

Effect of tire pressure on cabin comfort for off-road vehicles -Xiaohan Zheng



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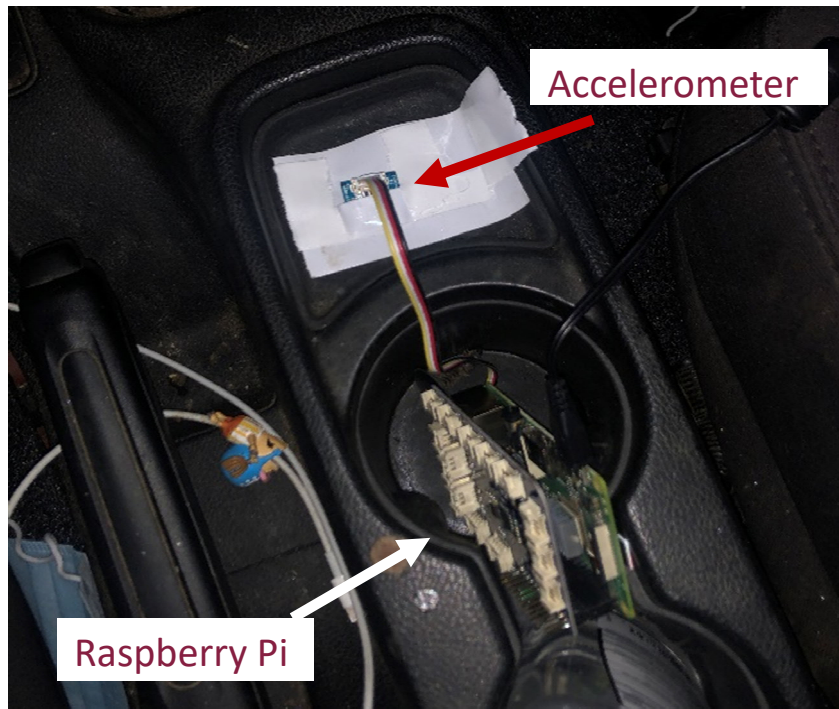
Project motivation and overview

- There are many ways to minimize the vehicle jerks due to road input
 - Tires
 - Suspension
 - Wheelbase
 - etc.
- Tires act like a spring which can smooth out many of the roughness on the road
 - Different tire pressure basically change the spring rate of the tires
 - Three different tire pressure are tested :
 - 30 psi (regular tire pressure)
 - 20 psi (low tire pressure)
 - 13 psi (minimum tire pressure without the risk of tire unseating from the wheel)
- The accelerometer is used to collect the vehicle jerks when vehicle is driving
- The human body vibration frequency are generally located in about 3Hz-17Hz [1]
 - This project only focus on frequency content between 3-17 Hz and the peak accelerations



The accelerometer was taped on the center console and speed bump was used to generate the input signal

Location of accelerometer

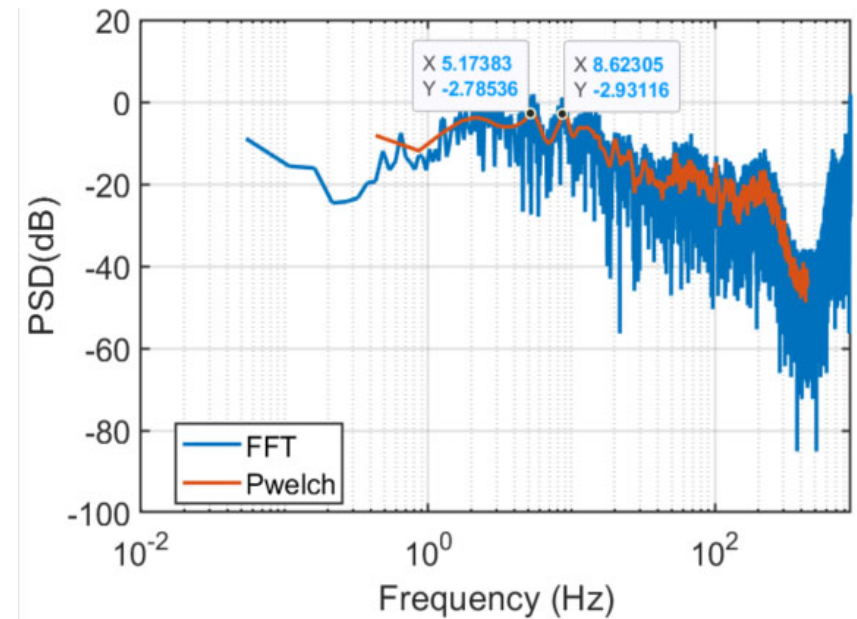
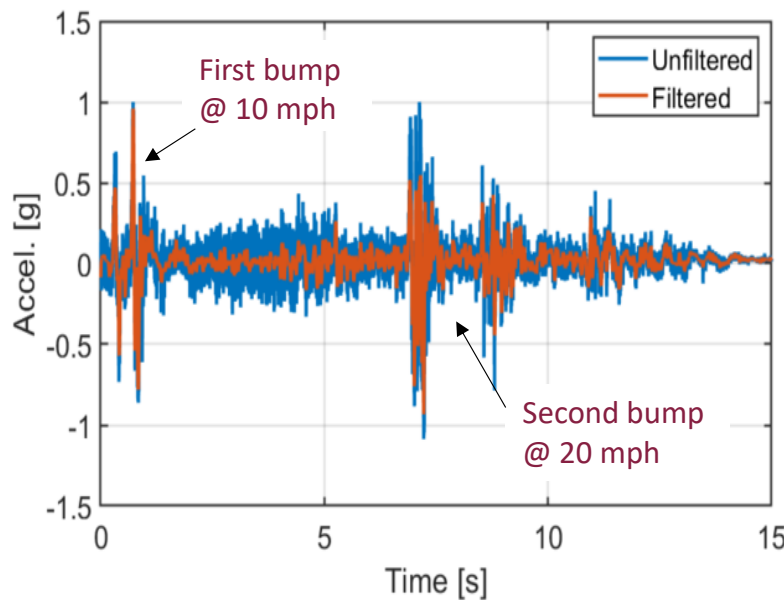


Vehicle travel through a speed bump



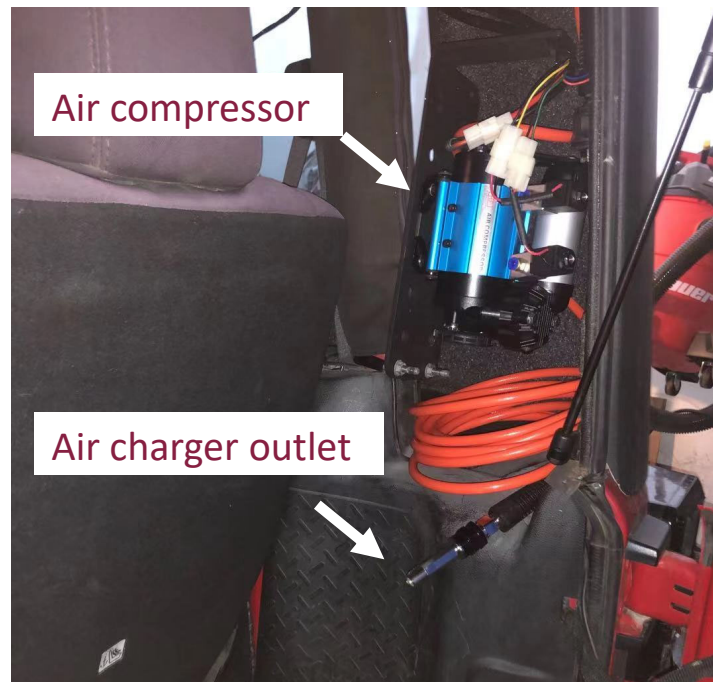
The preliminary result was collected and analyzed to prove the methodology

- In the preliminary test, two different vehicle speed are tested.
- Sample rate (833Hz) is maxed out for data collection
- Both FFT and Pwelch are used for comparison for this preliminary data
- Peak frequencies are found on 5.2 Hz and 8.6Hz

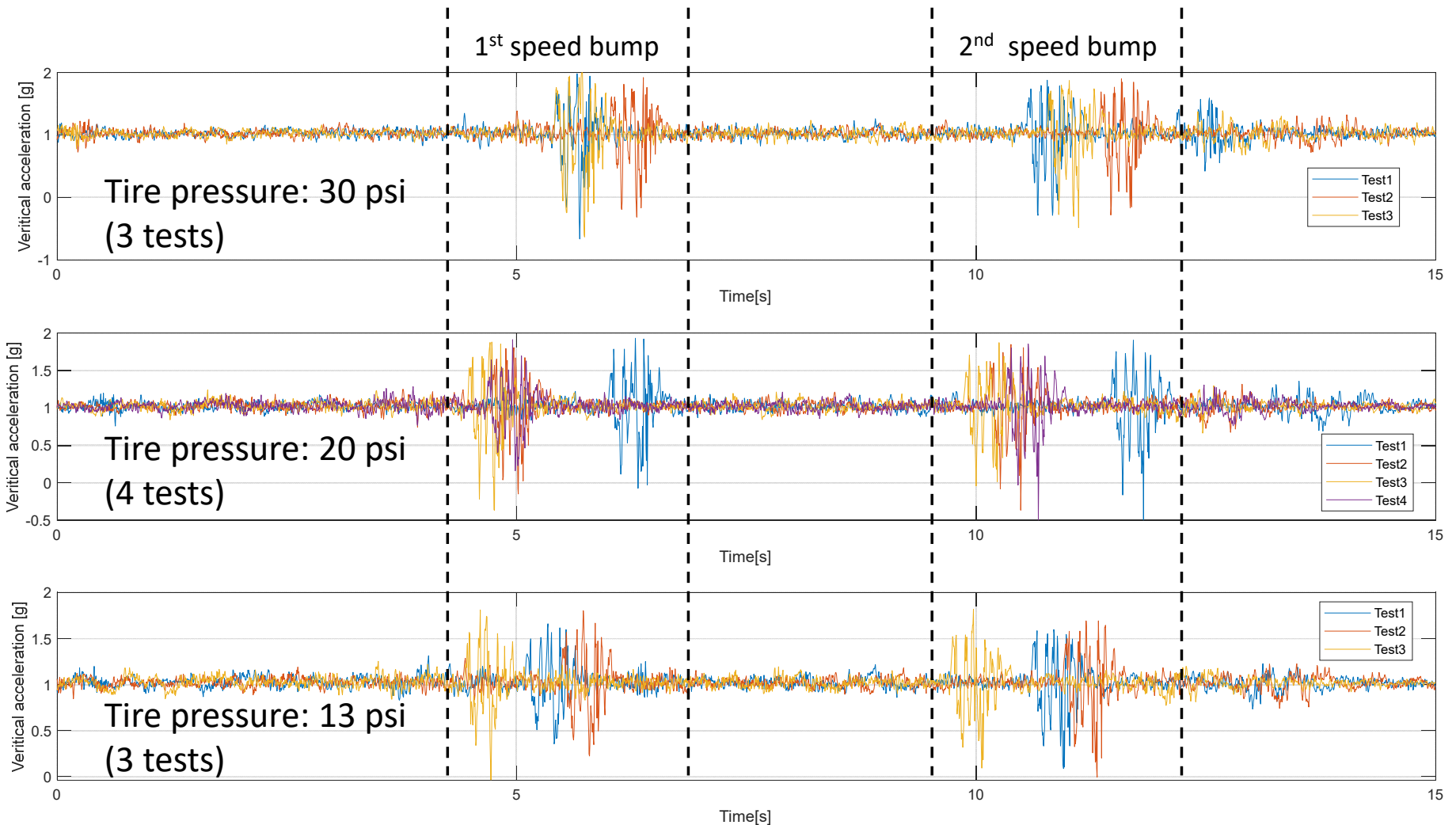


The similar test was continued with three different tire pressure: 30psi, 20psi, 13psi

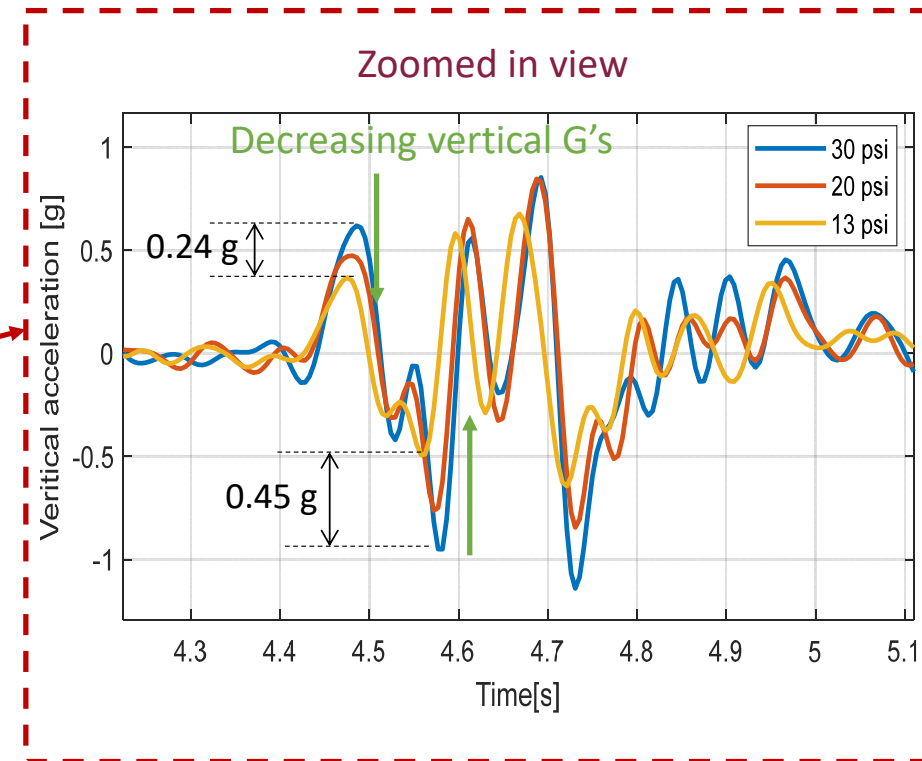
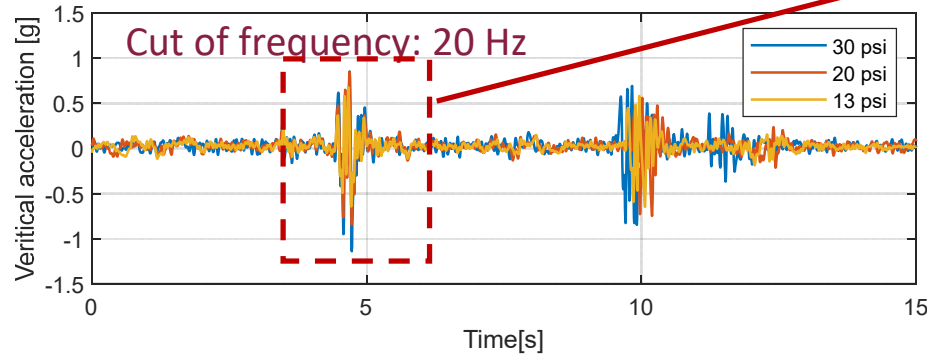
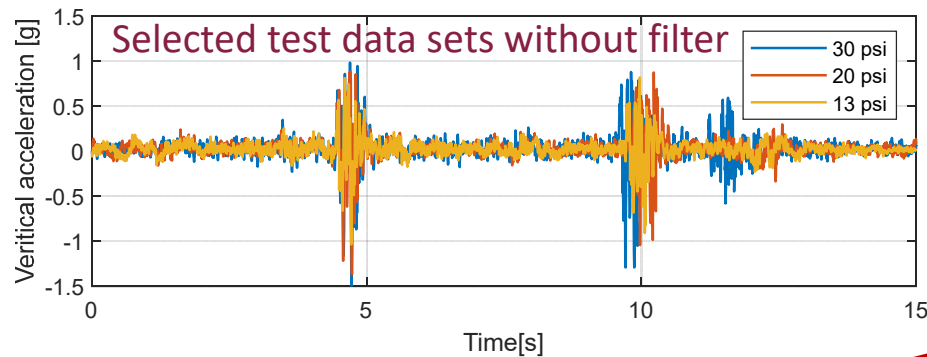
- Air compressor was installed to the vehicle to adjust the tire pressure before and after the test
- Digital pressure gauge measures tire pressure for four corners



Total of 10 tests were performed with different tire pressures



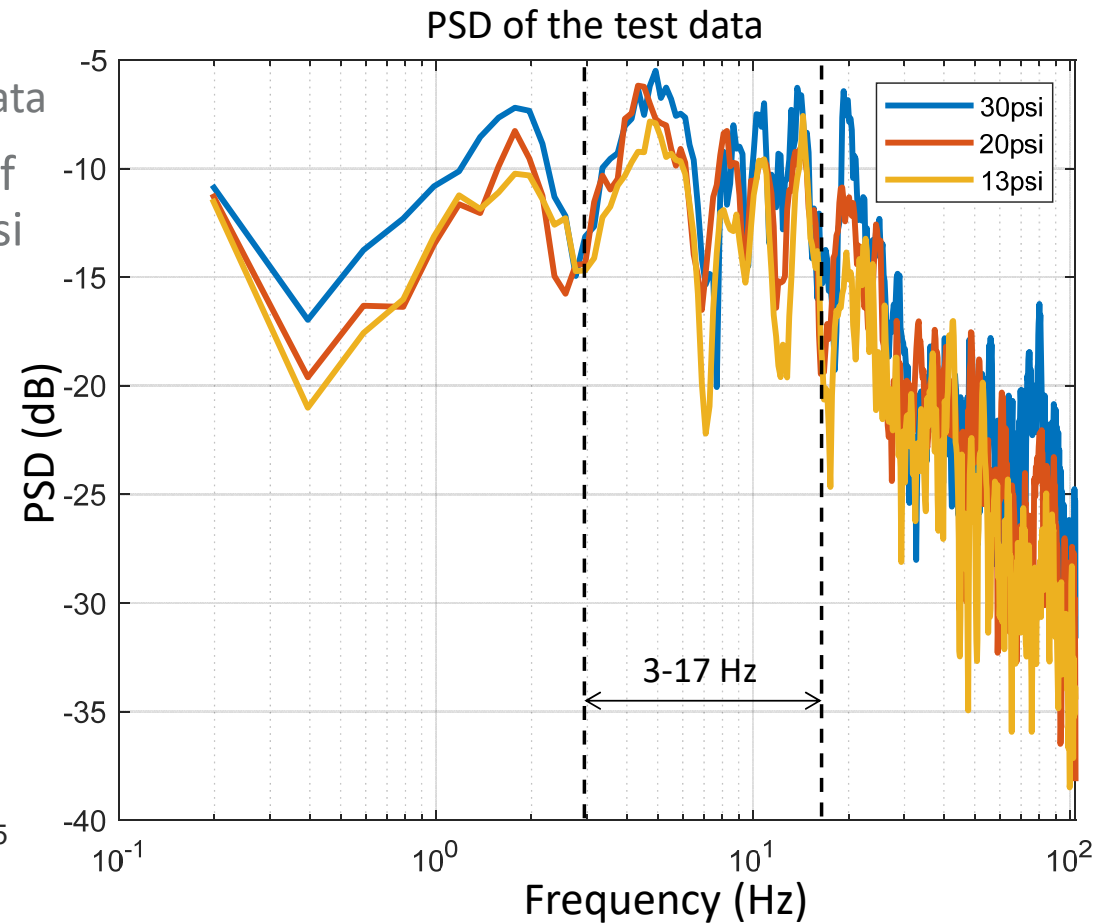
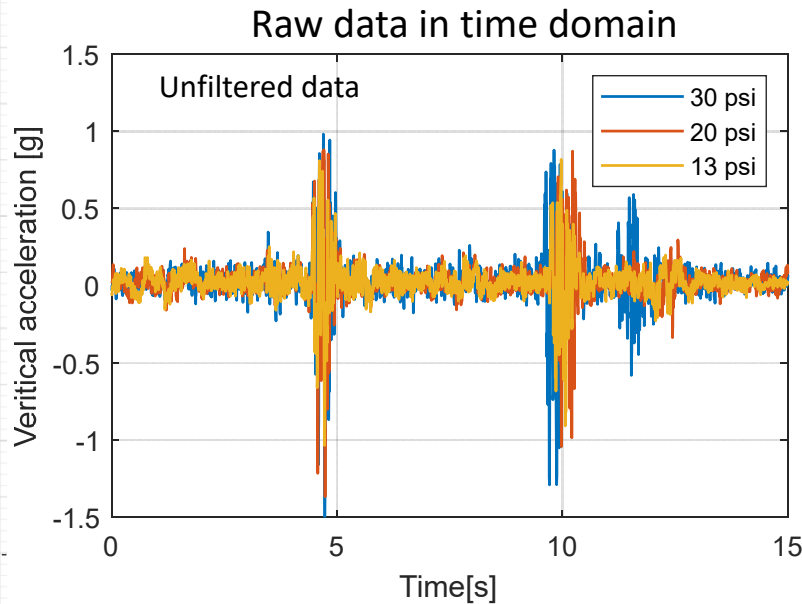
The maximum acceleration is decreased with a lower tire pressure



- Cut-off frequency is set to 20 Hz because human body is not very sensitive to any frequency above 20 Hz

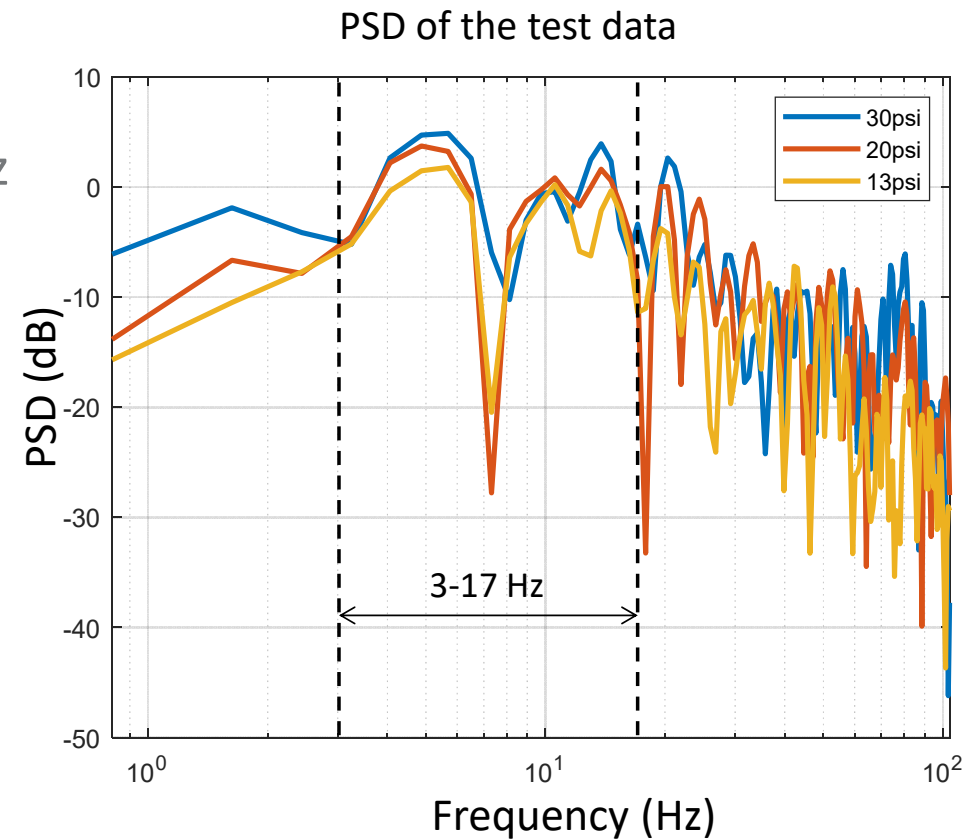
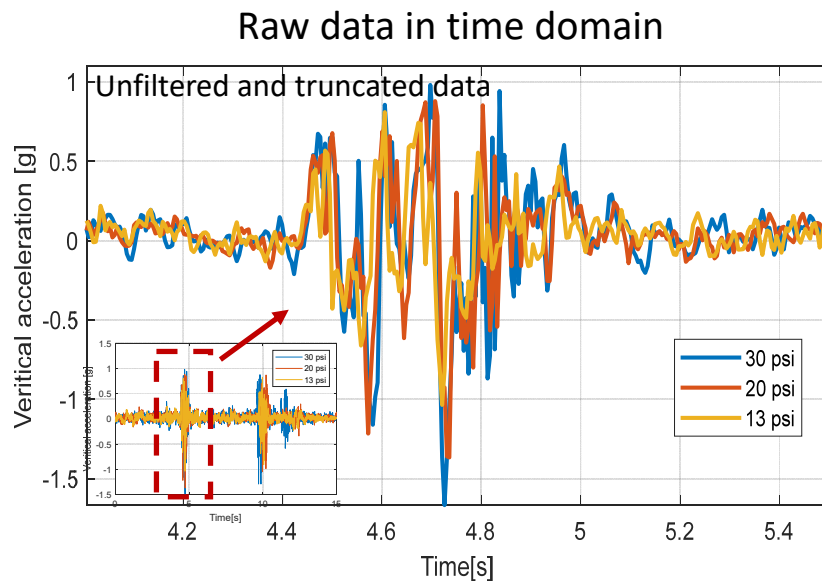
Lower tire pressure has a lower PSD in the range of 3-17 Hz, indicating a smoother ride

- PSD is applied to entire length of the data
- More energy content in the range of 3-17 Hz is found on 30psi than 13 psi



Data truncated to the section of hitting speed bump, 13 psi still shows less energy in range of 3-17 Hz

- PSD is applied to the portion of the data when vehicle hit the bump
- The PSD still shows a least amount of energy content between 3-17 Hz with tire pressure of 13 psi



Conclusion and future work

- The lower tire pressure has many benefits for off-road vehicles
 - Decreasing the peak acceleration (vehicle jerks)
 - Smoother ride quality in frequency range of 3-17Hz
- Future work
 - The most effective tire pressure for different size of tires
 - Repeat the test but in road that is very rough
 - Relate the tire pressure and vehicle suspension to optimized off-road performance



VIRGINIA TECH.

Question?

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Reference

- [1] Ren, Wu, et al. “Study on Vibration Characteristics and Human Riding Comfort of a Special Equipment Cab.” *Journal of Sensors*, vol. 2018, 2018, pp. 1–8., doi:10.1155/2018/7140610.