Question 1 - Particle Filter Tracking

State Vector-

The state vector in the code is represented by the particles array. It is a 4-dimensional vector that contains the state information of each particle in the particle filter.
The state vector has the following components:

1. X-position: np.random.random_integers(0, imgW-1, numParticles) generates a random integer between 0 and imgW-1 (inclusive) for each particle, representing the X-coordinate of its position on the image plane.
2. Y-position: np.random.random_integers(0, imgH-1, numParticles) generates a random integer between 0 and imgH-1 (inclusive) for each particle, representing the Y-coordinate of its position on the image plane.
3. X-velocity: 3 * np.random.randn(numParticles) + 3 generates a random value from a normal distribution with mean 3 and standard deviation 3 for each particle. It represents the velocity component of the particle in the X-direction.
4. Y-velocity: 3 * np.random.randn(numParticles) generates a random value from a normal distribution with mean 0 and standard deviation 3 for each particle. It represents the velocity component of the particle in the Y-direction.

By combining these four components, the state vector captures the essential information about the position and velocity of each particle. It provides a representation of the particles' current state, which is necessary for the tracking algorithm's prediction and update steps.

Prediction noise-

Prediction Noise Assignment:
In the code, prediction noise is assigned for the position and velocity components using two different Gaussian distributions.
Position Prediction Noise:

1. The position prediction noise is defined by the variable posNoise. It represents the uncertainty in the predicted position of the particles after the state update step. The gaussian2D function is used to generate a 2D Gaussian noise vector with a mean of 0 and a standard deviation of posNoise. This noise is added to the predicted position components (x and y) of each particle in the state vector.

Velocity Prediction Noise:

2. The velocity prediction noise is defined by the variable velNoise. It represents the uncertainty in the predicted velocity of the particles after the state update step. The gaussian1D function is used to generate a 1D Gaussian noise vector with a mean of 0 and a standard deviation of velNoise. This noise is added to the predicted velocity components (x-velocity and y-velocity) of each particle in the state vector.

Question 2: NCC template matching

Comments :

The first, second, and fifth closest matches have displayed very identical patterns. The search image also contains a similar match for the object shown in the template. The object in the right has been slightly cropped in the final image from the 100th match, but the elephant is still fully in focus. The 500th match revealed somewhat varied results and patterns, but all results' colors and textures stayed the same. The top-most object has been clipped in the final image. The top level matched templates have a higher level of similarity to the template than lower-ranked templates, according to all the results. The first four results appear satisfactory and demonstrate the effectiveness of the used matching strategy. Even if it's the 500th match, the most recent results show that the matching algorithms still need work.

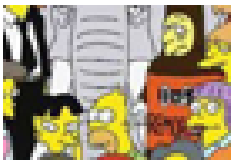
1st match

2nd Match

5th Match

10th Match

100th Match



500th Match