VisNav Exercise 02: Solution

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Exercise 1: Manual Flight
Exercise 2: EKF
Exercise 2: EKF

No Correction, small prediction noise

No Correction, large prediction noise
Exercise 2: EKF

Measurement Function:

\[
h\left( x = \begin{pmatrix} x_d \\ y_d \\ \Psi_d \end{pmatrix} \right) = \begin{pmatrix} \cos \Psi_d(x_m - x_d) + \sin \Psi_d(y_m - y_d) \\ -\sin \Psi_d(x_m - x_d) + \cos \Psi_d(y_m - y_d) \\ \Psi_m - \Psi_d \end{pmatrix}
\]

Drone's state

Marker Position

Measurement Function Jacobian:

\[
H = \frac{dh}{dx} = \begin{pmatrix} -\cos \Psi_d & -\sin \Psi_d & -\sin \Psi_d(x_m - x_d) + \cos \Psi_d(y_m - y_d) \\ \sin \Psi_d & -\cos \Psi_d & -\cos \Psi_d(x_m - x_d) - \sin \Psi_d(y_m - y_d) \\ 0 & 0 & -1 \end{pmatrix}
\]
void ExtendedKalmanFilter::correctionStep(const Eigen::Vector3f& measurement, const Eigen::Vector3f& global_marker_pose)
{
    printf("ekf: %f %f %f; obs: %f %f %f\n",
           state[0], state[1], state[2],
           measurement[0], measurement[1], measurement[2]);

    // compute expected measurement:
    Vector3f z_exp; // z_exp = h(x)
    float psi = state(2);
    z_exp(0) = cos(psi)*(global_marker_pose(0) - state(0)) + sin(psi)*(global_marker_pose(1) - state(1));
    z_exp(1) = -sin(psi)*(global_marker_pose(0) - state(0)) + cos(psi)*(global_marker_pose(1) - state(1));
    z_exp(2) = global_marker_pose(2) - psi;

    Vector3f err = measurement - z_exp;

    // normalize angle: diff has to be between -180 and 180 degree.

    // dh/dx
    Matrix3f H;
    H << cos(psi), -sin(psi), sin(psi)*(state(0) - global_marker_pose(0)) - cos(psi)*(state(1) - global_marker_pose(1)),
         sin(psi), cos(psi), cos(psi)*(state(0) - global_marker_pose(0)) + sin(psi)*(state(1) - global_marker_pose(1)),
         0, 0, -1;

    Matrix3f K = sigma * H.transpose() * ((H * sigma * H.transpose() + R).inverse()); // Kalman Gain

    // correct pose estimate
    state = (state + K*err);
    sigma = (Matrix3f::Identity() - K*H)*sigma;
Exercise 2: EKF

With Correction, small prediction noise

With Correction, large prediction noise
Exercise 2: EKF

With Correction, small prediction noise

With Correction, large prediction noise
Exercise 2: EKF

No Correction

With Correction

Final x-Drift: 1.8m
Final y-Drift: 0.8m