Motivation

- Popularity of rotary-wing unmanned vehicle is increasing, because of simple mechanical structure, small size, low manufacturing price, vast ability,
- Controlling UAV in adverse weather problem is an open problem,
- To address this problem, we need to know the precise dynamic model of UAV (Identification).

Background

Attitude estimation has been studied in terms of:
- Euler angles (Suffering from singularities)
- Quaternions (Challenging to represent sensitivities)
- Special orthogonal group (Using constrains or projections to avoid deviation of numerical trajectories of rotation matrices from SO(3))

Numerical Examples

<table>
<thead>
<tr>
<th>Initial error $|\theta_0 - \hat{\theta}_{exact}|$</th>
<th>Estimation error $|\theta - \hat{\theta}_{exact}|$</th>
<th>Number of Iterations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.88</td>
<td>$3.8 \times 10^{-2}$</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 1: Simulation results for $\theta_{exact} = [1, 0.1, 0.2, 3, 0.3, 2]^T$.

Conclusion and Future Research

- Identification problem is formulated as a constrained optimization problem,
- Cost function is defined as the discrepancies between the reference and simulated trajectories, constraints are imposed to satisfy the properties of the unknown parameters,
- attitude is represented on SO(3),
- discrete attitude dynamics are represented by Lie group variational integrator to preserve attitude on SO(3),
- perturbation model is constructed directly on the tangent space of SO(3),
- discrete-time necessary optimality conditions are constructed as variation of the cost function considering the constraints,
- proposed method can be applied to estimate of any unknown parameter of the attitude dynamics of the rigid body, e.g. blade flapping angle, and drag coefficients.