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Application Note 1003

Distance Applications Using the Non-Contact Speed Sensor

Measuring distance is an application of the non-contact speed sensor which sometimes goes unnoticed, but is a straight-forward way to accomplish certain tasks. This application note discusses the use of distance measurement in the following applications:

1. Vehicle distance traveled
2. In-place offset angle correction of the non-contact speed sensor

Summing Counts to Measure Distance

Distances are directly measured by summing the total number of counts, or pulses, generated at the output of the speed sensor. This can be done easily with an off-the-shelf pre-scaled counter or totalizer and yields a real-time output. The conversion between the speed sensor output and distance is given in Equation One.

$$\left(\frac{100.0Hz}{MPH}\right)\times\left(\frac{3600\sec}{Hour}\right)\times\left(\frac{\frac{1Count}{\sec}}{Hz}\right)=360000\,\frac{Counts}{Mile}=68.1818\,\frac{Counts}{ft} \qquad \text{(Equation 1)}$$

The value of Counts/Mile does not change with acceleration. This means that if the sensor is mounted on a car which travels at 10MPH for part of a mile and then accelerates to 30MPH the rest of the way, the total number of counts remains the same as if traveled entirely at 10MPH. This is because the pulse output frequency is directly proportional to speed. If the speed increases, so does the frequency.

According to Equation One, the uncertainty associated with one count is 1/68 ft. If the sensor is first corrected for offset angle as described below, most other sources of error are minimized or averaged out. For instance, vibrations or bumps encountered by the vehicle will be filtered out over time because they generate noise fluctuations in the data which will average out when the counts are summed. It is also important to remember that there is a minimum speed at which the non-contact speed sensor produces an output. Any distances traveled at speeds below the minimum speed are not measured.

Offset Angle Correction Ratio

As discussed in other application notes[1], speeds and distances measured using the non-contact speed sensor must be corrected for offset angle and cosine error. For vehicle mounted sensors, a distance comparison method is among the most accurate ways to correct the speed sensor output for offset angle, accounting for cosine error and beam geometry factors in one single step and minimizing other possible error sources.

To accomplish the correction, the vehicle travels a known distance while the distance measured by the sensor is recorded and a correction factor is determined by the ratio shown in Equation Two.

$$\text{OffsetCorrection}=\frac{\text{KnownDistance}\,(length)}{\text{MeasuredDistance}\,(length)}=\frac{\text{KnownSpeed}\left(\frac{length}{time}\right)}{\text{MeasuredSpeed}\left(\frac{length}{time}\right)} \qquad \text{(Equation 2)}$$

The accuracy of the correction factor depends on the length of the known distance and can be improved as necessary by increasing the distance traveled. Also shown in Equation Two is an equivalent method based on a speed ratio that can be computed by comparing the average speed measured by the sensor to the average speed copmuted using an external method, such as timing the vehicle as it travels over the distance. If the speed ratio is used then the correction factor is necessarily dependent on the accuracy of the externally measured speed.

An Example

Consider an application where the sensor was connected to a DataBRICK data acquisition system and mounted on a train as it covered a distance of one mile. Output from the sensor was recorded beginning at one milepost and the train was also timed with a stopwatch until it passed the next milepost, 88.3 seconds later. The *uncorrected* and *corrected* speeds and distances measured by the sensor are shown in Figure One.

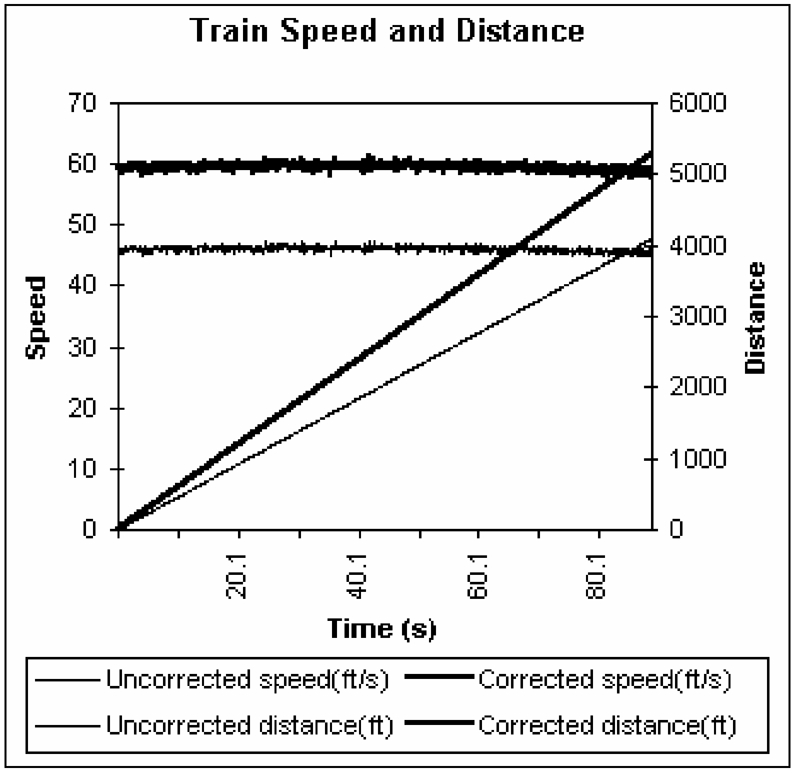

Figure 1 - Train Speed and Distance

Based on *either* the total, uncorrected distance or the average of the uncorrected speed shown in Figure One, an offset correction factor can be computed as in Equation Three. The uncorrected speed and distance are multiplied by the offset correction factor to produce the corrected measurements.

$$\text{OffsetCorrection} = \frac{5280\,ft}{\text{UncorrectedDistance},\,ft} = \frac{5280\,ft}{4088\,ft} = \frac{\text{TimedSpeed}}{\text{AvgSpeed}} = \frac{\frac{5280}{88.3}\frac{ft}{s}}{46.1\,\frac{ft}{s}} = 1.29 \qquad (\text{ Equation 3 })$$

Contact Us

GMH Engineering personnel are available to discuss applications using non-contact speed sensing. If you have questions, please contact us at (801) 225-8970 or info@gmheng.com.

[1] For example *Application Note 1000 Fundamentals of Non-Contact Speed Measurement Using Doppler Radar*

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