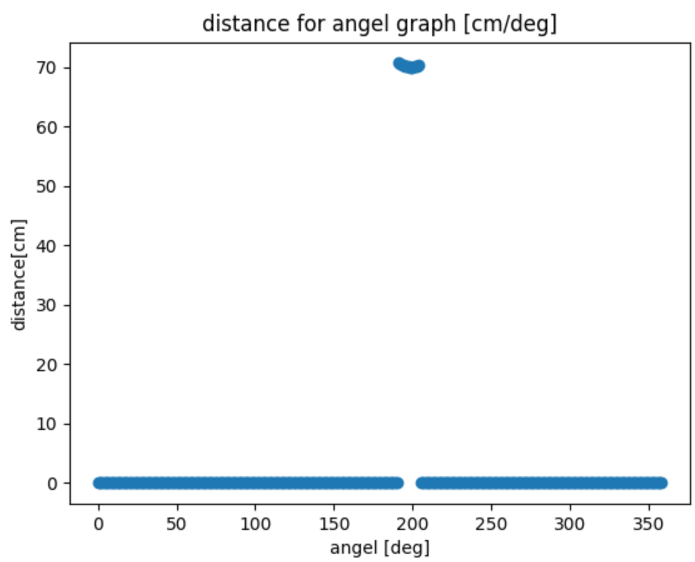
Explanation: Pure pursuit algorithm with larger lookahead distance tend to converge to the path more gradually and with less oscillation, while smaller values tend to oscillate more.

In the figure, we see that C oscillated the most, therefore he has the smallest value of 0.3m. A is indeed gradually converges to the path, However, it gets stuck in the wall because he sees the end goal from too far away, therefore I concluded A is 0.9m. And B is exactly in between, it is not small enough to oscillate too much, and not to large enough to get stuck in the wall, So B is 0.6m.

Question3

I will use python to make all necessary graphs and calculations.

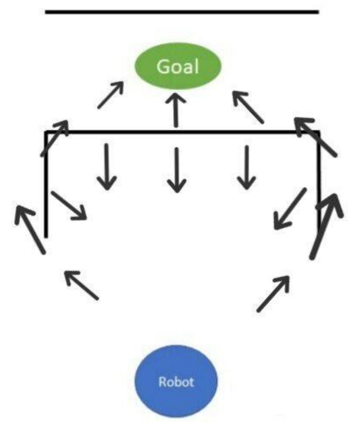
- First, I made a mean vector of all samples. The output graph:



- To calculate w, I used the cosine sentence. I have the first/last angles from which values are getting/stopping to be significant (around 190/200 as the graph indicates) alongside the actual distances. So, w could be extracted in the resulted triangle using the cosine sentence. $w^2 = len1^2 + len2^2 - 2 * len1 * len2 * \cos(ang2 - ang1)$
  Using this formula, we get: $w = \ 17.18cm$
  D is simply the closest distance to the obstacle, which is $69.999 \approx 70cm$.
  Theta is the number of samples until D is obtained times the angel distance (1 degree), All in all it comes out to 199 angles. To summarize: $w = 17.18cm \ \ D = 70cm \ \theta = 199°$
- To find P, I will calculate $\left(Dcos(\theta), Dsin(\theta)\right) = (-66.186, -22.79)$
- To calculate $x^w \ and \ y^w$ I will use the following formulas:
  $x^w = x_0 + x' * \cos(\Psi) - y' \sin(\Psi) \quad and \quad y^w = y_0 + x' * \sin(\Psi) + y' * \cos(\Psi)$
  So, we get: $x^w = -15.92 \quad and \quad y^w = -12.82$

<u>Question4</u>

I will describe two problems that can occur and an appropriate solution.



The first problem is that the Robot could get stuck at a local minimum. Say, at some point in this field, the repulsive forces from the robot and the attractive force from the goal adds up to zero, the robot will stop its movement. An appropriate solution would be adding a potential field that comprises random values.

The second problem is, according to our definition of the potential field, when the robot is far away from the goal, the attraction force will be great. This attribute can cause the robot to collide with the obstacles (The wall in our case). The solution would be to modify the potential energy function to have a threshold value on the distance from the goal, upon crossing this threshold, our potential energy function would change.

A modified potential energy found online: (“Robotshop” community)

$$U_{att}(q) = \begin{cases} \frac{1}{2}\varepsilon \rho^2(q, q_{goal}) & \rho(q, q_{goal}) \le d^*_{goal} \\ d^*_{goal}\varepsilon \rho(q, q_{goal}) - \frac{1}{2}\varepsilon (d^*_{goal})^2 & \rho(q, q_{goal}) > d^*_{goal} \end{cases}$$