Overview:

This report aims to investigate the effect of changing boundary conditions on the APPVMD algorithm. Three boundary conditions were simulated; namely, pinned-pinned (default), fixed-pinned, and fixed-fixed. These simulations were carried out for all four vehicle classes to gain an understanding of these effects of almost all vehicle classes. It is worth mentioning that I reran the default one again, so it might look a little different from the one we have on paper due to the variability of the surface roughness.

Results:

Table 1: Pinned-pinned condition.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Vehicle Class | Not Detected | Low CFR | Med CFR | High CFR | % detected |
| Hatchback | 9 | 20 | 8 | 2 | 76.9% |
| Sedan | 1 | 12 | 17 | 9 | 97.4% |
| SUV | 2 | 8 | 16 | 13 | 94.8% |
| Truck | 7 | 7 | 9 | 16 | 82.1% |

Table 2: Fixed-pinned condition.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Vehicle Class | Not Detected | Low CFR | Med CFR | High CFR | % detected |
| Hatchback | 10 | 19 | 10 | 0 | 74.4% |
| Sedan | 1 | 26 | 11 | 1 | 97.4% |
| SUV | 4 | 22 | 11 | 2 | 89.7% |
| Truck | 15 | 18 | 6 | 0 | 61.5% |

Table 3: Fixed-fixed condition.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Vehicle Class | Not Detected | Low CFR | Med CFR | High CFR | % detected |
| Hatchback | 14 | 14 | 10 | 1 | 64.1% |
| Sedan | 2 | 27 | 10 | 0 | 94.8% |
| SUV | 2 | 25 | 10 | 2 | 94.8% |
| Truck | 14 | 15 | 10 | 0 | 64.1% |

I also inspected the ratio of the bridge psd amplitude to the vehicle natural frequency and made a brief relational plot, as shown below. Each column represents a boundary condition type (bc\_type) where pp, fp, and ff correspond to pinned-pinned, fixed-pinned, and fixed-fixed, respectively. The x and y axes are the ratio and bridge IDs, respectively, and the points are distinguished based on color and type. The color classifies based on whether the vehicle was able to capture the frequency and the type corresponds to the vehicle class.

Chart, scatter chart

Description automatically generated

Afterwards, I arbitrarily decided to select the points that are above 0.25 ratio, since the peak picking algorithm would be able to distinguish it as a peak. These points are then classified into tables based on the boundary condition type and vehicle class, as shown in the table below.

Table 4: Number of successful detection that demonstrate a PSD ratio greater than 0.25.

|  |  |  |  |
| --- | --- | --- | --- |
| Vehicle Class | Count for PP | Count for FP | Count for FF |
| Hatchback | 11 | 14 | 17 |
| Sedan | 32 | 27 | 25 |
| SUV | 27 | 20 | 23 |
| Truck | 14 | 10 | 9 |

Sedan vehicle study:

While looking at my code, I noticed that I had the wrong bridge spans in one of the case studies. When I fixed this issue, the sedan vehicle study showed consistent results in the sense that higher velocities assisted the APPVMD algorithm in making successful bridge frequency detections to a certain extent. Below are the tables before and after, respectively. I think the new results provide a deeper conclusion where higher speeds increased successful detections in the low confidence regions but reduced the number in the higher confidence regions. Moreover, improvements were also observed in the number of unsuccessful detections where increased speeds reduced this number.

Before:

Table

Description automatically generated

After:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Vehicle Model | Undetected | Low CR | Medium CR | High CR | % True |
| Sedan 20 mph | 4 | 9 | 18 | 8 | 89.7 |
| Sedan 30 mph | 3 | 14 | 17 | 5 | 92.3 |
| Sedan 40 mph | 2 | 17 | 16 | 4 | 94.8 |
| Sedan 50 mph | 5 | 22 | 8 | 4 | 87.2 |