

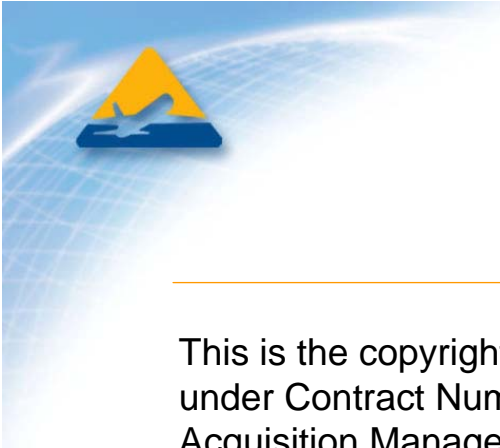


CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

Idealized Truth Data for System Modeling and Testing

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Case # 08-0708



Introduction

- **Existing truth data may contain hidden noise**
 - **Sensor measurement noise**
 - **Time stamp latency and jitter**
 - **Tracker artifacts such as lagging velocity**
 - **Linear velocity and discontinues acceleration from well defined scenarios**
- **Hidden noise may cause instantaneous spikes in velocity, acceleration, or higher order terms**
- **Forcing the higher order terms to be smooth and continuous produces a more natural track**
- **Allow the continuous time equations for the more natural track to represent truth with no errors**



Idealization Process

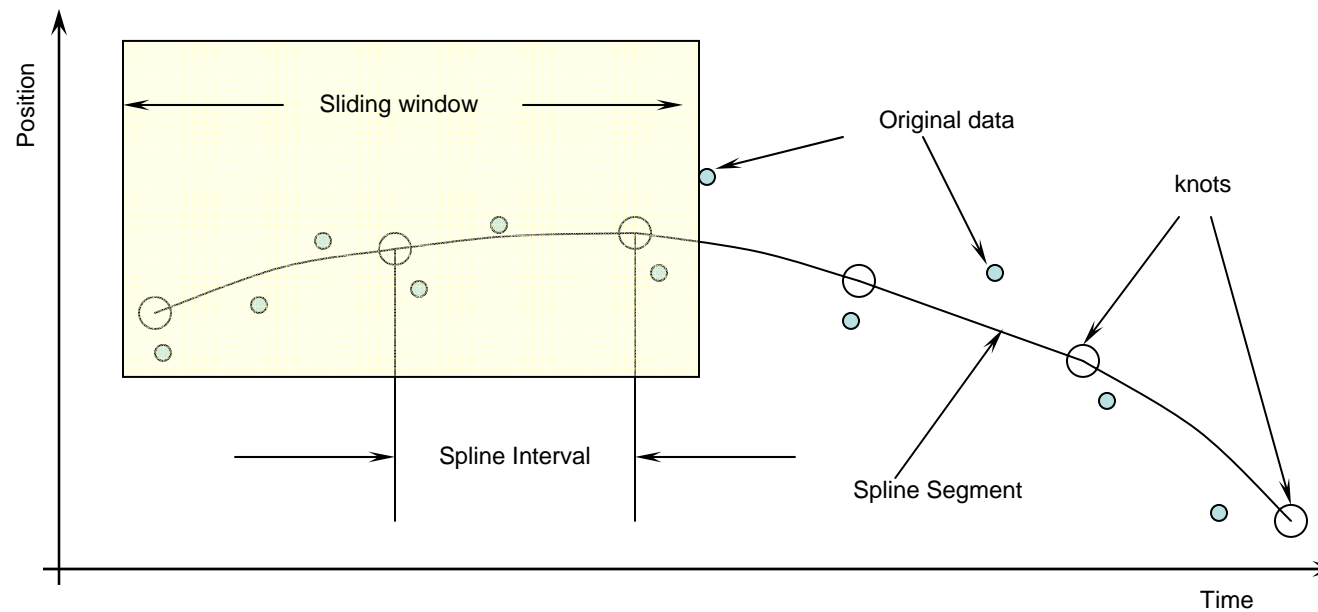
Smoothing Filter

- **Cubic spline**
 - **A piecewise third degree polynomial**
 - **Smooth and continuous position**
 - **Knots have matching derivatives (slope)**
 - **Smooth and continuous velocity**
 - **Knots have matching second derivatives (curvature)**
 - **Continuous acceleration**
- **Knots are derived using least squared polynomial interpolation**
 - **A curve of N degree is fit through all reports that fall inside the sliding window**
 - **This curve is solved at each spline interval**
- **Spline is created from the uniform knot positions**



Idealization Process Tuning Parameters

- Update interval
- Spline interval
- Sliding window
- Least squares degree





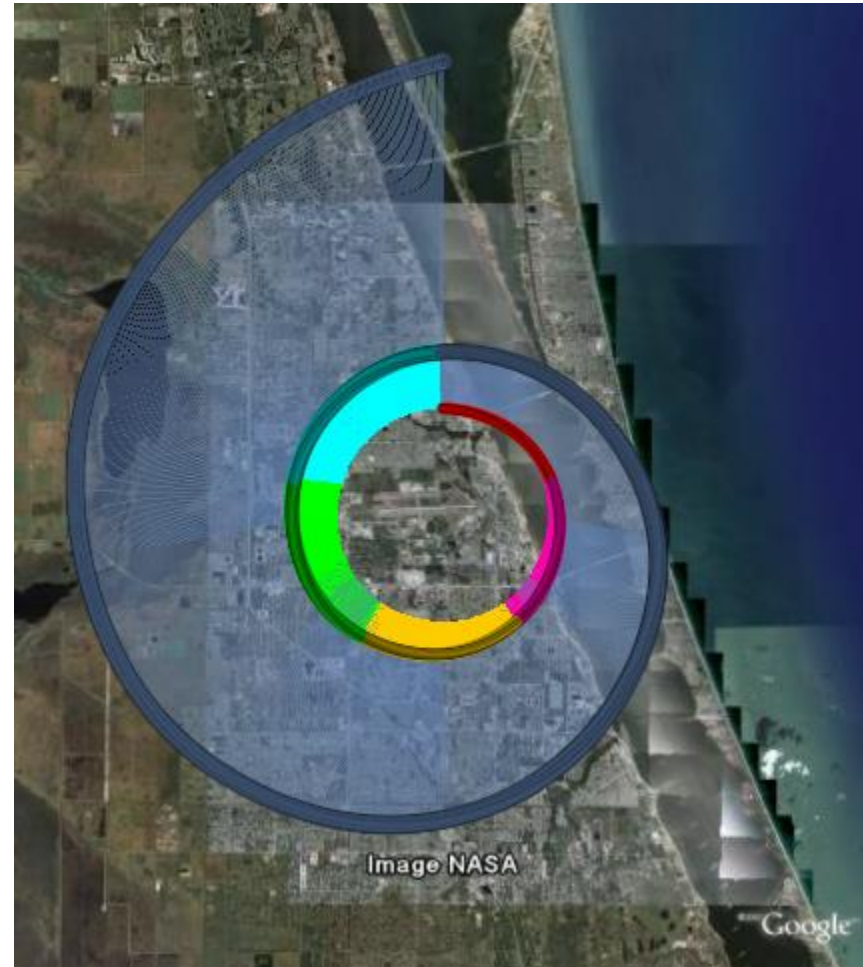
Idealization Process Algorithm

- **Smooth raw data**
- **Obtain Initial conditions (ICs)**
- **Quadratic velocity spline from the derivative of position**
- **Oversample velocity**
- **Smooth velocity**
- **Integrate for position using ICs**
- **Oversample position**
- **Smooth position**

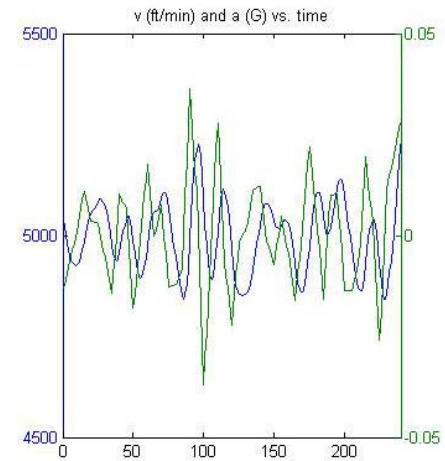
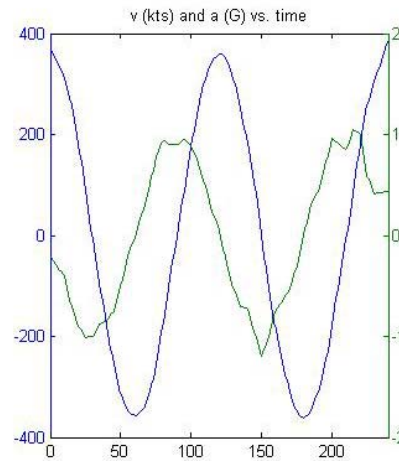
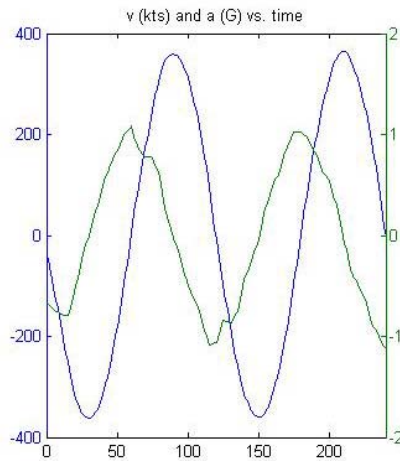
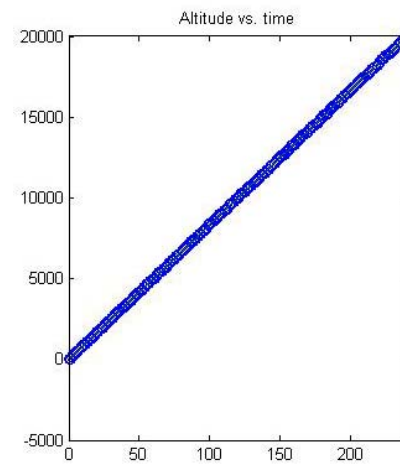
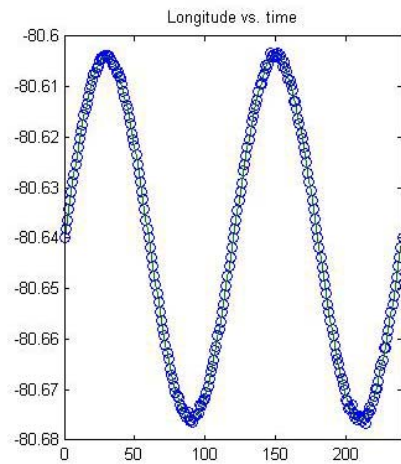
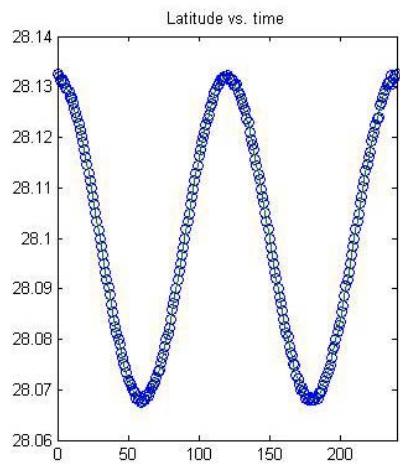


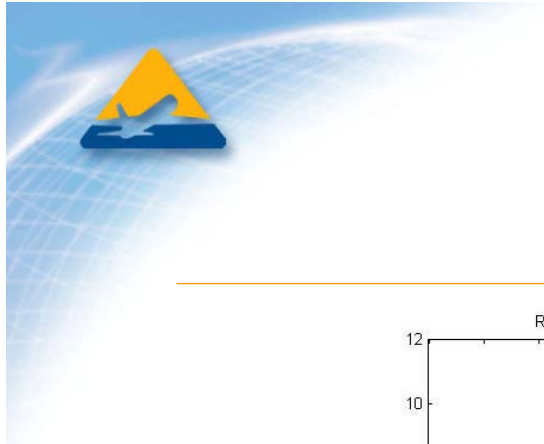
Case Study

- **Circular flight at constant climb rate**
 - Continually changing acceleration
 - Decomposition of circle in two dimensions are sinusoids
- **Simulated sensor measurement error**
 - 100 feet in range
 - 1 ACP in azimuth
 - 25 feet in altitude
- **Idealized tuning parameters**
 - 5 second spline interval
 - +/-20 second sliding window

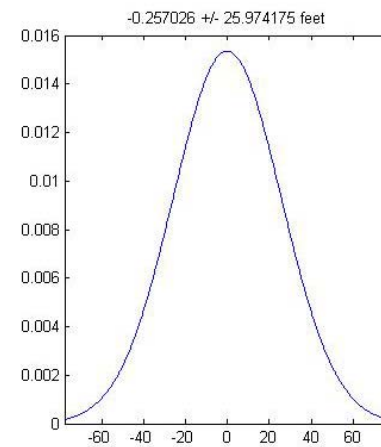
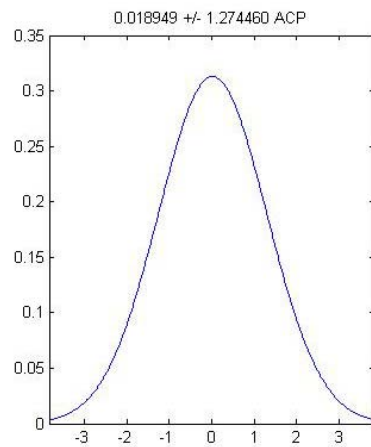
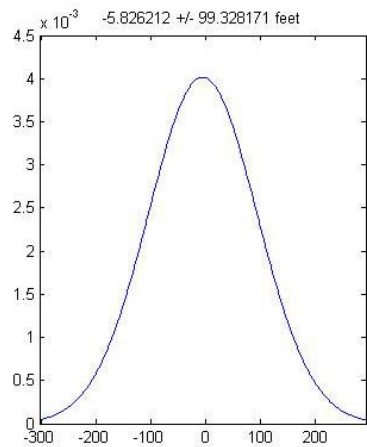
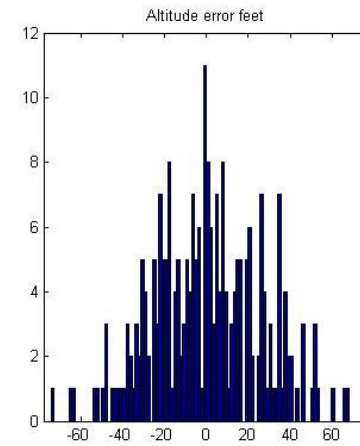
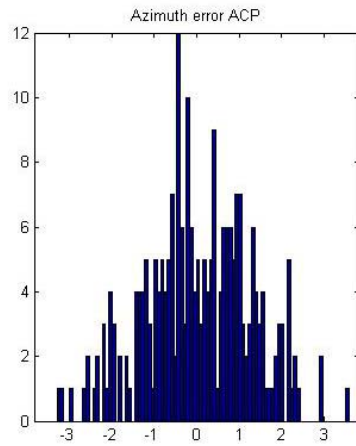
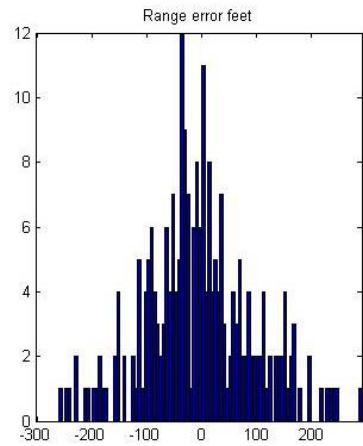


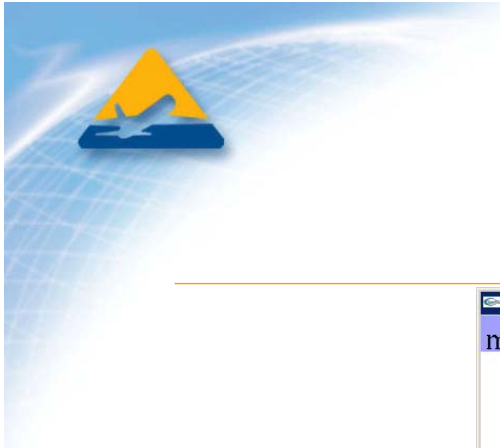
Case Study



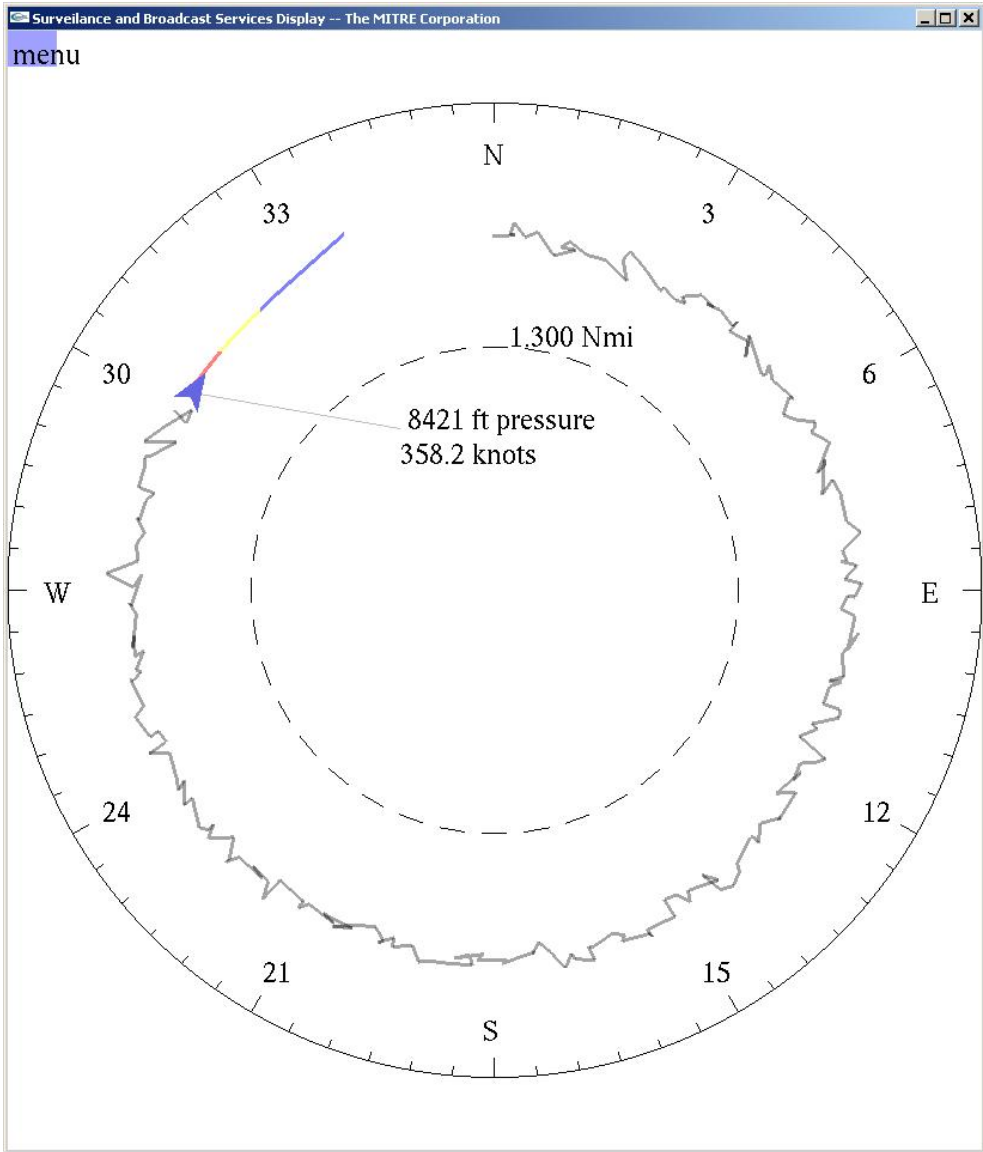


Case Study Error Analysis



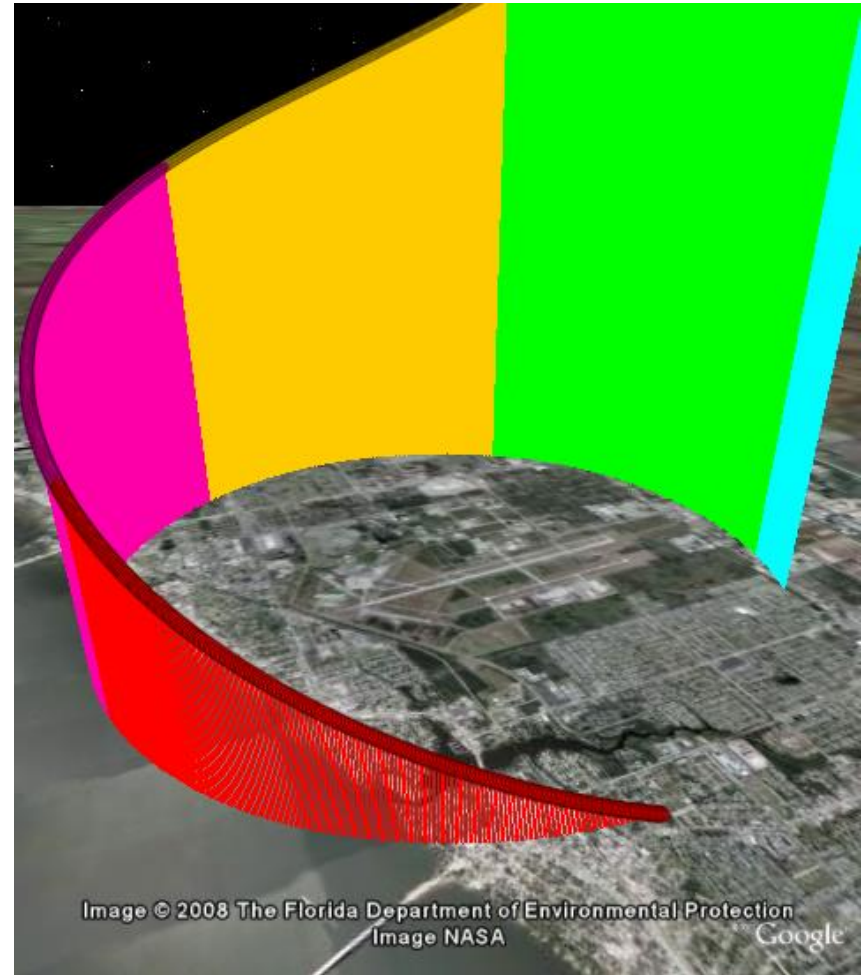
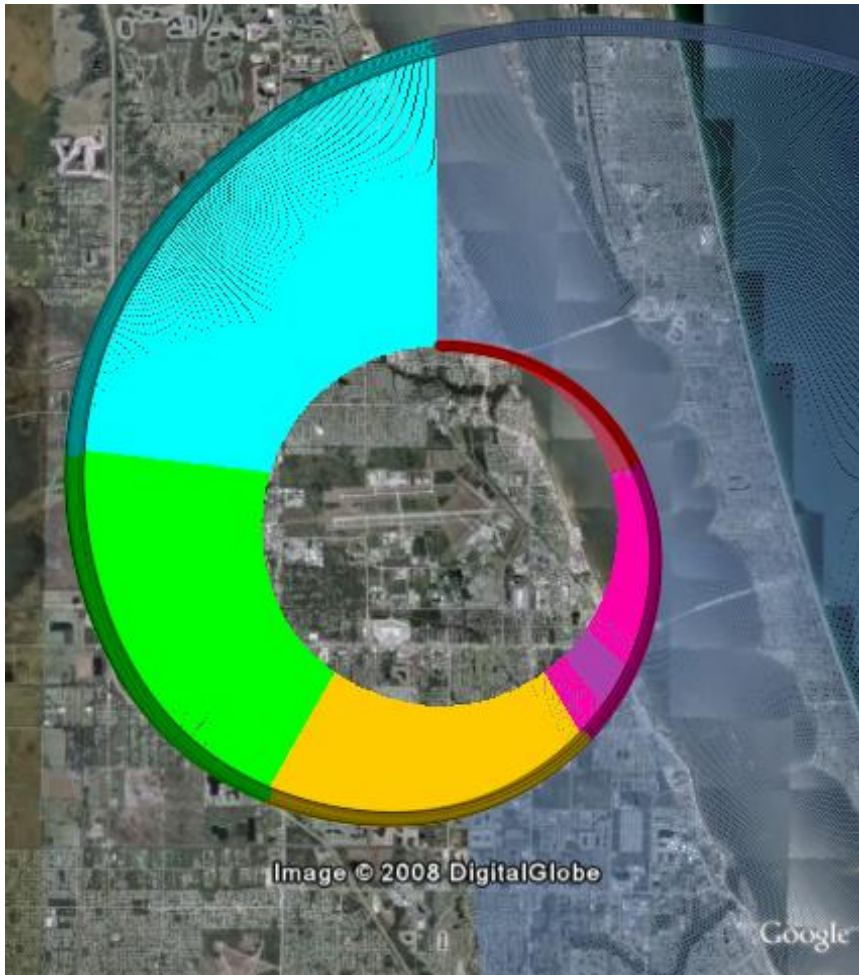


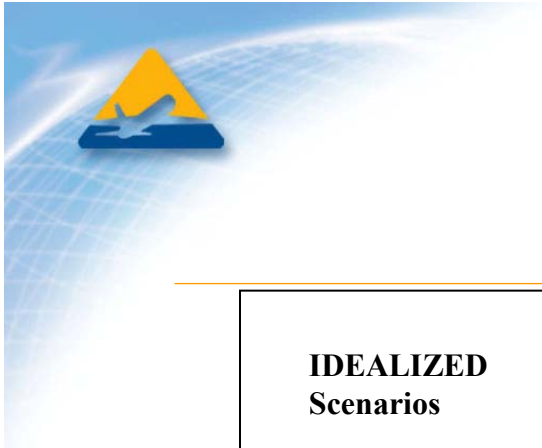
Applications Real-time Playback





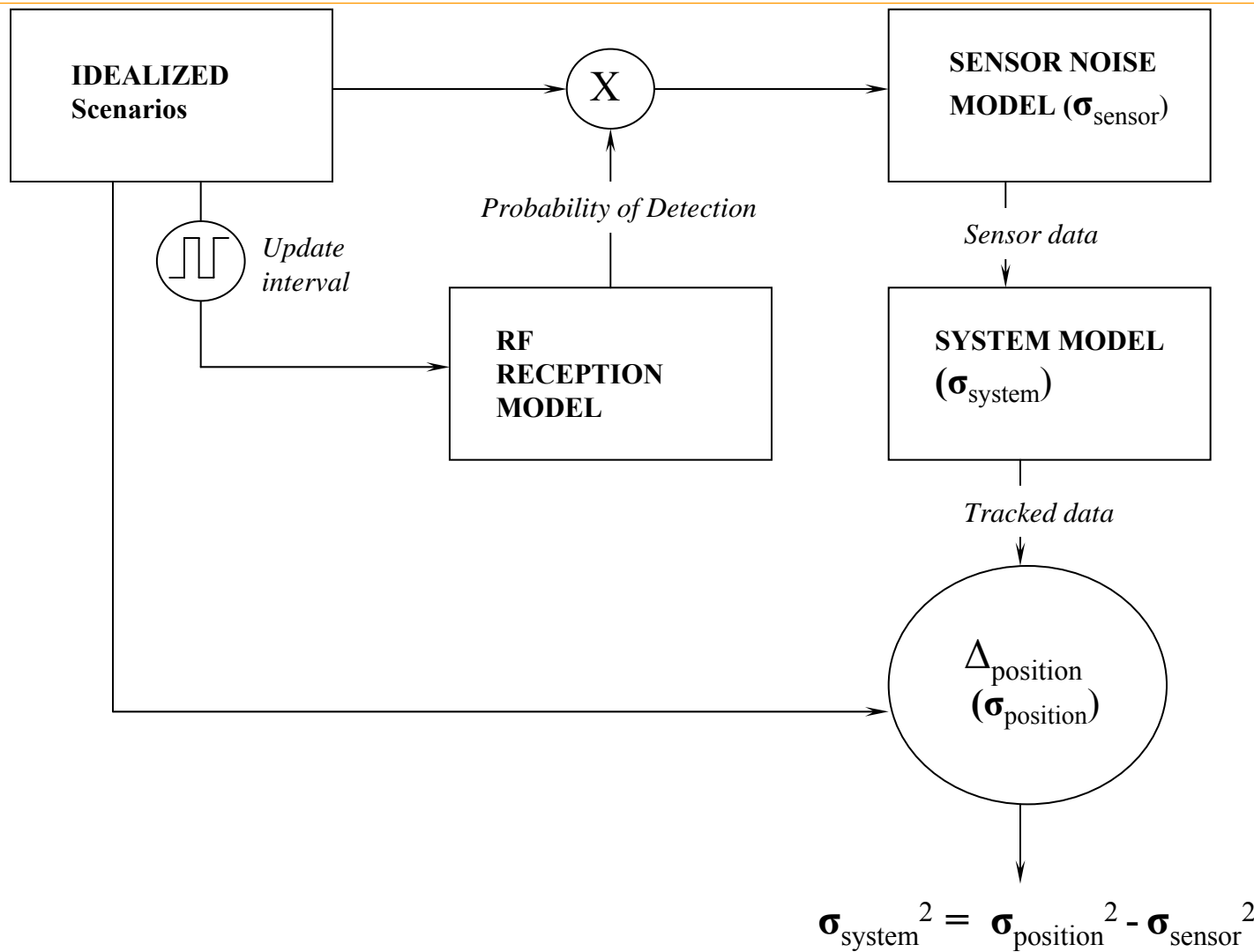
Applications Visualization





Applications

Putting it All Together





Deficiencies

- **Continuous but jagged acceleration**
- **Static tuning parameters**
- **Induced motion anomalies at end points**
- **Discontinuities from integration**
- **Reasonableness checking**



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