# Question #1

## Continuous-time System Equations

The non-linear equations of motions of our UGV-UAV two-agent system are provided in the problem description as:

|  |  |  |
| --- | --- | --- |
|  |  | ( 1 ) |
|  |  | ( 2 ) |
|  |  | ( 3 ) |
|  |  | ( 4 ) |
|  |  | ( 5 ) |
|  |  | ( 6 ) |

The inputs to our system are the UGV linear velocity (m/s), UGV steering angle (rad), UAV linear velocity (m/s) and UAV angular rate (rad/s). Our state vector is comprised of the easting position (m), northing position (m) and heading angle (rad) for both the UGV and UAV; each state equation is assumed to be corrupted by AWGN. For measurements we are provide the UAV easting and northing position along with the UGV-UAV relative azimuth angles and range; the output sensing equations are then:

|  |  |  |
| --- | --- | --- |
|  |  | ( 7 ) |
|  |  | ( 8 ) |
|  |  | ( 9 ) |
|  |  | ( 10 ) |
|  |  | ( 11 ) |

Our system can be expressed in standard non-linear state-space form by stacking the NL state equations and measurements from above in to and *h* matrices:

|  |  |  |
| --- | --- | --- |
|  |  | ( 12 ) |
|  |  | ( 13 ) |

To find the linear CT perturbation model of our system we linearize about the nominal operation point provided in the problem description and find the partial derivatives / Jacobians (see Appendix A for supporting derivations):

|  |  |
| --- | --- |
|  | ( 14 ) |
|  | ( 15 ) |
| = | ( 16 ) |
|  | ( 17 ) |

The resulting CT linear matrices F, G and H are , and , where equals the number of states (6), equals the number of inputs (4) and equals the number of measurements (5).