Project 8:
Lateral Velocity Control
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• So far, we have focused on orientation control
  • Proportional error: relative to a goal
  • Damping: prefers zero rotational velocity

• Next step:
  • Estimate actual lateral velocity from the cameras
  • High level controller specifies a desired lateral velocity
  • Use lateral forces to “close the gap” between desired and sensed lateral velocity
Estimating Lateral Velocity

You already have implemented:

```c
void accumulate_slip(int32_t adx[3], int32_t ady[3])
```

- Update adx/ady with slip information from each of the cameras
- Note: now, we will only accumulate slip over 5ms

```c
void compute_motion(int32_t adx[3], int32_t ady[3], float motion)
```

- Translate slip distance into movement of the chassis
Smoothing Velocities

• From one 5ms step to the next, the number of pixels slipped can vary a lot (especially when velocity is low)
• In order to address this sampling noise, we will filter our velocity estimates

• New global variable:
  
  ```
  float velocity_filtered[3]; // x_dot, y_dot, theta_dot
  ```
Instantaneous Velocity

Your function \texttt{compute\_motion()} gives us movement of the chassis within the last 5ms: call this \(dx\)

• Our instantaneous estimate of velocity is: ??
Smoothing the Velocity Estimate

“Low pass filter”: remove the high frequency components of some signal

• In our case, we assume that the true velocity is slowly changing and that sampling noise manifests itself as high-frequency changes
Velocity Control

• High-level specifies desired velocity
• Controller chooses acceleration to close the distance between desired and actual velocity
Low-Pass Filter in Code

\[ f_{vx} = f_{vx} \times (1 - \frac{dt}{\tau}) + \frac{dx}{\tau}; \]
Lateral Velocity Control in Code

\[ f_x = KL_v \times (velocity\_goal[0] - velocity\_filtered[0]); \]
FSM

• Wait for button press
• Hover in place for 10 sec
• Move forward for 10 sec
• Hover in place for 10 sec
• Move leftward for 10 sec
• Hover in place for 10 sec
• Spin down
Testing

Just hover in place

• Your lateral velocity controller should resist lateral perturbations