Topics

• Digital Filtering
• Software Robustness- Observer
• Steering through Differential Braking
• Skid steering

Notes:
1. Mon. 4/25: (430-530 pm) round 2 (NATCAR rules)
   1. 13 makes first turn
   2. 15 half track in < 5 minutes
   3. 18 whole track in less than 1 minute
   4. > 18 For cars which are fast and/or well-stabilized
2. Thanks for CalDay Sat. April 16 @ UCB
3. Safety
4. Oral reports-scheduling Th 4/28 (930-11?)
   Thurs 11-1230, 10-1230, 1-2 pm, 3-4, 4-530, 5-630 pm? Fri 9-10, 3-4,
5. Lab share Tues 5-7 pm, all of April. Also two benches
6. Quiz 5 result.
Digital Filtering

- **Moving average**
  
  \[ y_1[n] = \frac{y[n-2]+y[n-1]+y[n]}{3} \]

- **Median filter (outlier rejection)**

- **Notch filter (mechanical vibration)**
  
  \[ y[n] = \frac{x[n-2]+2x[n-1]+x[n]}{4} \]

- **Model based filtering (or Kalman filter)**

(on board)
Software Robustness: Observer

Steering command \( \delta \)

\[ r = 0 + u \]

Observer

State feedback:
Lateral position and velocity

N. Nise, 6th edition, Fig. 12.23
Steering References (on web page)

• Vehicle Dynamics and Control During Abnormal Driving
  
  http://soliton.ae.gatech.edu/people/dcsI/research-abnormal.html

  Prof. Panagiotis Tsiotras, Georgia Tech

  
  http://soliton.ae.gatech.edu/people/dcsI/movies/skidding.avi

  http://soliton.ae.gatech.edu/people/dcsI/movies/TrailBraking.avi
Steering References (on web page)

• Vehicle Dynamics and Control During Abnormal Driving (Georgia Tech)
• Some nice turning simulation (Georgia Tech): (video 1) (video 2)
• Chankyu Lee K. Hedrick Kyongsu Yi , “Real-time slip-based estimation of maximum tire-road friction coefficient,” Mechatronics, IEEE/ASME Transactions on Publication Date: June 2004
Steering: Trail Braking Maneuver

1. Brake hard, drive straight (increased load on front wheels)
2. Increase steering command, reduce braking (oversteering)
3. Decrease steering, counter steers, apply throttle to stabilize

Steering: Trail Braking Maneuver

Vehicle Dynamics and Control During Abnormal Driving
http://soliton.ae.gatech.edu/people/dcsI/research-abnormal.html

Prof. Panagiotis Tsiotras, Georgia Tech

http://soliton.ae.gatech.edu/people/dcsI/movies/TrailBraking.avi
Steering: Pendulum Turn Maneuver (Sim)

1. Turn opposite while applying brakes (increased load on front wheels, oversteering)
2. Throttle blip to damp rotation
3. Steer in direction of turn and apply brakes to rotate fast
4. Decrease steering command, counter-steers, applies throttle to stabilize

Vehicle Stability through Differential Braking

Fig. 1 Seven DoF vehicle model

Fig. 2 Two DoF model

Tire Slip Angle

More derivation on board

http://technicalf1explained.blogspot.com/2012/10/f1-tirespart-2.html