SYSTEM AND METHOD FOR OPTICAL LOCOMOTIVE DECOUPLING DETECTION

Inventors: Rahul Bhotika, Albany, NY (US); Kenneth Brakeley Welles, II, Scotia, NY (US); John Erik Hershey, Ballston Lake, NY (US); David Michael Davenport, Niskayuna, NY (US)

Correspondence Address:
GENERAL ELECTRIC COMPANY
GLOBAL RESEARCH
ONE RESEARCH CIRCLE, PATENT DOCKET
RM. BLDG. K1-4A59
NISKAYUNA, NY 12309 (US)

Assignee: GENERAL ELECTRIC COMPANY, Schenectady, NY (US)

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Abstract
An apparatus and method for indicating whether a coupler of a locomotive is in a coupled or uncoupled state is provided.

The apparatus comprising: an optical sensor positioned on a portion of the coupler, wherein the sensor provides a real-time signal indicative of either a coupled or an uncoupled state of a coupler, wherein the signal is transmitted wirelessly by a transmitter in operable communication with the sensor. The method comprising: providing a signal indicative of the presence or proximity of a second coupler to the first coupler, the signal being provided by an optical sensor configured to provide the signal as the state of the coupler has changed; transmitting the signal wirelessly to a controller; processing the signal with a control algorithm resident upon the controller; and providing visually perceivable indication of the position of the coupler.
Figure 5

Figure 6
Figure 10

Figure 11
SYSTEM AND METHOD FOR OPTICAL LOCOMOTIVE DECOUPLING DETECTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of co-pending U.S. patent application Ser. No. 11/317,067 entitled "SYSTEM AND METHOD FOR DETERMINING WHETHER A LOCOMOTIVE OR RAIL ENGINE IS COUPLED TO A RAIL CAR OR OTHER ENGINE," filed on 23 Dec. 2005, the entirety of which is incorporated by reference herein.

TECHNICAL FIELD

[0002] The systems and techniques described herein relate generally to rail yards, and more particularly to methods and apparatus for determining whether a train engine is coupled to a rail car.

BACKGROUND

[0003] Rail yards are the hubs of railroad transportation systems. Therefore, rail yards perform many services, for example, freight origination, interchange and termination, locomotive storage and maintenance, assembly and inspection of new trains, servicing of trains running through the facility, inspection and maintenance of railcars, and nuclear storage. The various services in a rail yard compete for resources such as personnel, equipment, and space in various facilities so that managing the entire rail yard efficiently is a complex operation.

[0004] The railroads in general recognize that yard management tasks would benefit from the use of management tools based on optimization principles. Such tools use a current yard status and a list of tasks to be accomplished to determine an optimum order in which to accomplish these tasks.

[0005] However, any management system relies on credible and timely data concerning the present state of the system under management. In most rail yards, the current data entry technology is a mixture of manual and automated methods. For example, automated equipment identification (AEI) readers and AEI computers determine the location of rolling stock at points in the sequence of operations, but in general, this information is limited to data indicating rolling stock whereabouts at particular times only, such as the moment at which the rolling stock arrived, the moment at which the rolling stock passes the AEI reader, and the moment at which the rolling stock departs.

[0006] The location of assets within a rail yard is typically reported using voice radio communications. Point detection approaches such as wheel counters, track circuits, and automatic equipment identification (AEI) tag readers have been used to detect assets at specific, discrete locations on the tracks. Modern remote control systems use GPS and AEI tags to prevent the remote-controlled locomotive from traveling outside the yard limits. Cameras have been deployed throughout rail yards with shared displays to allow rail yard personnel (i.e. yard masters, hump masters, manager of terminal operations) to locate engines and other assets.

[0007] In particular, rail yard operators couple and uncouple rail cars as they enter, leave and traverse through the rail yard. These rail cars are coupled and uncoupled to train engines including locomotive engines and yard engines. For example, operators can uncouple rail cars from inbound locomotive engines and couple rail cars to outbound locomotive engines. Further, yard engines can be coupled to rail cars in order to transport the rail cars to appropriate locations within the rail yard for loading, unloading, or other processing.

[0008] Train engines in the rail yard can be tracked to determine the progress of a task being performed, as well as to determine whether the train engine(s) is/are being utilized efficiently. In order to track engines at a rail yard, an operator can monitor the coupling and decoupling of locomotive engines and yard engines wherein information about the train status is provided via radio communications. However, an operator-monitored system can be inefficient in that it does not result in real time monitoring of the train engine’s status as such communication, if present, may be exchanged well after the coupling or uncoupling event has occurred.

[0009] For efficient rail yard operations it would be useful to have an automatic system, which monitors the status of the yard engines and provides real time data. In particular, real time data indicating whether an engine is coupled or decoupled from a rail car will provide insight as to the progress of rail yard operations. In addition, rail yards may have many yard engines actively working to process inbound trains and to build outbound trains.

[0010] Therefore, yard operational efficiency may be realized by the ability to automatically verify that an engine is coupled to and moving one or more rail cars. Further benefits may be realized by using yard engine operational status in yard planning tasks. With automated, real-time knowledge of the operation of yard engines, the yard operation team will be able to assess available and utilized resources to plan subsequent tasks accordingly.

[0011] Accordingly, it is desirable to provide an apparatus and system for indicating whether train engines are coupled or decoupled from rail cars, wherein real time data is provided from an automatic monitoring system.

SUMMARY

[0012] In one aspect of an exemplary apparatus for indicating whether a first coupler of a locomotive is in a coupled or an uncoupled state described herein, an optical or visual sensor is positioned on a portion of the coupler. The sensor provides a real-time signal indicating either a coupled state or an uncoupled state, based on the presence of proximity or presence of a portion of a second coupler within a receiving area of the first coupler.

[0013] In an aspect of an exemplary system for detecting whether a coupler of a locomotive is coupled to another rail car as described herein, a sensing device, a wireless transmitter and a status detection system are provided. The sensing device is configured to provide a signal indicative of a coupled state of the coupler, and includes a video camera configured to provide video signals to a controller of the status detection system. The wireless transmitter is in operable communication with the sensing device and is configured to receive and transmit the video signal from the sensing device. The status detection system is configured to receive the signal from the wireless transmitter and includes a controller with image processing algorithms for determining whether the video signals depict a coupled or uncoupled locomotive and a storage medium.

[0014] In an aspect of an exemplary method for determining whether a coupler of a locomotive engine is coupled as provided herein, a video camera is configured to provide
Video signals indicative of either a coupled or uncoupled state of the coupler. The video signals are transmitted wirelessly to a controller. A control algorithm resident in the controller processes the video signals, and a visually perceivable indication of the coupled or uncoupled state of the coupler is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These and other features, aspects, and advantages of the described systems and techniques will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, and wherein:

[0016] FIG. 1 is a schematic illustration of a monitoring system in accordance with exemplary embodiments described herein;

[0017] FIGS. 2, 2A and 2B are views illustrating couplers constructed in accordance with exemplary embodiments described herein;

[0018] FIG. 3 is a top plan view of a pair of couplers in a coupled state;

[0019] FIG. 4 is a view of a sensing device in accordance with an exemplary embodiment described herein;

[0020] FIG. 5 is a graphical representation of output signals of a pair of sensors in accordance with an exemplary embodiment described herein;

[0021] FIG. 6 is a graphical representation of output signals in accordance with an alternative exemplary embodiment described herein;

[0022] FIGS. 7-9 are illustrations of an alternative exemplary embodiment;

[0023] FIG. 10 is a schematic illustration of yet another alternative exemplary embodiment; and

[0024] FIG. 11 is a schematic illustration of a rail yard.

DETAILED DESCRIPTION

[0025] Exemplary embodiments of the systems and techniques described herein are directed to a system and method for robust determination of a locomotive's coupler status. In general, yard engines or locomotives are dedicated to moving road locomotives or other rail cars (e.g., cars that are pushed or pulled by locomotives) to and from different service and staging areas of a rail yard. Accordingly, it is desirable to know when a yard engine is coupled to a rail car or road locomotive. In accordance with an exemplary embodiment, sensors are provided to determine whether a coupled or uncoupled state of a locomotive is achieved. The sensor output is conveyed over a wireless network to a control and monitoring system. In one exemplary embodiment the coupler sensor data may be combined with other data such as speed and direction of motion of the locomotive, which can also be provided wirelessly. This information allows assessment and utilization of the locomotive. Furthermore, the coupler status can be used to monitor progress in completion of assigned tasks and planning of subsequent tasks, thereby increasing productivity of rail yard operations.

[0026] Reference is made to the following patent application Ser. No. 10/360,055, filed: Feb. 6, 2003, the contents of which are incorporated herein by reference thereto.

[0027] Referring now to FIGS. 1 and 2, a monitoring system 10 for use with a railroad locomotive 12 is illustrated. The control system utilizes a sensor or sensors 14 to determine whether a coupler 16 of a locomotive or engine 12 is coupled to another coupler 18 of a rail car 20. In an exemplary embodiment sensor 14 is in operable communication with a transceiver (e.g., receiver and transmitter) or a transmitter 22 configured to transmit a signal 24 indicative of the coupled state of coupler 16.

[0028] In addition, a status detection system 26 is provided wherein a receiver or transceiver 28 is in operable communication with a controller 30. Receiver or transceiver 28 is configured to receive signal 24 and provide the same to controller 30 wherein controller 30 is configured to analyze one or more input signals from sensors 14 and to produce one or more appropriate output signals for use in yard management. The controller may be in the form of a microcomputer, microcontroller, or other programmable control device as either a separate component or integral part of a rail yard operating system. As such, the controller may be any known type of analog or digital device, and it may be embodied as hardware, software or firmware.

[0029] The status detection system further includes a storage media 32 such as nonvolatile memory to store the control program instructions for the controller and other data used by system 10. Furthermore, the status detection system includes a display device 34 such as a computer monitor or screen to indicate train location and movements on a graphical representation of the rail yard, wherein and in an alternative exemplary embodiment the graphical display will include train locations, track locations and other features of the rail yard being monitored by the system.

[0030] In addition, the act of “coupling” or the use of “coupling” herein includes a completed connection and/or the contacting of coupler devices of train engines and rail cars as they interact to make up a coupling connection. In order to couple rail cars and locomotives (or engines) a coupler is disposed on at least one end of the same. There are several types of couplers known to those skilled in the related arts one such source of the types of couplers found are described in “The Railroad What It Is, What It Does” by John H. Armstrong, 4th Edition, Simmons-Boardman Books Inc., 1998, page 106.

[0031] FIGS. 2, 2A and 2B illustrate a non-limiting example of a coupler device (16, 18) contemplated for use in various exemplary embodiments. Each coupler device comprises a neck portion 38 having a clamping portion or head portion 40 secured thereto. Clasping portion 40 defines a throat portion or receiving area 42 configured to receive a portion of another coupling device secured thereto. The coupler also comprises a knuckle portion 44 pivotedly mounted to a portion of the clasping portion defining the throat portion. Knuckle portion 44 is configured for pivotal movement between a coupled portion and an uncoupled portion in order to clasp another knuckle portion of another coupler therein.

[0032] In North America, the rail industry has standardized the use of a swinging knuckle design, which employs the principle of clasped hands. In order to automatically couple the couplers together, one or both of the knuckles must be open when the rail cars with the couplers are pushed together, wherein an open knuckle is moved (pushed) into a closed position by the second coupler device and a locking device 46 drops downward to keep the knuckle in this position and hold it closed. To uncouple the couplers, the cars are pushed together such that the load is removed from the coupler and an uncoupling lever 48 of the locking device is raised by an operator, who lifts a lock pin 50, which allows the knuckle to
swing open as the car and engine are pulled apart. An illustration of two couplers coupled together is shown in FIG. 3.

[0033] Conditions incident to coupling include approaching railcar 20 (FIG. 1) (the approach) actual contact with the railcar (the impact) and the various resulting effects of the impact (the effect). Information representative of these conditions can be identified, recorded and provided to monitoring system 10 through various sensors 14. In addition, the act of “coupling” as that term is used in this herein includes a completed connection and/or the contacting of the coupler devices as they interact to make up the coupling connection, as appropriate for the context of the description.

[0034] In addition and as used herein, “uncoupling” is defined as the absence of a connection between coupler devices or the opening and separation of coupler devices. It should be noted that uncoupling does not involve an impact such as that resulting from the coupling event (when locomotive is brought into contact with the rail car at speeds typically less than four miles per hour).

[0035] In accordance with an exemplary embodiment, sensors 14 are installed on couplers at each end (forward and rear) of a locomotive (or yard engine). The output of these sensors is conveyed using wireless network from the locomotive to a central control location (i.e. monitoring location) wherein the status detection system is located. In addition to the coupler sensors, the speed and direction of motion of the locomotive may also be conveyed to the central control location. Speed and direction may be obtained using GPS receiver or other devices 60 also equipped with a transceiver or transmitter 62 to at least transmit a speed and direction signal 64 to the transceiver of the status detection system.

[0036] In accordance with exemplary embodiments described herein the sensing of the couplers is implemented using one or more of the following approaches: proximity sensors embedded within the knuckle or throat of the coupler device; one or more strain gauge sensors affixed to the coupler neck; a magnetic circuit; and an optical or visual detection system comprising a camera and computer vision system or any other equivalent device capable of providing a real-time signal or signals indicative of coupler status.

[0037] Referring now to FIG. 3, an exemplary embodiment comprising one or more inductive proximity sensors 70 embedded within the knuckle or throat of the coupler device is illustrated. Here an industrial proximity sensor is located in the coupler body with its active end at the throat wherein the presence of a knuckle on another coupler in the throat triggers the sensor or causes the sensor to provide an output signal. Such inductive proximity sensors are commonly used within industrial environments to detect presence of ferrous metals. One non-limiting example of such an inductive proximity sensor is available from Turck, wherein additional information is found at www.turck.com. Of course, other inductive sensors are contemplated for use with exemplary embodiments described herein. Accordingly, such a sensor will respond to the presence of another steel knuckle in close proximity to the sensor. In accordance with an exemplary embodiment and referring now to FIGS. 4 and 5, multiple sensors 70 are used to detect a coupled or uncoupled state regardless of the direction of motion (i.e. pushing or pulling of the rail car).

[0038] FIG. 4 shows a non-limiting example as to where a pair of proximity sensors 70 would be installed within a knuckle, each sensor having their active end disposed to detect a portion of another knuckle. While the proximity sensors could be installed in the coupler neck or throat, installation of these sensors in the knuckle affords rapid configuration and utilization as knuckles can be changed by Carmen in a matter of minutes. Change of a coupler neck, on the other hand, requires service within a locomotive shop.

[0039] Referring now to FIG. 5, a graph of the sensors A and B are shown for signals of various coupling states. In the absence of a proximate metal, the proximity sensors will output a low (zero) voltage level (state 72). Using the configuration of FIG. 4, one or both proximity sensors will provide a high voltage level when another knuckle and coupler are brought in contact during a coupling event. Depending upon the relative position of the two couplers and their knuckles, open space referred to as “slack”, may place the coupler components beyond the sensor detection range. Under such a condition the sensors will not detect the coupled state. This is illustrated as state 76. As the railcar is moved, one or more of the proximity sensors will provide the high voltage output regardless of the direction of the movement (i.e. push or pull of the rail car). This is illustrated as states 70 and 80. Uncoupling and separation is also illustrated as state 82 wherein both sensors will provide an output. The location of the proximity sensors is selected to accommodate potential misalignment of the couplers, which is on the order of 10 degrees or less. Misalignment is shown as “free slack” in FIG. 3. Furthermore, the proximity sensors are selected to provide a detection distance for the metal surfaces on the order of ½ inch (which represents half of the ¼ inch cited as slack spacing for a pair of couplers in a nominal condition). Of course, other configurations are contemplated in accordance with exemplary embodiments described herein.

[0040] Referring back now to FIG. 5, wherein proximity sensor outputs for various coupling conditions and car movements is provided it is noted that during steady state the output levels from the sensors depends upon the resulting slack and detection distances of the proximity sensors. In accordance with an exemplary embodiment, both coupling and uncoupling events appear on one or both sensor outputs (state 74 and 82). Thus, as the locomotive moves, at least one of the proximity sensors is brought into contact or near contact with the opposing knuckle or coupler as the slack is pulled out from the cars. Accordingly, this output and data as provided to the controller wherein further processing is provided and the status of the yard engine or locomotive is provided to the yard operator.

[0041] In an alternative embodiment and referring now to FIGS. 1, 2 and 6, one or more strain gauge sensors 86 are affixed to the coupler neck. In this embodiment, the force on the neck is detected by the sensor, which will indicate whether a load is either being pushed or pulled by the locomotive. A non-limiting example of the output from a strain gauge 86 installed on the coupler neck is illustrated in FIG. 6. As shown, the force from the coupling event translates to a positive output signal 88 from the sensor. As the locomotive pushes or pulls the rail car (or another locomotive), the forces produce non-zero output from the strain gauge. Thereafter, FIG. 6 illustrates locomotive stoppage, locomotive reversing, bounce from pulling, and steady pulling by the engine. Thereafter, sensor outputs corresponding to reduced speed, breaking and stopped train conditions are also illustrated. Accordingly, each of these conditions is capable of being sensed by the strain gauge sensor or sensors (in any type of order)
wherein a sensor provides an output signal in digital or analog format for further interpretation by control algorithms of system 10.

[0042] In this embodiment, detection of an uncoupling event will also require combination of engine motion (i.e., speed) information from sensor 60. In other words, the uncoupling event will be recognized only when the locomotive moves and the speed signal will be the second signal required to show that the locomotive is moving and uncoupled. Non-limiting examples of a strain gauges sensor comprise a Wheatstone bridge and the output voltage is recorded using a V-Link wireless data recorder by MicroStrain.

[0043] Referring now to FIGS. 7-9, another alternative exemplary embodiment is illustrated. Here a magnetic signaling device 90 is illustrated. In this embodiment and when the locomotive is coupled to the car, there is a magnetic circuit of high average permeability 94 that is defined by a closed path that runs from the neck of one coupler through the adjacent coupler, through the adjacent car frame, and returns through the rail to the other car frame, and back to the point of origin on the original coupler’s neck. An effective air gap between the two couplers subserves such small distances as non-ferromagnetic iron oxide patina, oil interfaces, etc. When the locomotive and the car are decoupled (FIG. 7), the air gap portion of the magnetic circuit is significantly increased, as the flux then passes through the air from the coupler tip to the rails. This is illustrated as magnetic circuit 94. In this embodiment the magnetic sensing device comprises a means for differentiating between the coupled and uncoupled states by sensing the change in average permeability of the magnetic circuit.

[0044] As a very crude analysis: the inductance seen by the magnetic circuit is proportional to the relative permeability, \( \mu_r \), of the magnetic material in the circuit where \( \mu_r \) is defined as \( \mu_r = \mu_{material}/(1+\mu_{material}/\mu_{iron}) \), where \( \mu_r \) is the relative permeability of the iron, and \( L \) is the length of the gap.

[0045] Consider that in the locomotive-car separated case, an air gap of length \( L \) in the magnetic circuit is approximated by the effective length of flux line travel. In this case, \( \mu_{material}/(1+\mu_{material}/\mu_{iron}) \). If the locomotive is in contact with the car, locomotive-car contact case, we approximate \( L = 0 \) and \( \mu_{material} \). The change in inductance between the locomotive-car separated case and the locomotive-car contact case should be dramatic and this change should be detectable in a number of ways.

[0046] One way of providing this sensing device is illustrated in FIGS. 7-9, wherein the drawbar is surrounded with two electrical coils 100 and 102 at different locations. A time-varying current is passed through one coil that establishes a time-varying magnetic field. The time-varying magnetic field induces a current in the second coil. The magnitude of the induced current will be greater for the coupled state. Thus, the coupled state will be detected.

[0047] An alternative method for sensing the change in inductance of the magnetic circuit is to use a single coil as part of an inductance estimating circuit such as a simple tuned-circuit resonator.

[0048] Referring now to FIG. 10 yet another alternative exemplary embodiment is illustrated. Here an optical or visual sensing system 120 with remote sensing capabilities is provided. In this embodiment, a camera 122 is mounted on the end of the locomotive, above and oriented at the coupler. The camera is coupled to a transceiver 124 wherein video signals are provided to computer vision algorithms resident upon the microprocessor of the status detection system, wherein the vision algorithms are applied to the incoming video stream to detect a coupled state or uncoupled state. The image and computer processing algorithms can include such techniques as pattern matching, edge detection, location of recognized shapes or patterns within the visual field and such other techniques that would be understood to be applicable to discern the two states. The video camera may also include an illumination source to provide enhanced operation during night and inclement weather conditions. In some embodiments, an aperture cleansing system may also be provided to remove dirt, grime or other detritus that may interfere with the data capture capability of the camera or other sensor.

[0049] The image processing techniques can include pattern matching techniques that are used to identify specific visual signatures that indicate visible features of the coupler. For example, patterns identified with an open or closed state of a clamping portion 40 of a coupler can be recognized. In addition, patterns identified with the presence or absence of a portion of another coupling device being within the receiving area 42 of a coupler can also be identified. Such patterns may be identified in various, such as identifying the edges present within the visual field and using these edges to identify the configuration of the various components of the coupler(s) within the optical field of view of the camera.

[0050] When such optical recognition is based upon the geometry of the couplers, no additional sensors or preparation may be required in order for the system to properly recognize a coupled or uncoupled state. This may be of particular advantage when the system is in use with cars that are associated with various entities that may not be affiliated with the locomotive, and which may not have been prepared specifically to work with the optical imaging system described herein.

[0051] However, various techniques are available which may be used to enhance the operation of the system, both when recognizing coupling events with specially prepared cars, as well as when working with cars or engines that have not been specially prepared for detection by the visual sensors described herein.

[0052] One example of such enhancement is through the use of illumination of the couplers and the area within the field-of-view of the optical sensors. Such illumination can be provided via a light or other illumination source that is mounted on the locomotive 12 or another rail car. The illumination may be provided in a variety of wavelength ranges, but it will generally be understood that it will be at least one of the provided illumination wavelength ranges should overlap with the wavelengths which the sensor is able to detect. Such ranges are not limited to, but can include: the visible spectrum (which may also have practical benefits in that such illumination is also of benefit to yard workers, and may even already be present); the infrared spectrum, particularly the near-infrared spectrum, for which many common optical sensors (such as charge-coupled devices, or CCDs) provide sensitivity; the ultraviolet spectrum; and any other range that may be suitable.

[0053] The use of non-visible spectrum wavelengths may provide an advantage where very high levels of illumination are required that might cause difficulties for yard workers subject to such bright lights. In addition, the use of non-visible wavelengths may provide an ability to properly illuminate the desired area at night without damaging the night-vision of yard workers.
Light enhancement techniques may also be used either in place of, or in addition to, illumination. Such enhancement techniques may include the use of ambient light enhancement, such as with photomultiplier tubes sensitive to photons of appropriate wavelengths. The application of materials which respond to particular types of illumination, such as fluorescent materials, may also be used to increase the definition of the geometry within the optical field-of-view when properly illuminated.

Ordinary reflective materials may also be suitable for improving the definition within the visual field and enhancing the ability of the visual sensor to detect specific geometry patterns associated with a coupled or uncoupled state. In addition to such visual reflectivity enhancements, specific predetermined patterns may be placed on or near the coupler of either or both of the locomotive or the rail car to make detection of the presence and state of the coupler easier.

Such patterns can be disposed upon the coupler or related geometry using techniques described above, such as the use of reflective or emissive (such as fluorescent) materials, or can be disposed upon pre-made optical targets that can be attached to the coupler of the locomotive or rail car. It will be recognized that such patterns may be patterns that are more easily detected or processed by the controller. The use of such targets may also be effective to enhance detection in circumstances where the geometric design of the coupler is different from that originally intended to be recognized, or if limitations of the locomotive or rail car geometry prevent a clear line of sight from the camera to the couplers in the operative condition.

In addition, it will be recognized that in some embodiments, the camera or other visual sensor may be disposed upon a rail car other than a locomotive. It will also be understood that the detection techniques described herein are not strictly limited to detecting coupling between a locomotive and a rail car, but may be used to determine a coupling status of two rail cars (when appropriately equipped), between a rail car and a piece of rail yard equipment other than a locomotive, or between any objects being monitored that provide an appropriate coupling mechanism. Examples of such objects may include without limitation tandem trailers with appropriate couplers for use on roadways and tugboats and/or barges.

In another embodiment of an optical sensor system, a visual sensor, such as a camera is provided that includes a control algorithm within the visual sensor. With electronics becoming ever more inexpensive, powerful and environmentally hardened, and with a general decrease in power consumption for electronic processing, an appropriate control algorithm may be included within the camera circuitry itself such that a determination as to whether a coupled or uncoupled state is detected may be made within the camera or other optical sensor at the point of detection.

This control algorithm may be executed on a controller which may be part of the video camera, or otherwise disposed in association with the camera, rather than being disposed at a remote status detection system. In such embodiments, a signal indicating the coupler's state (coupled or uncoupled) may be wirelessly broadcast from the camera or other sensor system, rather than transmitting the video signal for off-board processing in order to make a coupling-state determination. In some embodiments, such an embedded camera/controller could be configured such that the processing is incorporated at the focal plane rather than in a distinct controller component.

In accordance with various exemplary embodiments, a robust sensor for detecting coupled and uncoupled status of a locomotive or yard engine is provided. As disclosed herein and in accordance with an exemplary embodiment, wireless communication of the sensor state is provided from the locomotive to a control (monitoring) location.

In addition, the coupling detection of yard engines can be used by yard personnel to plan and assign yard tasks as these inputs can also be used to feed an automated monitoring system which captures historical performance data as to task completion for individual locomotives and their operators. Moreover, such an automated monitoring system can also be used by yard personnel to enhance their planning and overall yard productivity.

Accordingly, exemplary embodiments allow for fast, simple and low cost methods of creating an accurate track location database for a rail yard. A generic view of a rail yard is illustrated in FIG. 11.

In accordance with an exemplary embodiment, the monitoring system comprises at least a central computer, a rail track database and sensors to provide real time data of rail yard assets for use with the rail track database to provide a visual representation of the assets as they move through the rail yard, which may include various sub yards including but not limited to a receiving yard, a classification yard, a storage and receiving yard, and a departure yard. In accordance with an exemplary embodiment, the described systems employ GPS receivers to provide accurate track placement of locomotives on a status display. Exemplary embodiments provide real-time location of rail yard assets to rail yard personnel in order to enable time-critical decisions to be made relative to task planning, safety and efficiency.

As described above, algorithms for implementing exemplary embodiments can be embodied in the form of computer-implemented processes and apparatuses for practicing those processes. The algorithms can also be embodied in the form of computer program code containing instructions embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, or any other computer-readable storage medium, wherein, when the computer program code is loaded into and executed by a computer and/or controller, the computer becomes an apparatus for practicing the described technique. Existing systems having reprogrammable storage (e.g., flash memory) that can be updated to implement various aspects of command code, the algorithms can also be embodied in the form of computer program code, for example, whether stored in a storage medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein, when the computer program code is loaded into and executed by a computer. When implemented on a general-purpose microprocessor, the computer program code segments configure the microprocessor to create specific logic circuits.

These instructions may reside, for example, in RAM of the computer or controller. Alternatively, the instructions may be contained on a data storage device with a computer readable medium, such as a computer diskette. Or, the instructions may be stored on a magnetic tape, conventional hard disk drive, electronic read-only memory, optical storage
device, or other appropriate data storage device. In an illustrative embodiment, the computer-executable instructions may be lines of compiled C++ compatible code.

In accordance with exemplary embodiments the central control unit may be of any type of controller and/or equivalent device comprising among other elements a microprocessor, read only memory in the form of an electronic storage medium for executable programs or algorithms and calibration values or constants, random access memory and data bases for allowing the necessary communications (e.g., input, output and within the microprocessor) in accordance with known technologies. It is understood that the processing of the above description may be implemented by a controller operating in response to a computer program. In order to perform the prescribed functions and desired processing, as well as the computations therefore, the controller may include, but not be limited to, a processor(s), computer(s), memory, storage, register(s), timing, interrupt(s), communication interfaces, and input/output signal interfaces, as well as combinations comprising at least one of the foregoing.

The various embodiments of detection systems and techniques described above thus provide a way to achieve a determination as to whether or not a locomotive is coupled to a rail car while at an arbitrary location within a rail yard. These techniques and systems also allow real-time detection of such coupling states even when a particular rail car is not disposed at a monitored location.

Of course, it is to be understood that not necessarily all such objects or advantages described above may be achieved in accordance with any particular embodiment. Thus, for example, those skilled in the art will recognize that the systems and techniques described herein may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

Furthermore, the skilled artisan will recognize the interchangeability of various features from different embodiments. For example, the use of near-infrared optical detection as described with respect to one embodiment can be adapted for use with optical targets having pre-determined patterns to enhance detection and recognition as described with respect to another. Similarly, the various features described, as well as other known equivalents for each feature, can be mixed and matched by one of ordinary skill in this art to construct additional systems and techniques in accordance with principles of this disclosure.

Although the systems herein have been disclosed in the context of certain preferred embodiments and examples, it will be understood by those skilled in the art that the invention extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the systems and techniques herein and obvious modifications and equivalents thereof. Thus, it is intended that the scope of the invention disclosed should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the claims that follow.

What is claimed is:
1. An apparatus for indicating whether a first coupler of a locomotive is in a coupled or an uncoupled state, the apparatus comprising:
   a visual sensor positioned on a portion of the coupler, wherein the sensor provides a real-time signal indicative of either a coupled state or an uncoupled state, the coupled or uncoupled state indicating a proximity or presence of a portion of a second coupler within a receiving area of the first coupler.

2. The apparatus as in claim 1, wherein the signal is transmitted wirelessly by a transmitter in operable communication with the sensor.

3. The apparatus as in claim 1, wherein the signal provided by the sensor is responsive to the wavelengths of light outside of the human-visible spectrum.

4. The apparatus as in claim 1, wherein the visual sensor comprises a charge-coupled device whose field-of-view includes the coupler.

5. The apparatus as in claim 1, wherein the coupler comprises an optical target configured to present a predetermined optical pattern within the field-of-view of the visual sensor.

6. The apparatus as in claim 1, wherein the coupler includes a predetermined optical pattern within the field-of-view of the visual sensor.

7. The apparatus as in claim 6, wherein the predetermined optical pattern is disposed upon the coupler using a surface treatment.

8. The apparatus as in claim 7, wherein the surface treatment is fluorescent and the apparatus includes an illumination source whose emitted wavelengths of light are in the ultraviolet spectrum.

9. The apparatus as in claim 1 further comprising a control algorithm for determining whether the coupler is in a coupled or an uncoupled state.

10. A system for detecting whether a coupler of a locomotive is coupled to another rail car, the system comprising:
   a sensing device configured to provide a signal indicative of a coupling state of the coupler;
   a wireless transmitter in operable communication with the sensing device, the wireless transmitter being configured to receive and transmit the signal; and
   a status detection system configured to receive the signal from the wireless transmitter, the status detection system comprising:
   a controller including image processing algorithms for determining whether the video signals depict a coupled or uncoupled locomotive and
   a storage medium,

11. The system as in claim 10, further comprising an illumination source configured to illuminate the coupler.

12. The system as in claim 11, wherein the illumination source provides illumination wavelengths outside of the human-visible spectrum.

13. The system as in claim 10, further including an optical target disposed upon the coupler and having a predetermined optical pattern.

14. The system as in claim 10, wherein the coupler includes a predetermined optical pattern within the field-of-view of the visual sensor.

15. The system as in claim 14, wherein the predetermined optical pattern is disposed upon the coupler using a surface treatment.

16. The system as in claim 15, wherein the surface treatment is fluorescent and the system further comprises an illumination source whose emitted wavelengths of light are in the ultraviolet spectrum.
17. The system as in claim 10, further comprising:
a display device, wherein the controller is configured to
provide a graphical indication of the coupling state on
the display device, wherein the graphical indication pro-
vides real time status of the locomotive.

18. A method for determining whether a coupler of a loco-
motive engine is coupled, the method comprising:
configuring a video camera to provide video signals indica-
tive of either a coupled or uncoupled state of the coupler;
transmitting the video signals wirelessly to a controller;
processing the video signals with a control algorithm resi-
dent upon the controller; and
providing visually perceivable indication of the coupled or
uncoupled state of the coupler.

19. The method as in claim 18, further comprising:
programming the controller with image processing algo-
rithms for determining whether the video signals depict
a coupled or uncoupled locomotive.

20. The method as in claim 18, further comprising:
disposing an optical target having a predetermined optical
pattern upon the coupler.

21. The method as in claim 20, further comprising:
illuminating the coupler with a light source.

22. The method as in claim 21, wherein the light source
provides illumination wavelengths outside of the human-vis-
ible spectrum.

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