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:

```
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

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

```
fvx = fvx * (1 - dt / tau) + dx / tau;
```

Lateral Velocity Control in Code

```
fx = KLv * (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