# Question #4

## Implementing Linearized Kalman Filter (LKF)

To implement the LKF for this Cooperative Localization problem we define an LKF function which performs the prediction [Equation ( 1 )] and correction [Equation ( 2 )] step.

The function takes in the ground truth values (state dynamics and measurements), the nominal state and measurement trajectories without process or measurement noise, the process noise covariance () for tuning, and initial values for and . The function outputs the state estimates (), measurement estimates and estimation errors ( and ).

|  |  |  |
| --- | --- | --- |
|  |  | ( 1 ) |

|  |  |  |
| --- | --- | --- |
|  |  | ( 2 ) |

This function is included in a Monte Carlo run which feeds the ground truth models, nominal state and measurement trajectories, and the DT state space matrices linearized around the nominal trajectories () according to the methods from Question #2 and Question #3.

The truth model is a simulated run of the nonlinear model with the process and measurement noise generated using the covariances uploaded on Canvas.

## Truth Model Testing (TMT) for LKF

For the TMT we do 50 Monte Carlo () runs. This is an appropriate number of Monte Carlo runs as we will have enough data sets for performing an unbiased NEES and NIS test.

Additionally, for the multiple runs in the TMT we feed the LKF the following initial values:

|  |  |  |
| --- | --- | --- |
|  |  | ( 3 ) |

These initial conditions were selected for the following reasons: the initial perturbation is small enough such that the state’s evolution does not veer off from the nominal trajectories; furthermore, we have a sufficient degree of certainty of our initial state perturbation such that the state perturbation covariance is finite ().

We set these initial conditions as constants for every Monte Carlo run so that the NEES and NIS chi-square tests are not adversely affected. One problem that might arise due to this is that we might inadvertently tune our LKF for just this one condition and may fail for a different set of initial conditions.

In addition to this, in the LKF, the covariance matrix for the measurement noise () is set to be the one uploaded on canvas, i.e. Rtrue.

## Tuning

There are two aspects that we need to