Yaw Rate Estimation from Differential Wheel Speeds

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Menu

- Motivation
- Vehicle Model
- Test Bed Description
- Data
- Future Steps
- Questions
Motivation

• Vehicle navigation during GPS dropouts

• Yaw gyros add additional expense

• ABS is standard on many vehicles today

• Need high accuracy: signals are integrated
\[
r = \frac{(V_{rf} - V_{lf})}{d \cdot \cos(\delta)} = \frac{(V_{rr} - V_{lr})}{d}
\]
Wheel Radius Estimation

\[ R = \frac{V}{\omega} \]

if (not yawing){
  Compare rev/sec to GPS velocity
}
else{
  Output last non-yaw result
}
Wheel Speed Sensor

- Stock ABS
- Variable Reluctance
- 48 [teeth/rev]
- Digital Counter
Novatel GPS

- Velocity @ 20 [Hz]
- Accuracy 0.2 [m/s]
Bosch Yaw Rate Sensor

- Range: 100 [deg/s]
- BW: >30 [Hz]
Single Board Computer

- AMD K6 350
- Analog I/O
- Wheel Speed Interface
- GPS Data Port
\[ V_{\text{rear}} = V_{CG} + r \times \left( \pm \frac{d}{2} \right) \]
Future Directions

• Look at a dynamic model to compensate for lag in rear wheel yaw rate estimate
  – First order slip model
  – Side Slip?

• Model Reduction
  – How can we know quantitatively when our model is good enough?
Conclusion

- First pass system shows promise

- The smaller the error, the longer we can keep a good estimate of attitude

- Need to increase model sophistication
Questions