

CLAIMS

What is claimed is:

1. A method for determining usage of a vehicle, the method comprising:
 - acquiring a vibration signal from a sensor of a device affixed to the vehicle;
 - 5 processing the vibration signal in the device to determine a characteristic of the signal related to travel by the vehicle;
 - using the determined characteristic to identify time periods during which the vehicle is in a first mode of travel;
 - accumulating usage in a data storage in the device, including accumulating a first
 - 10 usage for the vehicle during the identified time periods in which the vehicle is in the first mode of travel; and
 - transmitting the accumulated usage from the device.
2. The method of claim 1 wherein the sensor of the device affixed the vehicle comprises an accelerometer.
- 15 3. The method of claim 2 wherein the vibration signal comprises a multidimensional signal, each dimension of the multidimensional signal corresponding to a different direction relative to the vehicle.
4. The method of claim 1 wherein the sensor of the device affixed to the vehicle comprises a microphone.

5. The method of claim 1 wherein the first mode of travel corresponds to travel on a first road type.
6. The method of claim 1 wherein the first mode of travel corresponds to travel at a first speed or range of speed.
- 5 7. The method of any one of claims 1 through 6 wherein accumulating the first usage includes accumulating at least one of a duration and a distance of travel in the first mode of travel.
8. The method of claim 7 wherein accumulating the first usage includes accumulating a distance of travel of a first road type according to a duration of the identified time periods and an average travel speed on the first road type.
- 10 9. The method of any of claims 1 through 8 comprising:
 - using the determined characteristic to identify time periods during which the vehicle is in each mode of travel of a plurality of modes of travel including the first mode of travel; and
 - accumulating usage of the vehicle in each mode of the plurality of modes according to
 - 15 the identified time periods.
10. The method of claim 9 wherein the plurality of modes of use comprises a travel on a plurality of road types, each mode of travel corresponding to a different road type.
11. The method of claim 10 wherein the plurality of road types includes at least one or a highway road type and an urban road type.

12. The method of any of claims 1 through 11 wherein the sensor signal comprises a time series.
13. The method of any of claims 1 through 11 wherein the characteristic comprises a spectral characteristic.
- 5 14. The method of claim 13 wherein the spectral characteristic characterizes frequencies of one or more energy peaks.
15. The method of claim 14 wherein the spectral characteristic characterizes a vibration frequency of a component of the vehicle.
- 10 16. The method of claim 13 wherein the spectral characteristic characterizes an energy distribution over frequency.
17. The method of any of claims 1 through 11 wherein the characteristic comprises a nonlinear or linear characteristic.
18. The method of any of claims 1 through 11 wherein the characteristic comprises a timing characteristic.
- 15 19. The method of claim 18 wherein timing characteristic comprises a periodicity time characteristic.
20. The method of claim 18 wherein timing characteristic comprises an inter-event time characteristic.

21. The method of any of claims 1 through 20 wherein the data associating speed of the vehicle with value of the at least one characteristic comprises data characterizing a statistical relationship.
22. The method of any of claims 1 through 20 wherein the data associating speed of the vehicle with value of the at least one characteristic comprises a data table with records, each record associating a speed of the vehicle with a value of the at least one characteristic.
23. The method of any of claims 1 through 20 wherein the data associating speed of the vehicle with value of the at least one characteristic comprises data representing a linear relationship between a frequency of an energy peak and a vehicle speed.
24. The method of any of claims 1 through 20 wherein the data associating speed of the vehicle with value of the at least one characteristic comprises data representing an inverse relationship between an inter-event time characteristic and a vehicle speed.
25. The method of any of claims 1 through 20 further comprising determining and storing the data associating speed of the vehicle with the one or more characteristics, the determining comprising:
- acquiring a second sensor signal from a sensor traveling with the vehicle and acquiring a vehicle speed signal;
 - processing the second sensor signal to estimate the at least one characteristic of the speed related component of the acquired sensor signal; and

determining the data associating speed of the vehicle with the at least one characteristic to represent an association of the acquired vehicle speed and the estimated at least one characteristic.

26. The method of any of claims 1 through 25 further comprising repeating use of estimates of the characteristic over time to estimate speed over time, and combining the estimate of speed over time to estimate a distance traveled by the vehicle.
27. The method of any of claims 1 through 25 further comprising correcting a drift in an output of an inertial sensor according to the accumulated usage.
28. The method of claim 27 wherein the sensor traveling with the vehicle is the inertial sensor.
29. The method of any of claims 1 through 25 wherein transmitting the accumulated usage from the device comprises transmitting the accumulated usage to a personal communication device.
30. The method of claim 29 further comprising augmenting usage information stored in the personal communication device with the accumulated usage transmitted from the device.
31. The method of any one of claims 1 through 30 further comprising using the information transmitted from the device to assess driving risk associated with the vehicle.
32. The method of claim 31 wherein assessing the driving risk associated with the vehicle is associated with assessing an insurance risk.

33. Software stored on a non-transitory machine readable medium, the software comprising instructions for causing one or more processors to perform all the steps of any one of claims 1 through 30.
34. Software stored on a non-transitory machine readable medium, the software comprising instructions for causing one or more processors to:
- 5 acquire a vibration signal from a sensor of a device traveling with the vehicle;
- process the vibration signal in the device to determine a characteristic of the signal related to a use of the vehicle;
- use the determined characteristic to identify time periods during which the vehicle is
- 10 in a first mode of travel;
- accumulate usage in a data storage in the device, including accumulating a first usage for the vehicle during the identified time periods in which the vehicle is in the first mode of travel; and
- transmit the accumulated usage from the device.
- 15 35. A device for affixing to a vehicle configured to perform all the steps of any one of claims 1 through 30.
36. A device for affixing to a vehicle, the device comprising:
- a vibration sensor for providing a vibration signal;
- a signal processor configured to processes the vibration signal in the device to
- 20 determine a characteristic of use of the vehicle;

- a usage mode detector configured to process the determined characteristic and provide an indicator or whether the vehicle is in a first mode of travel;
- a data storage for accumulating a usage for the vehicle according to time periods determined from the provided indicator; and
- 5 a transmitter for transmitting the accumulated usage from the device.

37. A kit comprising a non-transitory machine readable medium having stored thereon software for execution on a personal communication device to perform functions including communicating with a device, the kit further comprising the device, the device being configured to perform all the steps of any one of claims 1 through 28.