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Visual Odometry for Bounding Legged Robots

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Background

- Visual odometry - estimation of position and orientation of a robot based on camera images
- Challenging task due to noises
- Use filter to combine with inertial information
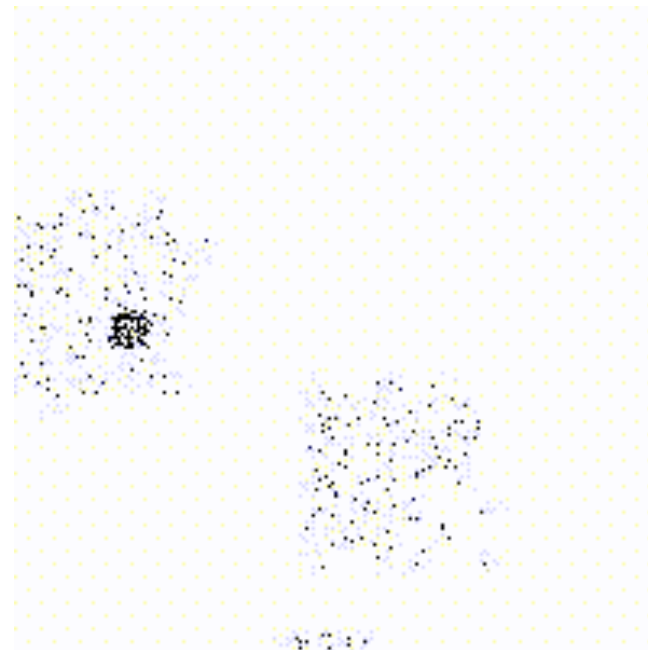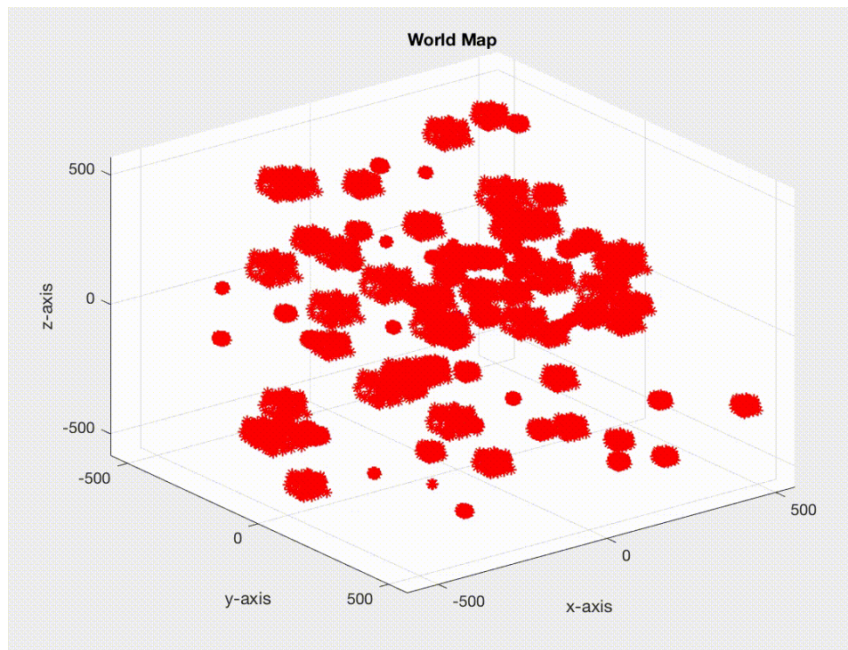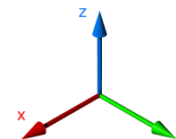- Extra challenge for bounding robot

Hypothesis

The error in visual odometry estimation of a bounding legged robot is primarily caused by the pitch motion being confused as vertical displacement in the z-axis (vertical axis).
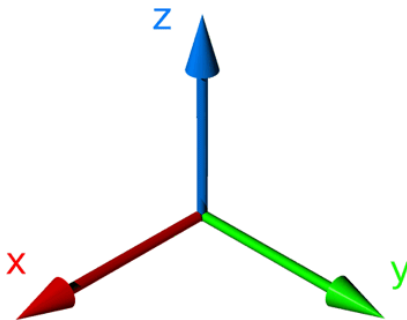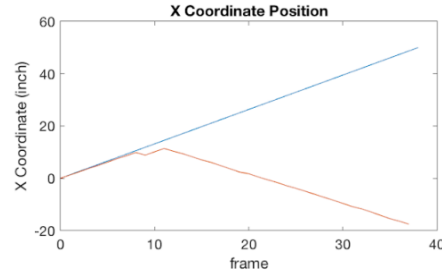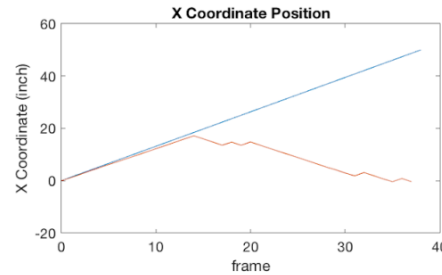
MATLAB Simulation

Assumptions

- Speed is known

- Perfect match of point pairs in two consecutive images

- Good lighting condition
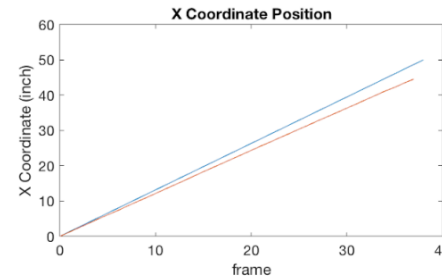
- High resolution

Effect of Resolution

- No pitch

- 50 inch straight in x-direction

- 40 inch/sec velocity

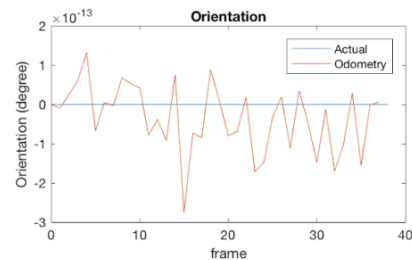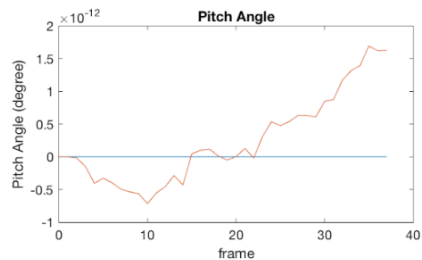- Estimation
- Actual

500x500

1000x1000

5000x5000

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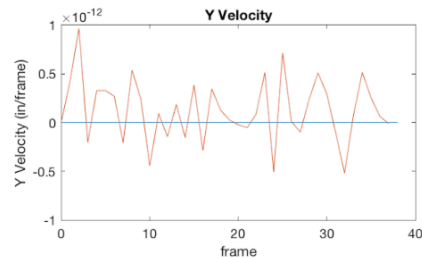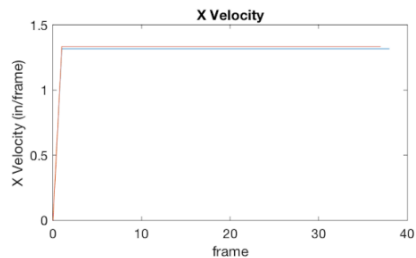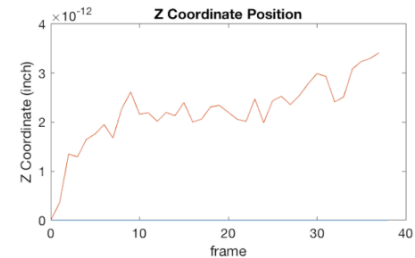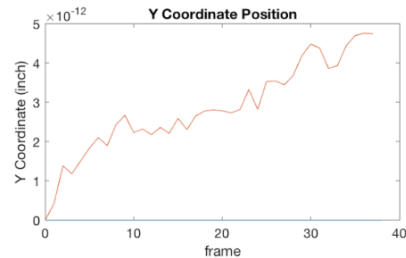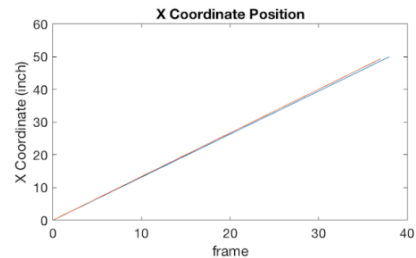
No Pitch

No pitch

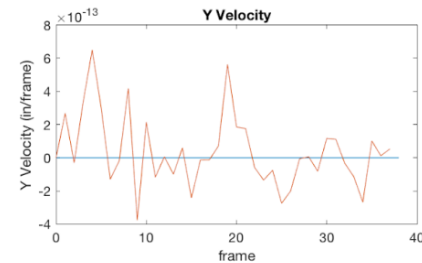50 inch straight in x-direction
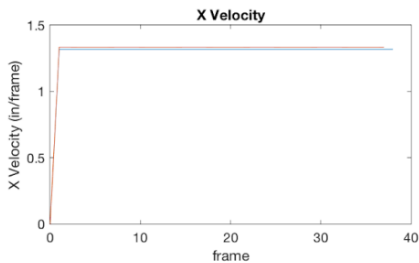
40 inch/sec velocity
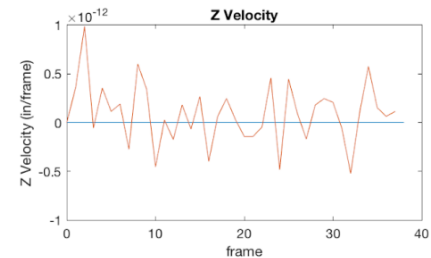
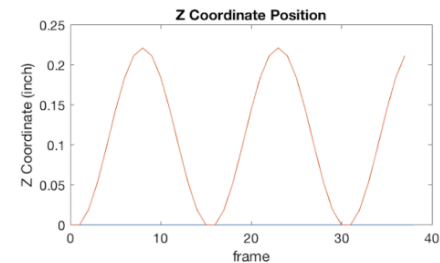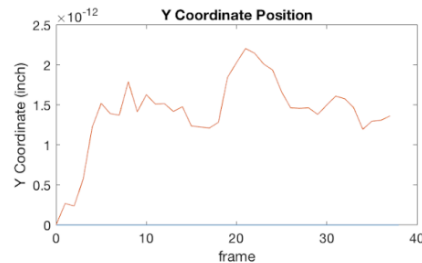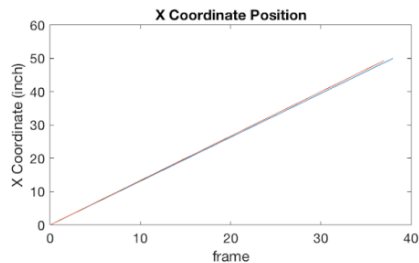# Pitch

2° pitch angle
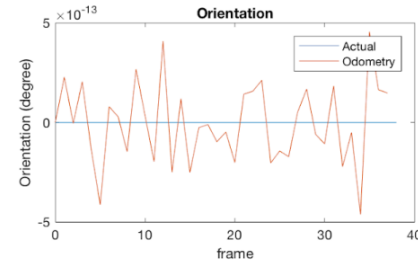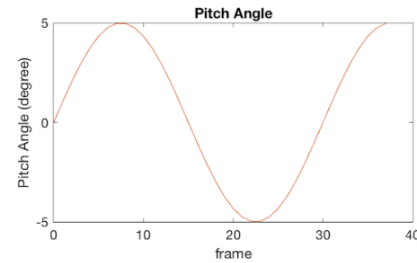
50 inch straight in x-direction

40 inch/sec velocity
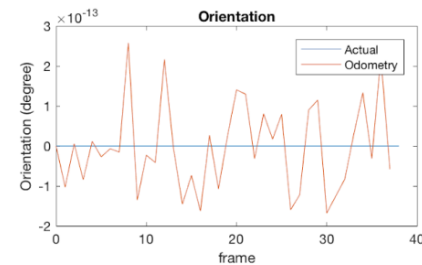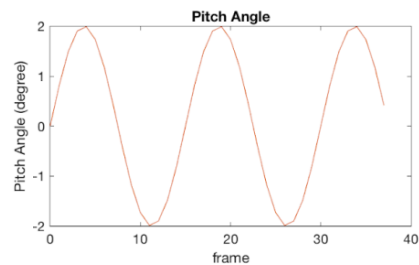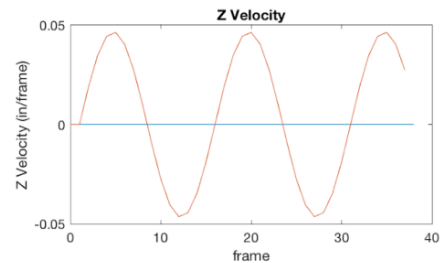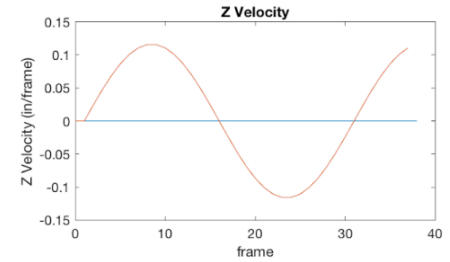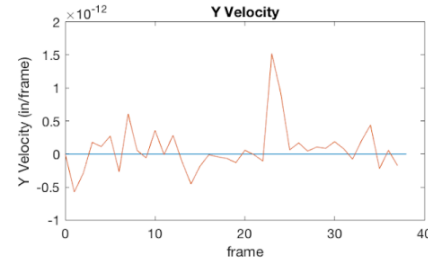
Pitch

5° pitch angle

50 inch straight in x-direction

40 inch/sec velocity
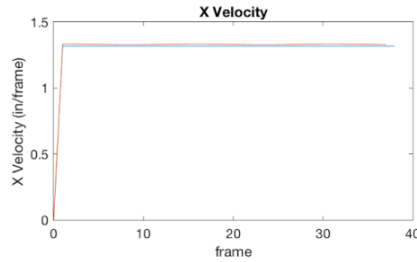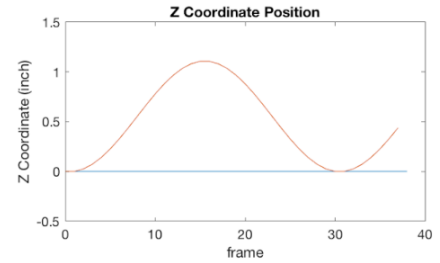
Pitch Frequency

- 2~20 degree pitch angles

- 50 inch straight in x-direction

- 40 inch/sec velocity

Conclusions

- For a bounding legged robot, visual odometry estimation makes error in z-displacement
  - Pitch motion is confused as vertical displacement
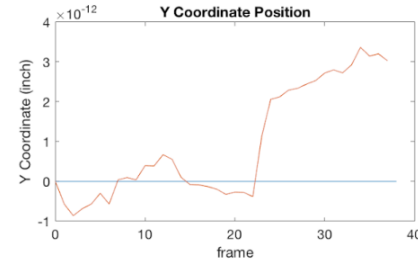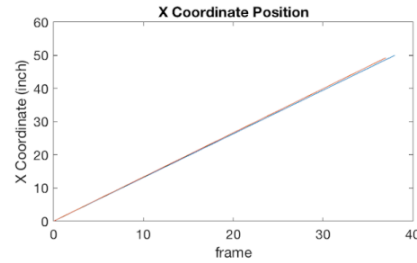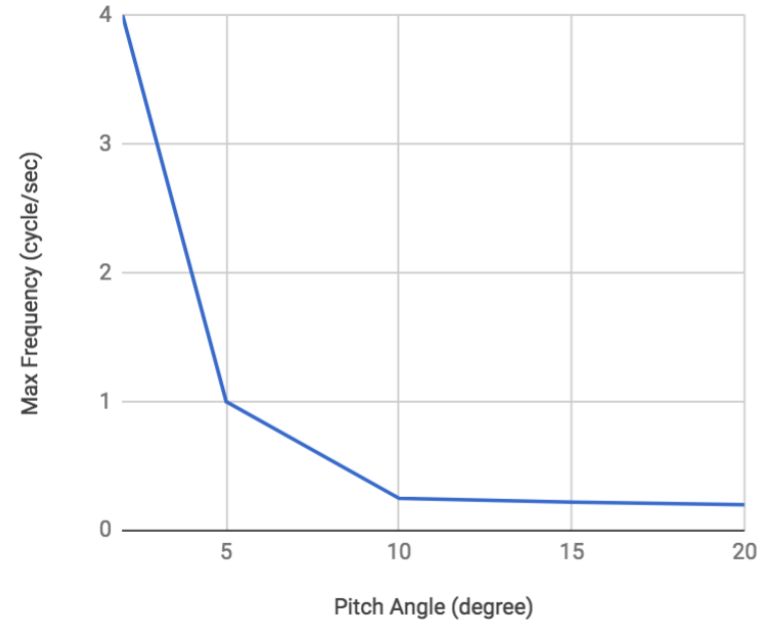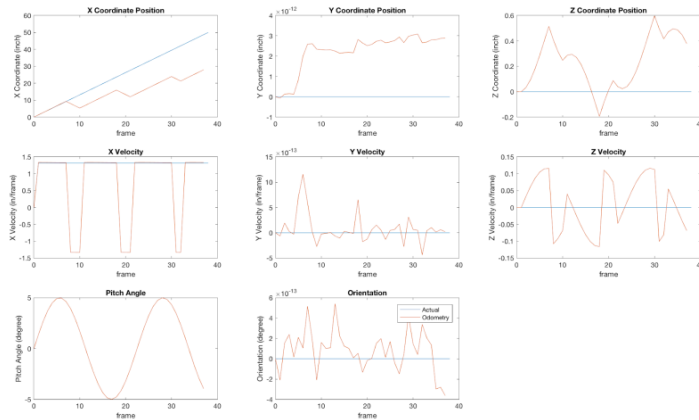- Increasing pitch frequency causes directional confusion and increases error

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Future

- Introduce noises such as point pair mismatch, inaccurate inertial data, etc.

- Include turns in the robot's path

- Motivate others to do research in improving the accuracy of visual odometry estimation for legged robots

Thank You