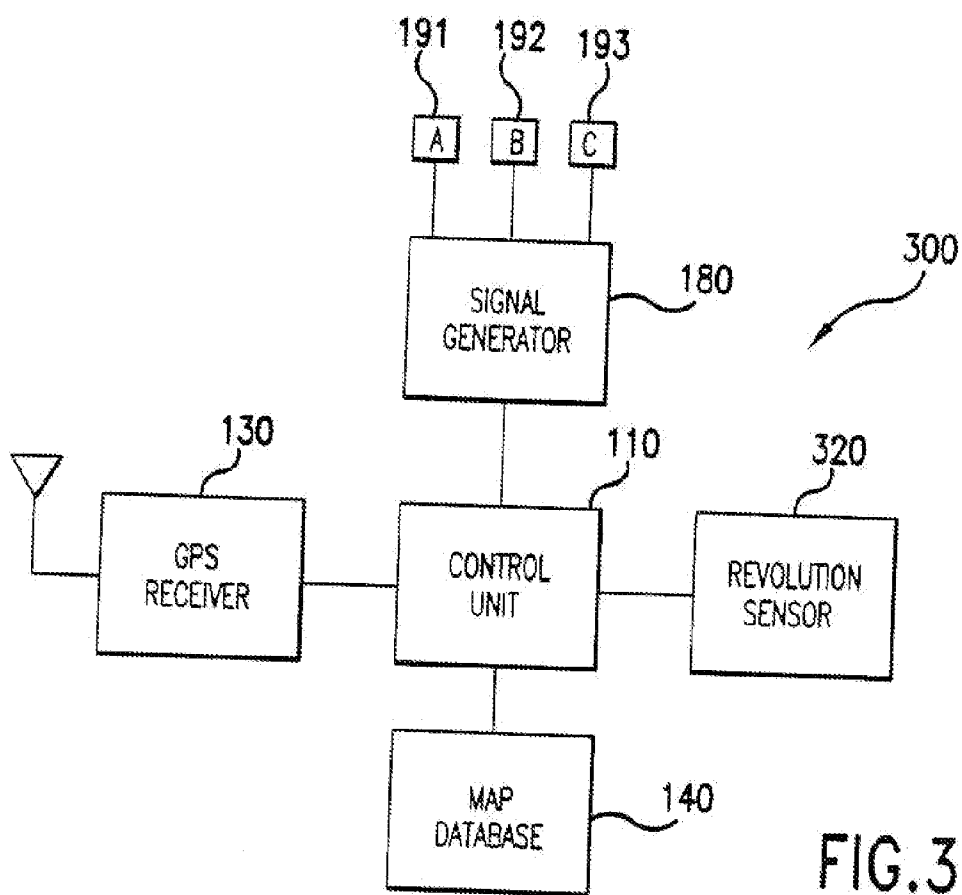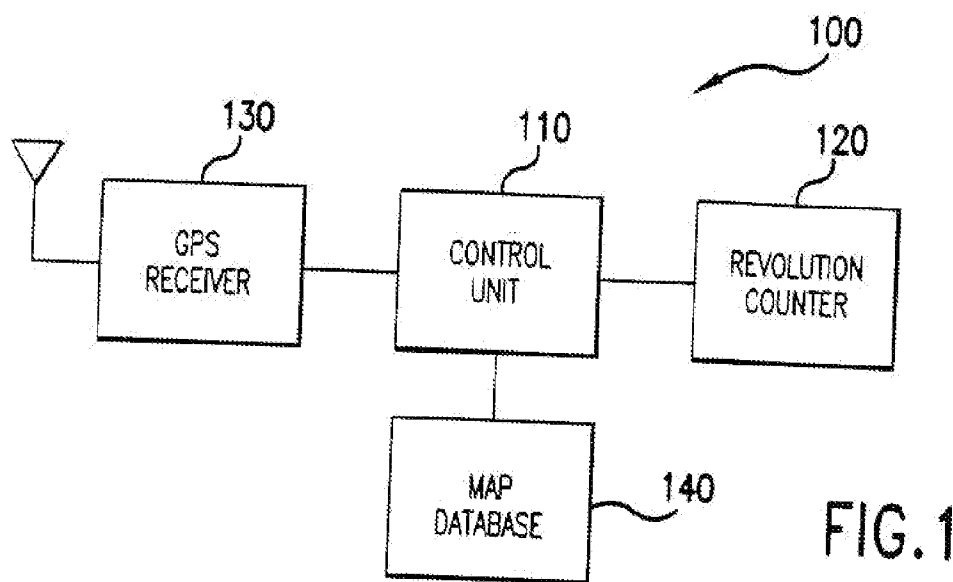(19) **United States**

(12) **Patent Application Publication** (10) Pub. No.: **US 2007/0095988 A1**

Kane et al. (43) Pub. Date: **May 3, 2007**

(54) **METHOD AND SYSTEM FOR COMPENSATING FOR WHEEL WEAR ON A TRAIN**

(75) Inventors: **Mark Edward Kane**, Orange Park, FL (US); **James Francis Shockley**, Orange Park, FL (US); **Harrison Thomas Hickenlooper**, Palatka, FL (US)

Correspondence Address:
DLA PIPER US LLP
ATTN: PATENT GROUP
1200 NINETEENTH STREET, NW
WASHINGTON, DC 20036 (US)

(73) Assignee: **QUANTUM ENGINEERING, INC.**, Orange Park, FL

(21) Appl. No.: **11/608,324**

(22) Filed: **Dec. 8, 2006**

Related U.S. Application Data

(60) Division of application No. 10/609,377, filed on Jul. 1, 2003, which is a continuation-in-part of application No. 10/157,874, filed on May 31, 2002, now Pat. No. 6,701,228.

Publication Classification

(51) **Int. Cl.**
 B61L 3/00 (2006.01)

(52) **U.S. Cl.** .... **246/182 R**

(57) **ABSTRACT**

A method and system for compensating for wheel wear uses position and/or speed information from an independent positioning system to measure some distance over which the train has traveled. Wheel rotation information is also collected over the distance. The wheel rotation information and distance and/or speed information are then use to determine the size of the train wheels. The method is performed periodically to correct for changes in wheel size over time due to wear so that the wheel rotation information can be used to determine train position and speed in the event of a positioning system failure.

100

130   110   120

GPS
RECEIVER

CONTROL
UNIT

REVOLUTION
COUNTER

MAP
DATABASE   140

FIG.1

191   192   193

A   B   C

SIGNAL
GENERATOR   180

300

130   110   320

GPS
RECEIVER

CONTROL
UNIT

REVOLUTION
SENSOR

MAP
DATABASE   140

FIG.3

```
                              ┌─────────────┐
                              │    START    │
                              └─────────────┘
                                     │
                                     ▼                     200
                   NO         ╱ TRACK ╲        210          290
  ┌─────────┐  ◄─────────   ╱ CONDITIONS ╲   ◄──────   ┌─────────┐
  │  DELAY  │              ╲ ACCEPTABLE  ╱              │  DELAY  │
  └─────────┘               ╲    ?    ╱                 └─────────┘
       │                        │                            ▲
      220                      YES                           │
                                │                            │
                                ▼                            │
                   ┌──────────────────────────┐  230        │
                   │   GET START POSITION      │            │
                   │ FROM POSITIONING SYSTEM   │            │
                   └──────────────────────────┘            │
                                │                            │
                                ▼                            │
                   ┌──────────────────────────┐  240        │
              ┌──► │     COUNT ROTATIONS       │            │
              │    └──────────────────────────┘            │
              │                 │                            │
              │                 ▼           250              │
              │   NO       ╱ THRESHOLD ╲                     │
              └─────────  ╱  REACHED    ╲                    │
                          ╲     ?      ╱                     │
                           ╲        ╱                        │
                                │                            │
                               YES                           │
                                │                            │
                                ▼                            │
                   ┌──────────────────────────┐  260        │
                   │  GET STOP POSITION FROM   │            │
                   │    POSITIONING SYSTEM     │            │
                   └──────────────────────────┘            │
                                │                            │
                                ▼                            │
                   ┌──────────────────────────┐  270        │
                   │   CALCULATE DISTANCE      │            │
                   │  BASED ON START AND       │            │
                   │     STOP POSITIONS        │            │
                   └──────────────────────────┘            │
                                │                            │
                                ▼                            │
                   ┌──────────────────────────┐  280        │
                   │  DETERMINE WHEEL SIZE     │            │
                   │ BASED ON DIFFERENCE       │            │
                   │     IN DISTANCES          │            │
                   └──────────────────────────┘            │
                                │                            │
                                └────────────────────────────┘
```

FIG.2

400

FIGURE 4(a)

FIGURE 4(b)

START

Reset Revolution Counter
502

Get Current Position From
Positioning System
504

Temporarily Store Current
Position As Last Position
506

Delay
508

Get Current Position From
Positioning System
510

Calculate Difference Between
Current Position and Last
Position
512

Add Difference To Total
Distance
514

Total Distance >
Threshold?
516

N

Y

Read Revolution
Counter
518

C=Total Distance/Number
Of Revolutions
520

END

500

FIGURE 5

METHOD AND SYSTEM FOR COMPENSATING FOR WHEEL WEAR ON A TRAIN

[0001] This application is a U.S. Divisional Application of U.S. application Ser. No. 10/609,377, filed Jul. 1, 2003, which is a Continuation-In-Part of application Ser. No. 10/157,874, filed May 31, 2002, now U.S. Pat. No. 6,701, 228, issued Mar. 2, 2004. The entirety of both of the above-mentioned applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to railroads generally, and more particularly, to a system and method for determining wheel size to compensate of wheel wear.

[0004] 2. Discussion of the Background

[0005] Controlling the movement of trains in a modern environment is a complex process. Collisions with other trains must be avoided and regulations in areas such as grade crossings must be complied with. The pressure to increase the performance of rail systems, in terms of speed, reliability and safety, has led to many proposals to automate various aspects of train operation. For example, positive train control (PTC) and automatic train control (ATC) systems have been widely discussed in recent years.

[0006] Some automated systems rely on global positioning system (GPS) receivers for indications of train speed and position (as used herein, "global positioning system" and "GPS" refer to all varieties of global positioning system receivers, including, but not limited to, differential global positioning system receivers. Still other systems use inertial navigation systems (INSs) for determining speed and location. However, GPS receivers and INSs sometimes fail, and for that reason it is desirable to have a back-up system.

[0007] One method that can be used in case of a positioning system failure is to measure the rotation of motor, axle or wheel rotation to determine the speed at which a train is traveling and/or the distance which a train has traveled. Each time the wheel makes a compete revolution, the distance traveled by the wheel is equal to its circumference in the absence of any slippage. Thus, if the radius R of the wheel is known, the distance traveled for each revolution of the wheel is equal to $2\pi R$. However, the radius of a wheel changes over time due to wheel wear. For example, a standard train wheel can decrease in size from 40 inches to 36 inches over its useful life. Therefore, the distance traveled in each wheel revolution can vary between 125.7" and 113.1" a difference of approximately 12.6 or 10%. This error is significant.

[0008] What is needed is a method and system that compensates for wheel wear.

SUMMARY OF THE INVENTION

[0009] The present invention meets the aforementioned need to a great extent by providing a method and system for compensating for wheel wear in which wheel rotation information from a revolution counter or a tachometer and position and/or speed information from an independent positioning system such as GPS or INS are measured over a predetermined distance and used to determine the size of the train wheels. This process is performed periodically to compensate for wheel wear.

[0010] In one aspect of the invention, the system includes a map database and the position information from the independent positioning system is used to as an index to ensure that the rotation data used for the speed/position comparison between the position system and rotation data is collected in an area of straight and flat track so as to exclude errors in the rotation data caused by wheel slippage and turns.

[0011] In another aspect of the invention, the data used for the comparison between the speeds/distances indicated by the positioning system and by the rotation data is collected over a long distance to minimize known errors in the positioning system. In yet another aspect of the invention, a total distance traveled is calculated using an integration technique by adding a plurality of linear differences in successive positions reported by the positioning system over short periods of time. This technique is particularly advantageous when performed over curved sections of track.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A more complete appreciation of the invention and many of the attendant features and advantages thereof will be readily obtained as the same become better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

[0013] FIG. 1 is a logical block diagram of a train control system according to one embodiment of the invention.

[0014] FIG. 2 is a flowchart showing a wheel wear compensation technique according to one embodiment of the invention.

[0015] FIG. 3 is a logical block diagram of a train speed signal distribution system according to another embodiment of the present invention.

[0016] FIG. 4(a) and 4(b) are, respectively, schematic drawings of distance calculated by a linear method and an integration method according to an embodiment of the present invention.

[0017] FIG. 5 is a flowchart of a wheel wear compensation technique employing the integration method of FIG. 4(b) according to an embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0018] The present invention will be discussed with reference to preferred embodiments of train control systems. Specific details, such as wheel sizes and types of positioning systems, are set forth in order to provide a thorough understanding of the present invention. The preferred embodiments and specific details discussed herein should not be understood to limit the invention.

[0019] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, FIG. 1 is a logical block diagram of a train control system 100 according to the present invention. The system 100 includes a control module

110, which typically, but not necessarily, includes a micro-processor. The control module 110 is connected to a revolution counter 120. The revolution counter 120 measures rotation of a locomotive wheel (not shown in FIG. 1) on a train. The revolution counter 120 may be of any type, including mechanical, magnetic, and optical. The revolution counter 120 may measure the rotation of a wheel directly, or may measure rotation of an axle to which the wheel is connected, or may measure rotation of a motor driveshaft or gear that powers the wheel.

[0020] Also connected to the control module 110 is a positioning system such as a GPS receiver 130. The GPS 130 receiver can be of any type, including a differential GPS receiver. Other types of positioning systems, such as inertial navigation systems (INSs) and Loran systems, can also be used. [As used herein, the tern "positioning system" refers to the portion of a positioning system that is commonly located on a mobile vehicle, which may or may not comprise the entire system. Thus, for example, in connection with a global positioning system, the term "positioning system" as used herein refers to a GPS receiver and does not include the satellites that are used to transmit information to the GPS receiver.] The GPS receiver 130 provides position and speed information to the control module 110.

[0021] The control module 110 uses the position information from the GPS receiver 130 as an index into a map database 140. The map database 140 provides information including track grade and curvature to the control module 110. As will be explained in further detail below, this information is used in some embodiments to ensure that rotation information from the revolution counter will not include rotation information that is corrupted due to wheel slippage and/or errors due to track curvature.

[0022] Referring now to FIG. 2, a flowchart 200 illustrates operation of a wheel wear correction method according to one embodiment of the present invention. The control module 110 determines whether track conditions are acceptable at step 210. In some embodiments, this is accomplished by obtaining the current position from the GPS receiver 130 and indexing the map database 140 to determine the track grade and curvature over a predetermined length of upcoming track over which rotation information is to be collected.

[0023] The predetermined length of track is preferably of a sufficient length such that any errors introduced by the inaccuracy of the global positioning system receiver 130 are minimized. Obviously, it is advantageous to use as great a length as possible since the effect of positioning systems errors are decreased as the length is increased. However, there is a trade-off that must be made because if the length is too great, the time required to complete the wheel correction algorithm is too long and/or the amount of curvature and grade in the track segment over which the data is to be taken preclude running the algorithm over too much track in the system. In some embodiments, the predetermined length of track is 100,000 meters. In such an embodiment, with a global positioning system having a position error on the order of 30 meters, the total error is equal to (30+30)/100, 000=0.0006=0.06%.

[0024] In the embodiment described by FIG. 2, the determination as to whether track conditions are acceptable is made at the start of the algorithm. In other embodiments, rotation data is only collected if the train is traveling greater than some minimum. The reason behind this is that most wheel slippage occurs at slow speeds as a locomotive is attempting to accelerate. Most locomotives use electric induction motors, and most electric motors used in locomotives have torque curves with torques decreasing as speed increases such that it is not possible for the locomotive to generate enough torque to cause the wheels to slip above certain speeds. In some embodiments, the minimum speed at which data will be collected is 15 m.p.h.; in other embodiments, the minimum speed is 20 m.p.h.

[0025] In yet other embodiments, the wheel acceleration is monitored to detect wheel slippage. If an acceleration exceeds a threshold, the collected information is discarded and the entire process is started over.

[0026] In still other embodiments, the system notes the upcoming sections of the track in which either the grade or curvature is above a corresponding threshold and does not include those distances and any corresponding rotation information collected over those distances in the calculations. Such embodiments are particularly useful for railroads in which long, straight and level sections of track are not present in many areas.

[0027] If the track conditions are not favorable at step 210, the system delays for a period of time at step 220 and repeats step 210 until track conditions air favorable. When track conditions are favorable at step 210, the control module 110 determines a start position from the global positioning receiver 130 at step 230 and counts rotations as measured by the revolution counter 120 at step 240. When a threshold (which may be a number of rotations and/or a time period has been reached at step 250, the control module 110 determines a stop position from the global positioning receiver 130 at step 260. Next, at step 270, the control module 130 calculates the distance D traveled based on the start and stop positions measured at steps 230 and 260, respectively. Then the control module 130 determines the radius R of the wheel at step 280 according to the equation $R=D/2\pi T_r$, where T_r is the total number of rotations counted over the distance D. The control module 110 then delays, at step 290, for a period of time such as a day (it is not necessary to run the algorithm often as train wheels wear slowly).

[0028] In the above-discussed embodiments, a predetermined distance is used. It should be noted that the predetermined distance will vary depending upon the accuracy of the positioning system used and the particular environment in which the invention is used.

[0029] In the foregoing embodiments, data is not collected when the system determines the track conditions are not favorable. However, in cases where curvature exceeds the threshold, it is also possible to allow data collection to occur and correct the data for the curvature.

[0030] In another embodiment of the invention, an integration technique is utilized to correct for track curvature. In this technique, the total distance traveled is determined by adding linear differences between positions reported by the positioning system at a plurality of short intervals. In this manner, the sum of linear distances closely approximates the actual "track distance" (the actual distance traveled by the train over the track). Consider the examples shown in FIGS. 4(a) and 4(b), which illustrate a section of track 400 between

two points A and B. In FIG. **4**(*a*), a linear distance D_0 between points A and B is illustrated. This distance D_0 is obviously less than the actual track distance between points A and B. In FIG. **4**(*b*), several linear distances D_{1-9} between a plurality of intermediate points I_{0-9} are calculated. The sum of these linear distances D_{1-9} is a much closer approximation of the track distance between points A and B. As the distance between the intermediate points I_{0-9} decreases, the approximation of the actual track distance becomes more accurate.

[0031] FIG. **5** illustrates a flow chart **500** of the steps performed by the control module **110** in an embodiment employing this integration technique. The revolution counter **120** is reset to zero at step **502** (in other embodiments, the revolution counter is simply read at step **502**). The position is then obtained from the positioning system **130** at step **504** and temporarily stored as the last, position at step **506**. The control module **110** then delays for a period of time at step **508**. As discussed above the shorter the period is, the more accurate the approximation will be. In preferred embodiments, the period is one second.

[0032] After the delay at step **508**, the control module **110** again obtains the current position at step **510**. Next, the linear difference between the current position and the temporarily stored last position is calculated at step **512** and the difference is added to a total distance at step **514**.

[0033] If the total distance does not exceed a threshold at step **516**, steps **506** et seq. are repeated. As discussed above, the selection of the threshold involves a tradeoff. Again, a threshold of 100,000 meters is used in some embodiments.

[0034] If the threshold is exceeded at step **516**, the revolution counter is read at step **518**. The wheel circumference is then calculated by dividing the total distance by the number of revolutions from the revolution counter **120**.

[0035] In the embodiment described above, the periods of time during which the total distance was traveled were contiguous such that one period began as soon as a previous period ended. This simplified the method by eliminating the necessity of reading the revolution counter at the beginning and end of each period. Those of skill in the art will recognize that it is not necessary for the periods to be contiguous and that the invention may also be practiced by using a plurality of non-contiguous periods and reading the revolution counter at the beginning and end of each period (or, alternatively, resetting the revolution counter at the beginning of each period).

[0036] In the foregoing embodiments, positional inputs from the positioning system are used; however, it will be readily apparent that speed can also be used. For example, if the current speed S of the train is known from the positioning system, then the wheel size can be determined according to the equation $S=DF_r=2\pi RF_r$ where D is the distance traveled in each rotation, F_r is the rotation frequency of the wheel, and R is the radius of the wheel. In practice, the speed from the global positioning system may be read a number of times and the wheel size corresponding to each reading may be averaged. It should be noted that using speed rather than position information allows the wheel size to be determined more rapidly than using position information and is therefore preferable when wheel size is needed quickly (such as when a gross error has been detected). However, using, position information, especially over a long distance, results in greater accuracy. Accordingly, in some embodiments, speed is used to rapidly generate an initial, estimate and position is used to generate a better estimate at a later time.

[0037] Furthermore, while track curvature and grade were determined by referencing a map database in the embodiments discussed above, it will be readily recognized by those of skill in the art that curvature and grade can be determined from altitude and direction information provided by the global positioning system. For example, the track curvature, may be determined by recording the train's position as reported by the positioning system at several times during the period in which data is collected. This position information can be used to construct a curvature profile so that the amount of curvature can be determined after the data is collected. If the curvature is greater than a threshold, the data can be ignored, or, in some embodiments, can be corrected for the curvature such as by using the integration technique discussed herein. The same techniques can be used to construct a grade profile.

[0038] It should also be noted that the invention may be incorporated into various types of train control systems, including the aforementioned PTC and ATC systems as well as many others.

[0039] In another embodiment of the invention, the wheel wear compensation method is incorporated into a wheel revolution sensor signal distribution/conversion system such as the QUIP™ system manufactured by the assignee of the present invention, Quantum Engineering. There may be several systems on board a train that input a signal representative of the wheel rotation and use that signal to calculate speed. For example, many locomotives that have been retro-fitted with a train control system also are equipped with a separate speed display. Such systems typically require the conductor/engineer or maintenance personnel to measure the diameter of the train wheel to which the wheel sensor is attached and set DIP switches or otherwise configure the devices to indicate the wheel size. Because the wheel size changes over time as discussed above, these other devices must be reconfigured on some periodic basis, thereby increasing labor costs.

[0040] Because there may be several systems that require the wheel sensor signal which together constitute a larger electrical load than the wheel sensor is capable of handling, and because some of these systems require an input signal of a different form than is supplied by the wheel sensor, signal conversion/distribution systems such as the aforementioned QUIP™ distribution/conversion system have been devised. A substantial savings can be realized by modifying these distribution/conversion systems to output a modified signal that is representative of a wheel sensor signal would be generated by a wheel of a fixed size. Thus, for example, if the conversion/distribution system outputs a modified wheel sensor signal that is representative of a 40 inch wheel, each of the other systems that use the wheel sensor signal could be configured once for a 40 inch wheel and would thereafter not need to be periodically reconfigured.

[0041] Such a conversion/distribution system **300** is illustrated in FIG **3**. The system includes a control unit **110** connected to a wheel revolution sensor **320**. In some embodiments, the wheel sensor **320** outputs a square wave, with each rising edge representing a revolution of the wheel.

Thus, the time between leading edges represents the time taken for one full revolution of the wheel. It will be readily understood that the signal output by the wheel sensor **320** may be of many forms, analog or digital, and that the particular form of the signal is not important. Also connected to the control unit **10** is a GPS receiver **130** and a map database **140**. The control unit **110** is configured to determine the wheel size using the method described in FIG. **2** or one of the other methods described herein. The control unit **110** determines the speed of the train, which can be taken from the GPS receiver **130** or can be determined with the knowledge of the previously determined wheel size. Using the actual speed of the train, the control unit **110** then determines the parameters necessary for a signal that would be representative of the signal that would be generated by the wheel sensor **320** if the wheel were a predetermined size such as 40". For example, where the wheel sensor outputs a square wave signal as discussed above, the period of the square wave when the train is traveling 30 m.p.h. would be the distance traveled by one revolution, $2*\pi*20$ inches, divided by the train speed, 30 m.p.h. or 528 inches/sec, which is equal to 125.7/528=0.238 seconds. This 0.238 second period is supplied by the control unit **110** to a signal generator **180**, which generates a square wave of the type discussed above with a period of 0.238 seconds. The signal generated by the signal generator **180** is then supplied to other systems A,B and C **191-193**. Because the signal output by signal generator **180** will always be representative of a 40 inch wheel, it is not necessary to reconfigure the other systems **191-193** once they have been configured for a 40 inch wheel, thereby substantially reducing labor costs associated with these operations.

[0042] In the embodiment discussed above, speed is determined as part of the process of determining the parameters of the signal to be generated by the signal generator **180**. It will be readily apparent to those of skill in the art that the parameters can be determined without actually calculating the speed. For example, once the wheel size is determined using the method of FIG. **2**, that wheel size can be used to form a ratio of the predetermined wheel size to the actual wheel size. Thus, for example, if the predetermined wheel size is 40 inches, and the actual wheel size is 36, the ratio would be 40/36. The control unit can then measure the period of the square wave and multiply the period by the ratio to determine the period of the signal that would be generated by the wheel sensor **320** if the wheel were actually 40 inches, and supply this period to the signal generator **180** to generate this signal.

[0043] As discussed above, it is possible to generate a signal for the other devices without using the signal from the wheel sensor **320**. That is, the speed can be determined from the positional system (e.g., GPS receiver **130**) and the parameters of the desired signal can be sent to the signal generator so that a signal can be generated and distributed to the other systems, all without an actual wheel rotation sensor **320**. This allows the system to serve as a back up for situations where the wheel sensor fails. This also allows the wheel sensor to be replaced, but such a system has the drawback that it will not provide a correct signal when the GPS system is not operational.

[0044] Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A computerized method for determining a size of a train wheel comprising the steps of;

inputting a speed from a positioning system installed on a train;

obtaining rotation information from a tachometer;

determining a wheel size based on the rotation information and the speed; and

outputting a signal indicating the wheel size.

2. The method of claim 1, further comprising the steps of repeating the inputting, obtaining and determining steps a plurality of times and calculating a average of the wheel sizes determined in the determining steps.

3. The method of claim 1, wherein the tachometer measures a rotation speed of the train wheel.

4. The method of claim 1, wherein the tachometer measures a rotation speed of a motor connected to drive the train wheel.

5. The method of claim 1, wherein the tachometer measures a rotation speed of a driveshaft connected to the train wheel.

6. The method of claim 1, wherein the tachometer measures a rotation speed of a gear connected to the train wheel.

7. The method of claim 1, wherein the wheel size based on the rotation information and the speed is used as an initial estimate, and further comprising the steps of:

obtaining a first position from the positioning system;

obtaining a second position from the positioning system;

calculating a distance between the first position and the second position; and

calculating an updated wheel size based at least in part of the distance and a number of wheel revolutions occurring between the first position and the second position.

8. The method of claim 1, wherein the positioning system is a global positioning system receiver.

9. The method of claim 1, further comprising the step of generating a second signal using the signal indicating the wheel size, the second signal having a parameter of a signal that would be generated by a wheel rotation sensor associated with a wheel of a predetermined size different from the wheel size determined in the determining step.

10. The method of claim 1, wherein the signal indicating the wheel size is used by a train control system to determine a correct speed of the train.

11. The method of claim 1, wherein the signal indicating the wheel size is used by a train control system to determine a correct distance traveled by the train.

12. A system for determining a size of a train wheel comprising:

a control unit;

a positioning system connected to the control unit; and

a tachometer connected to the control unit and configured to measure a rotation speed of a component on the train;

wherein the control unit is configured to perform the steps of:

receiving rotation information from the tachometer;

obtaining a speed from the positioning system;

determining a wheel size based on the rotation information and the speed; and

outputting a signal indicating the wheel size.

13. The system of claim 12, wherein the control unit is further configured to repeat the receiving, obtaining and determining steps a plurality of times and calculating an average of the wheel sizes determined in the determining steps.

14. The system of claim 12, wherein the tachometer measures a rotation speed of the train wheel.

15. The system of claim 12, wherein the tachometer measures a rotation speed of a motor connected to drive the train wheel.

16. The system of claim 12, wherein the tachometer measures a rotation speed of a driveshaft connected to the train wheel.

17. The system of claim 12, wherein the tachometer measures a rotation speed of a gear connected to the train wheel.

18. The system of claim 12, wherein the wheel size is based on the rotation information and the speed is used as an initial estimate, and wherein the control unit is further configured to perform the steps of:

obtaining a first position from the positioning system;

obtaining a second position from the positioning system;

calculating a distance between the first position and the second position; and

calculating an updated wheel size based at least in part on the distance and a number of wheel revolutions occurring between the first position and the second position.

19. The system of claim 12, wherein the positioning system is a global positioning system receiver.

20. The system of claim 12, wherein the processor is further configured to perform the step of generating a second signal using the signal indicating the wheel size, the second signal having a parameter of a signal that would be generated by a wheel rotation sensor associated with a wheel of a predetermined size different from the wheel size determined in the determining step.

21. The system of claim 12, wherein the signal indicating the wheel size is used by a train control system to determine a correct speed of the train.

22. The system of claim 12, wherein the signal indicating the wheel size is used by a train control system to determine a correct distance traveled by the train.

* * * * *