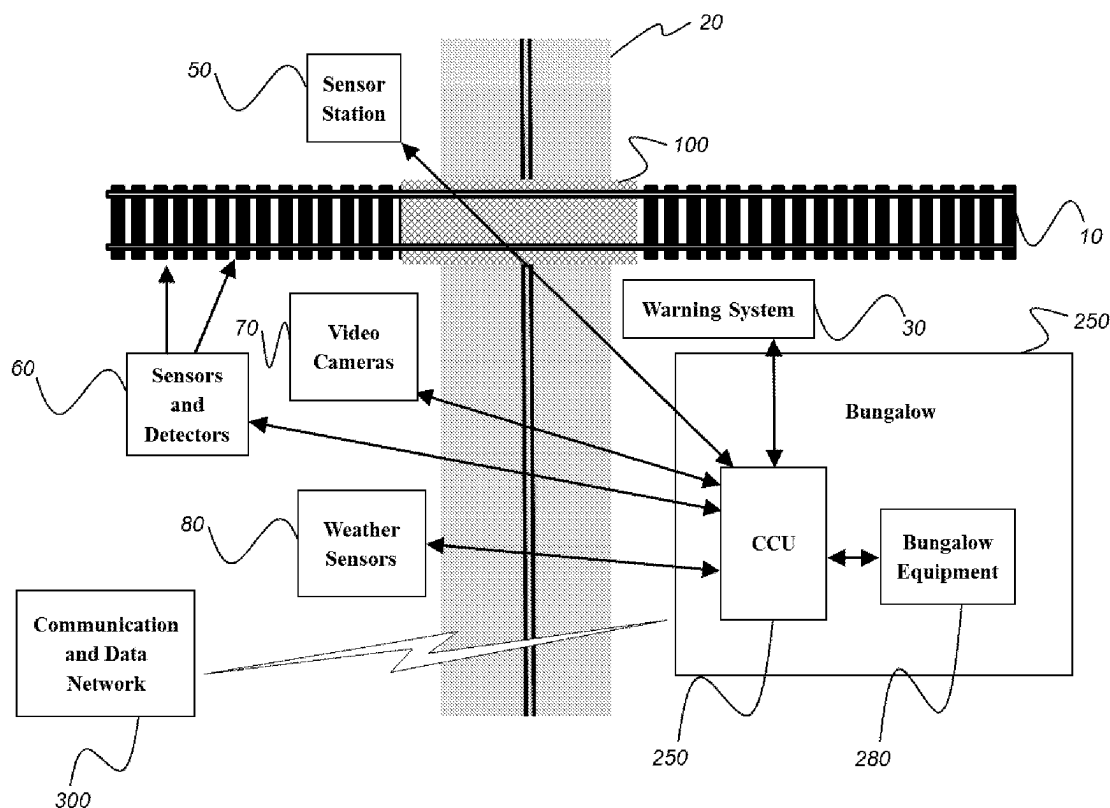




US 20130256466A1

(19) **United States**(12) **Patent Application Publication**
Carlson et al.(10) **Pub. No.: US 2013/0256466 A1**(43) **Pub. Date: Oct. 3, 2013**(54) **RAIL CROSSING REMOTE DIAGNOSTICS**(71) Applicant: **Metrom Rail, LLC**, Lake Zurich, IL
(US)(72) Inventors: **Richard C. Carlson**, Wauconda, IL
(US); **John Wolf**, Wauconda, IL (US);
Kurt Gunther, Round Lake Heights, IL
(US); **Richard Carlson, JR.**, Chicago,
IL (US)(21) Appl. No.: **13/855,118**(22) Filed: **Apr. 2, 2013****Related U.S. Application Data**(60) Provisional application No. 61/686,231, filed on Apr.
3, 2012.**Publication Classification**(51) **Int. Cl.**
B61L 5/00 (2006.01)(52) **U.S. Cl.**CPC **B61L 5/00** (2013.01)USPC **246/218**(57) **ABSTRACT**

The present technology provides a rail crossing remote diagnostics system. The rail crossing remote diagnostics system includes a rail crossing station monitor installed in a bungalow at a rail crossing station. The station monitor has a communication module, such as a wireless transceiver, a connection to the ethernet, a cellular transceiver, a telephone connection, or a modem. The rail crossing remote diagnostics system also includes one or more diagnostic sensors installed at the rail crossing station. The diagnostic sensors are adapted to communicate with the station monitor. The station monitor automatically monitors at least one device installed at the rail crossing station and generates rail crossing diagnostics reports. The present technology also provides a rail crossing diagnostics network that includes a network hub and one or more rail crossing remote diagnostics systems. Certain embodiments also provide methods for automatically monitoring the operation of a rail crossing station.



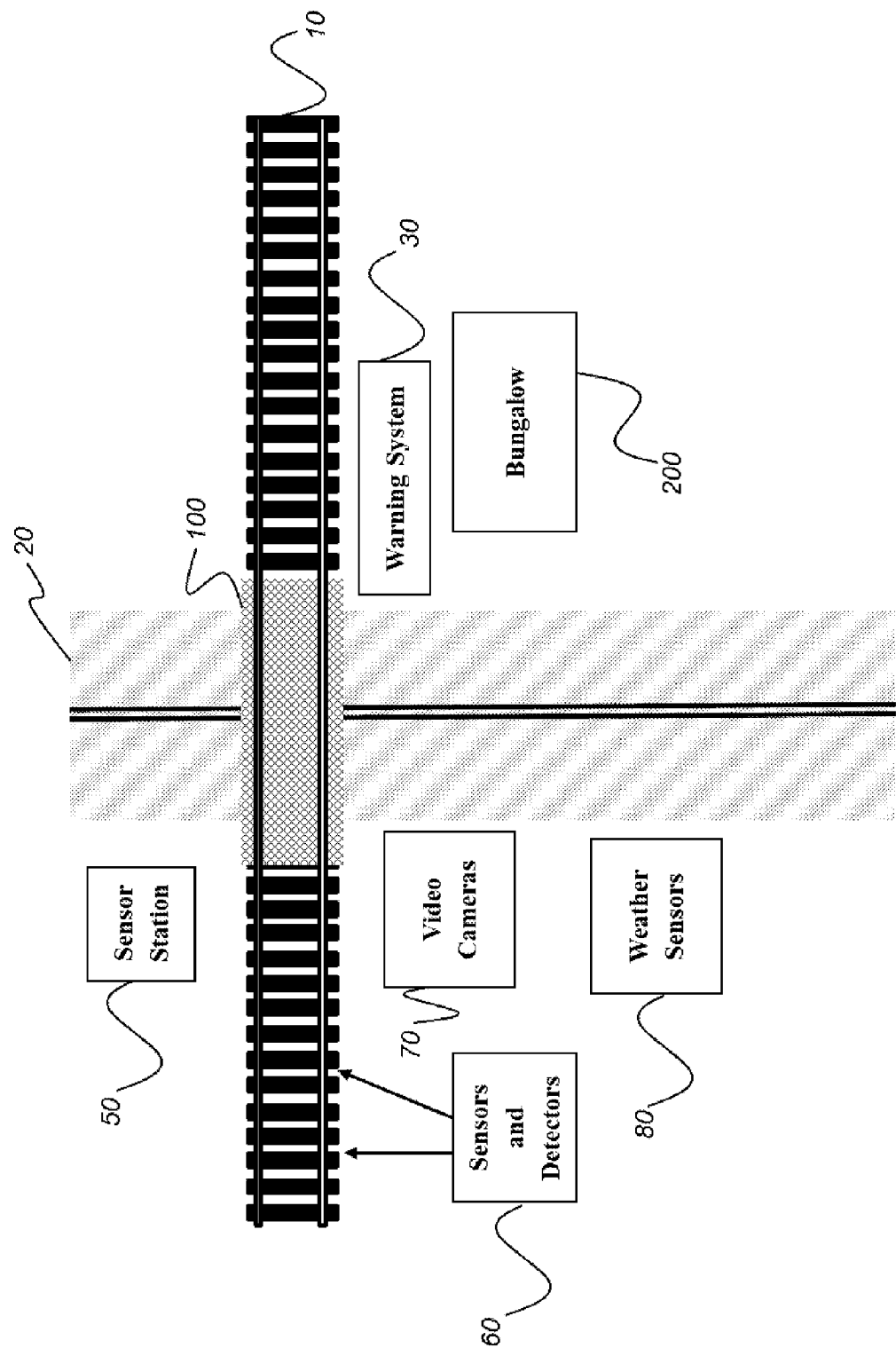


FIGURE 1

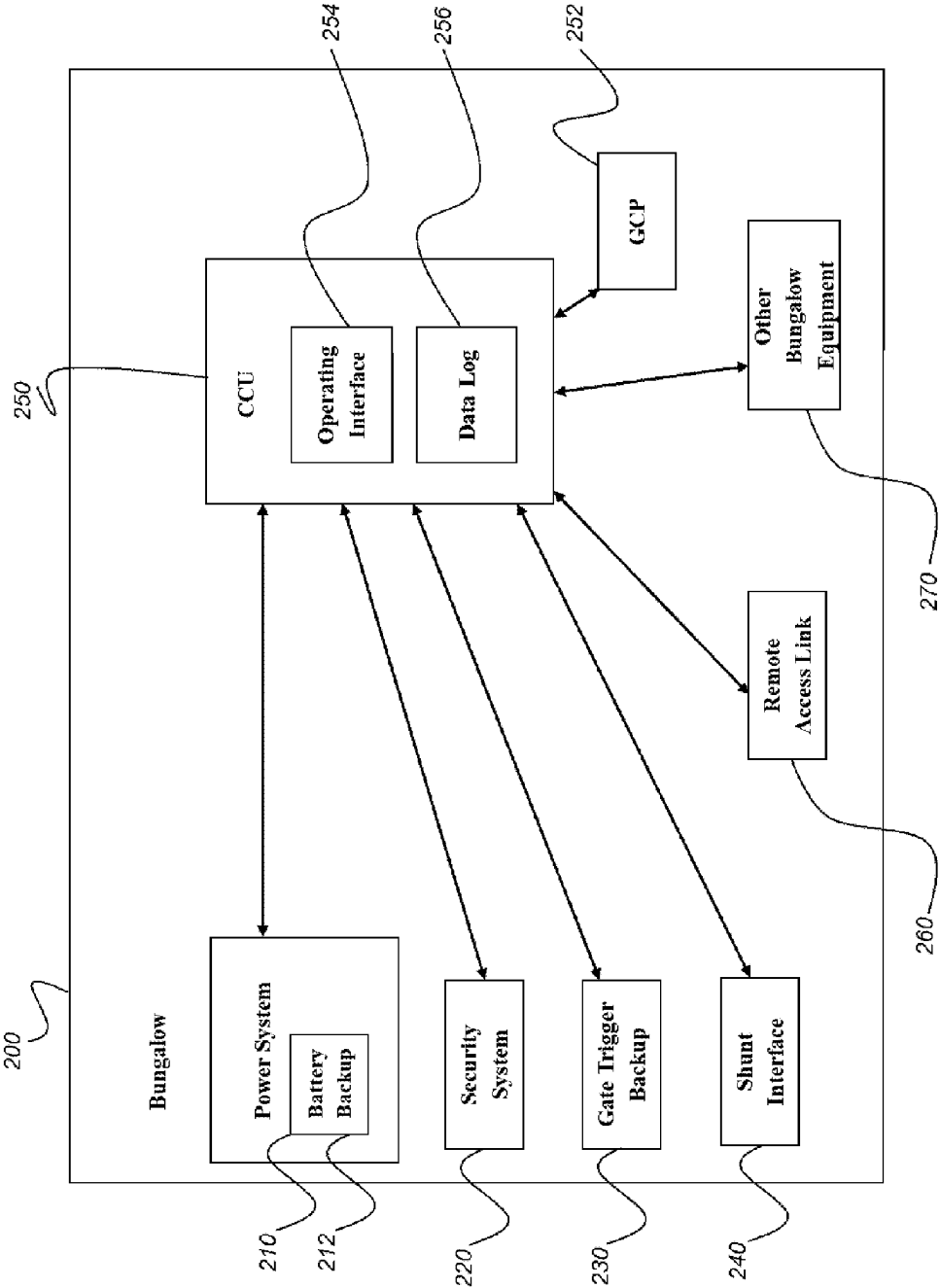


FIGURE 2

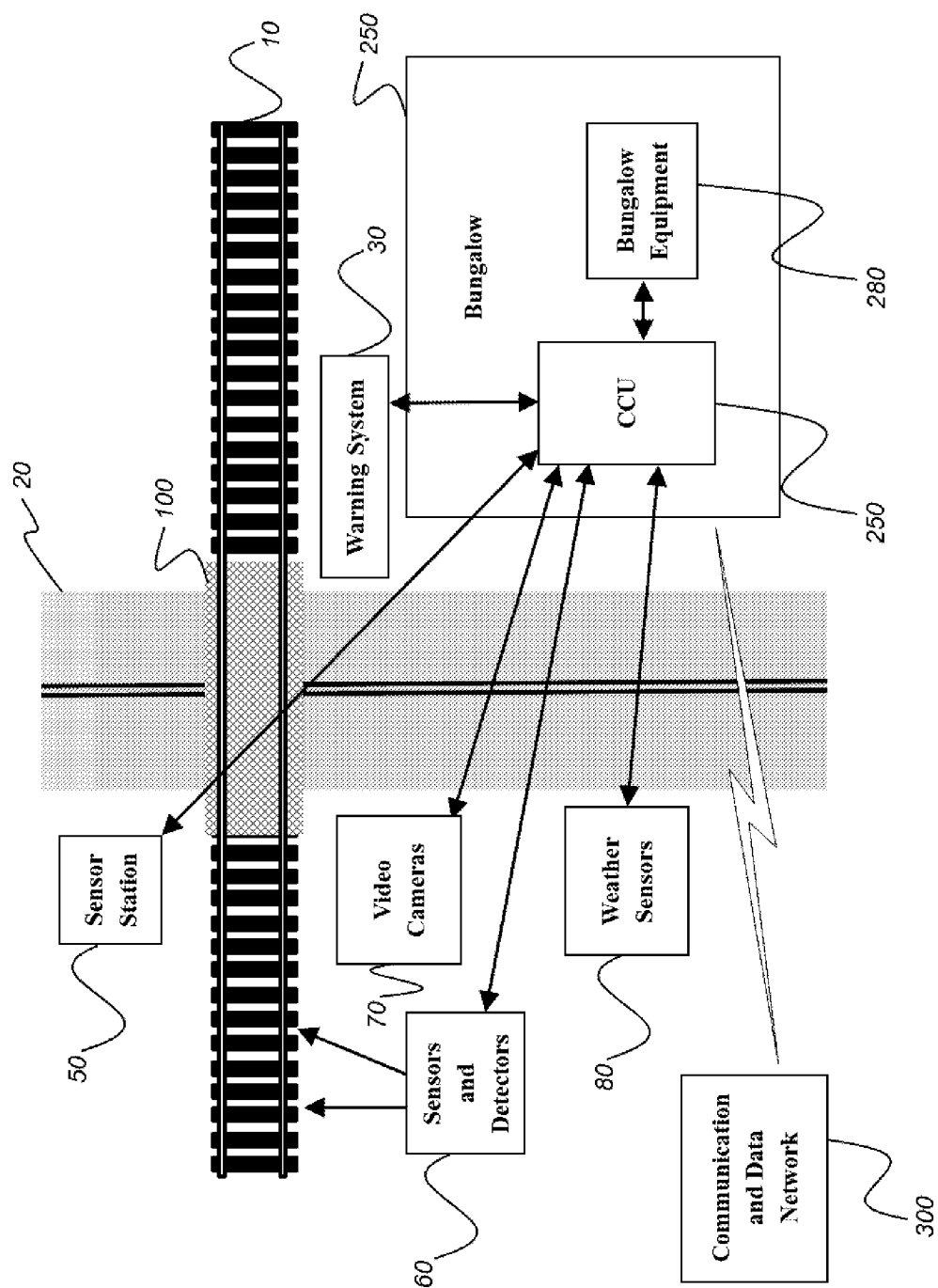


FIGURE 3

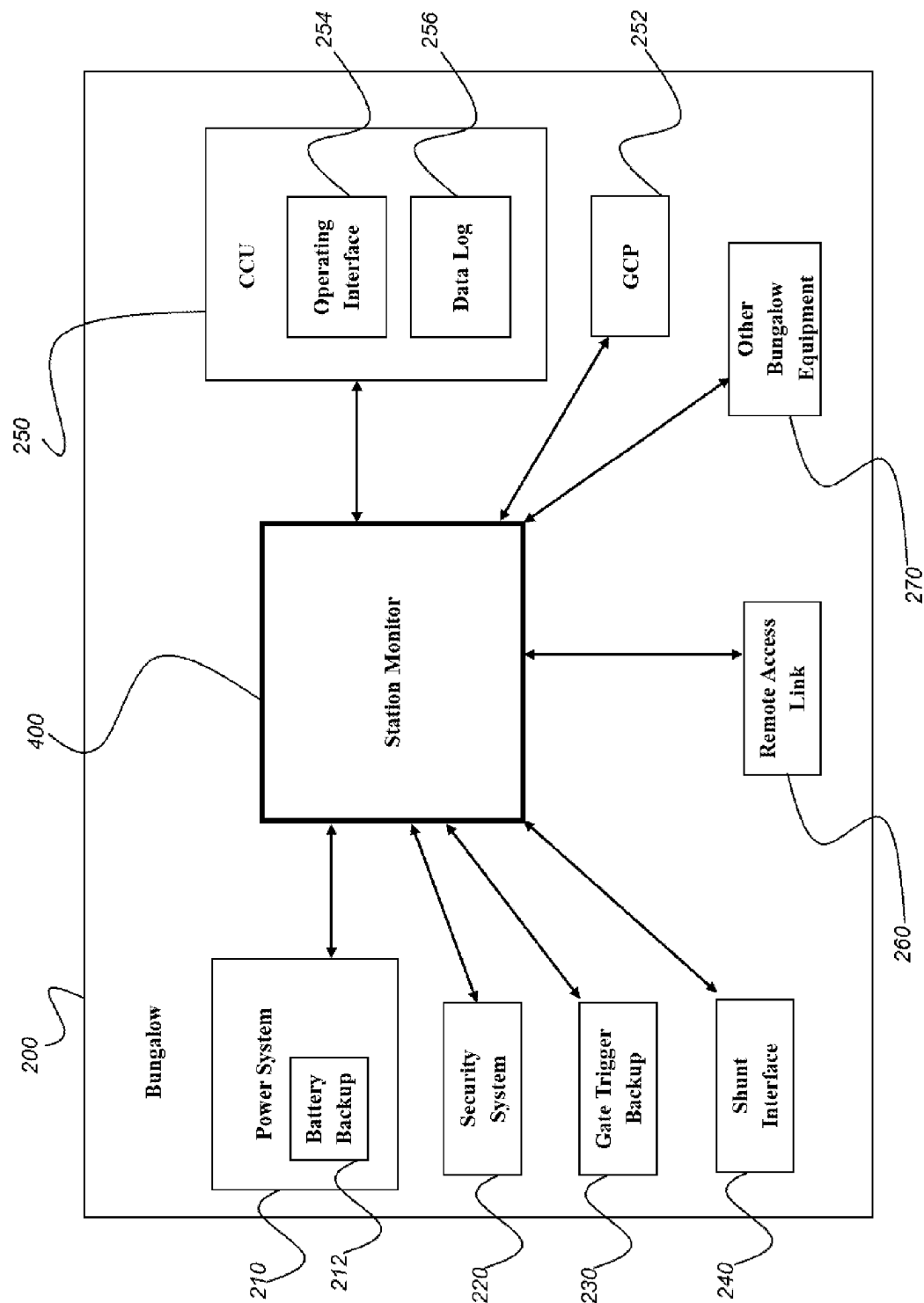


FIGURE 4

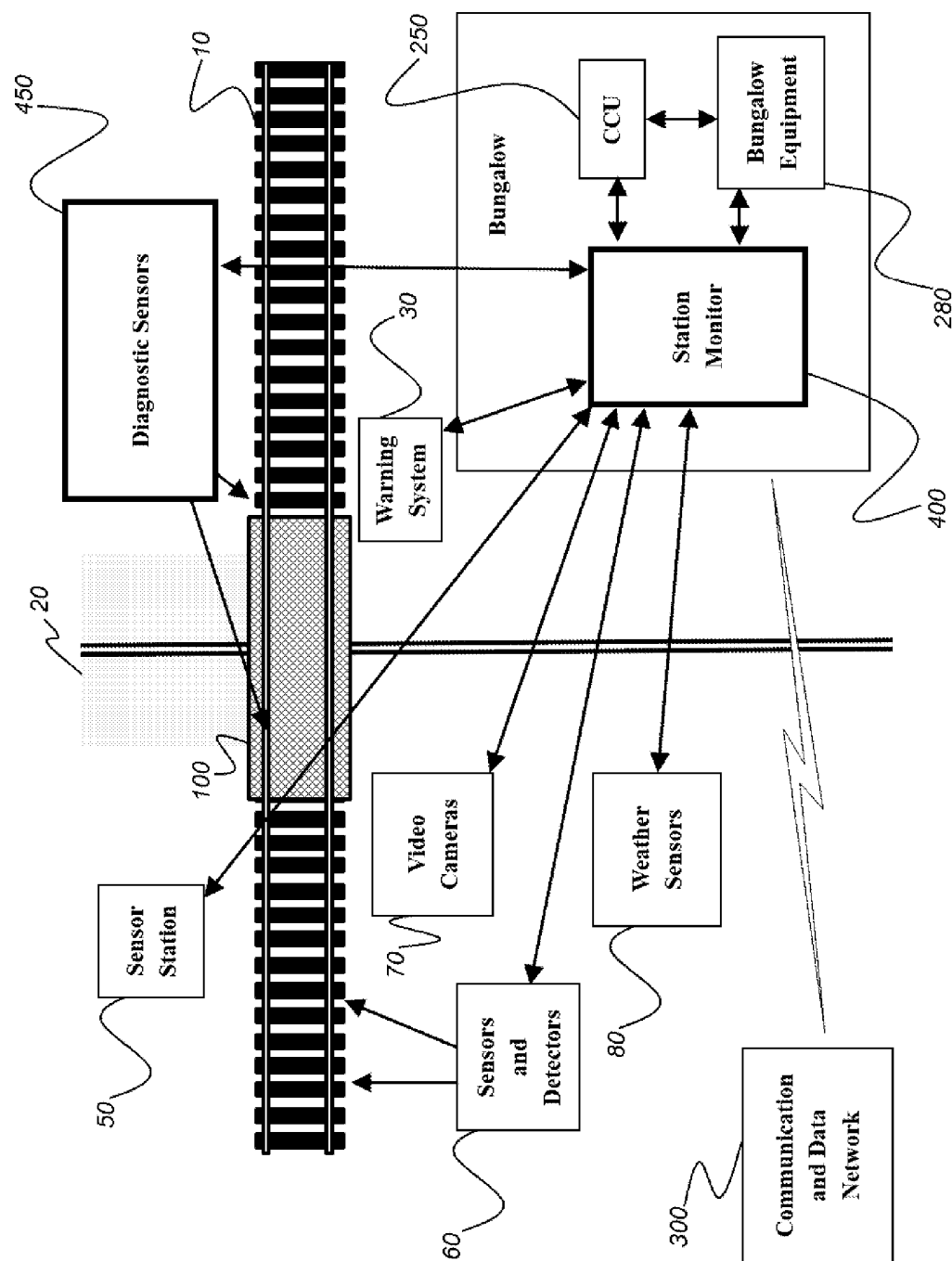


FIGURE 5

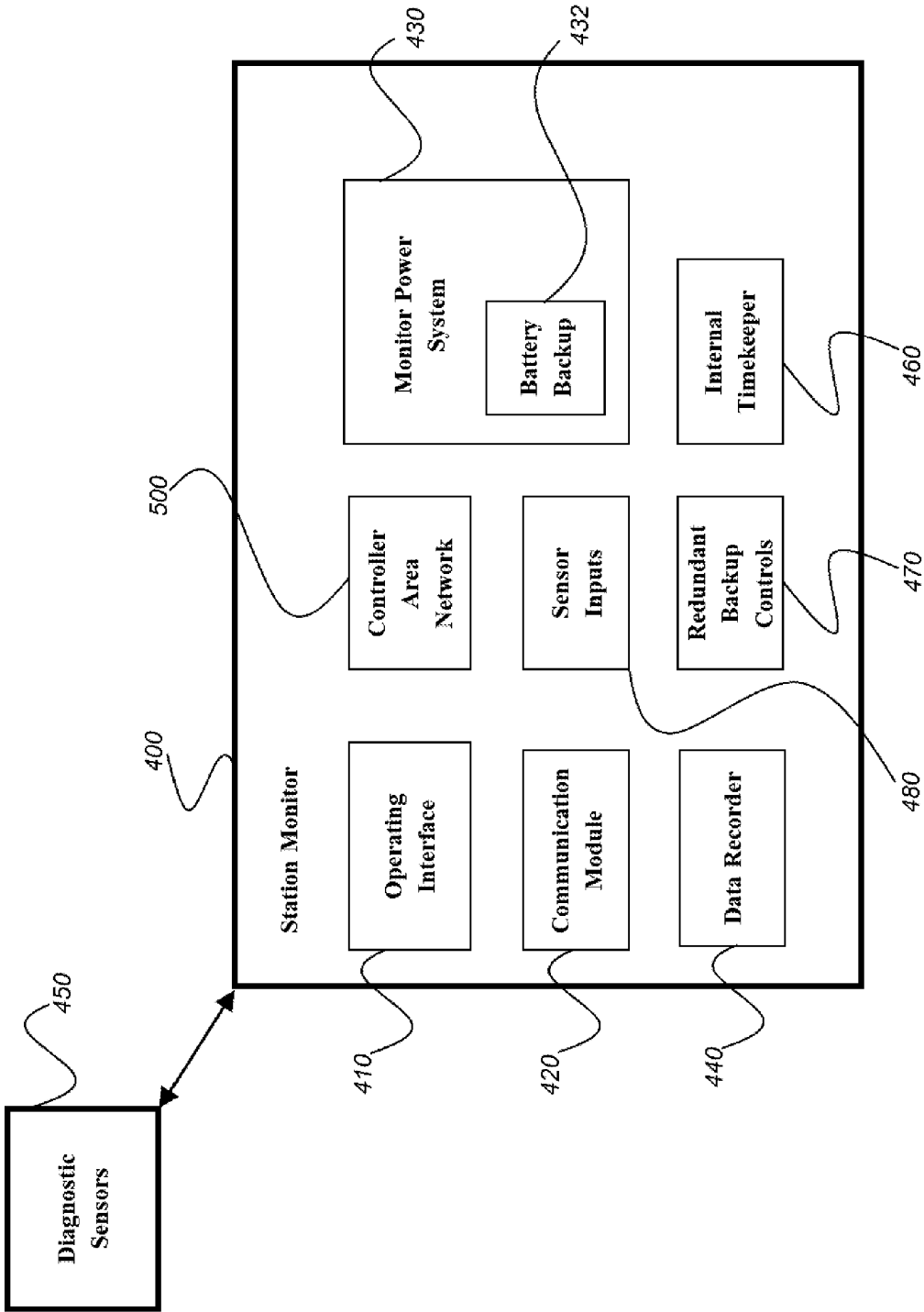


FIGURE 6

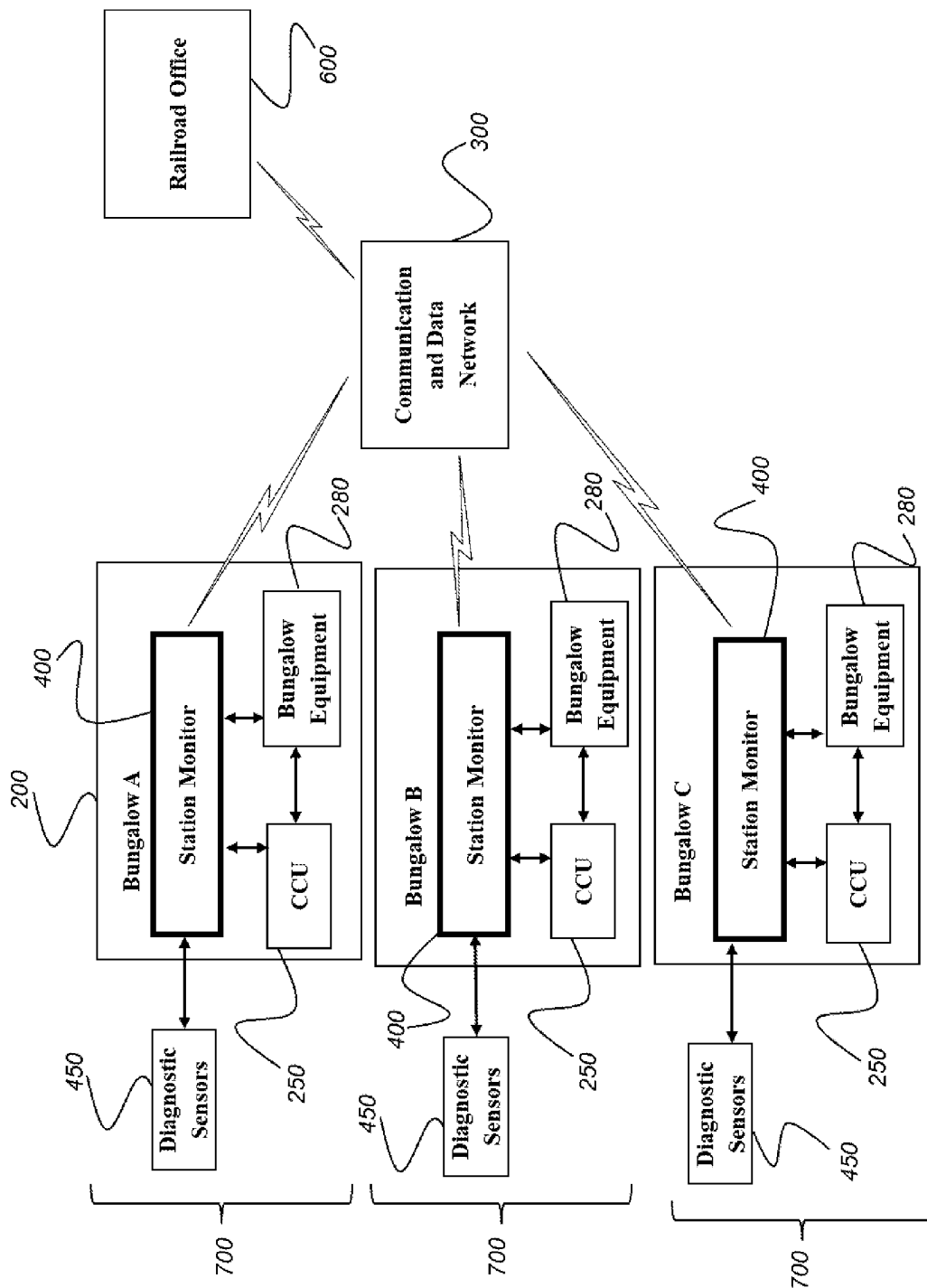
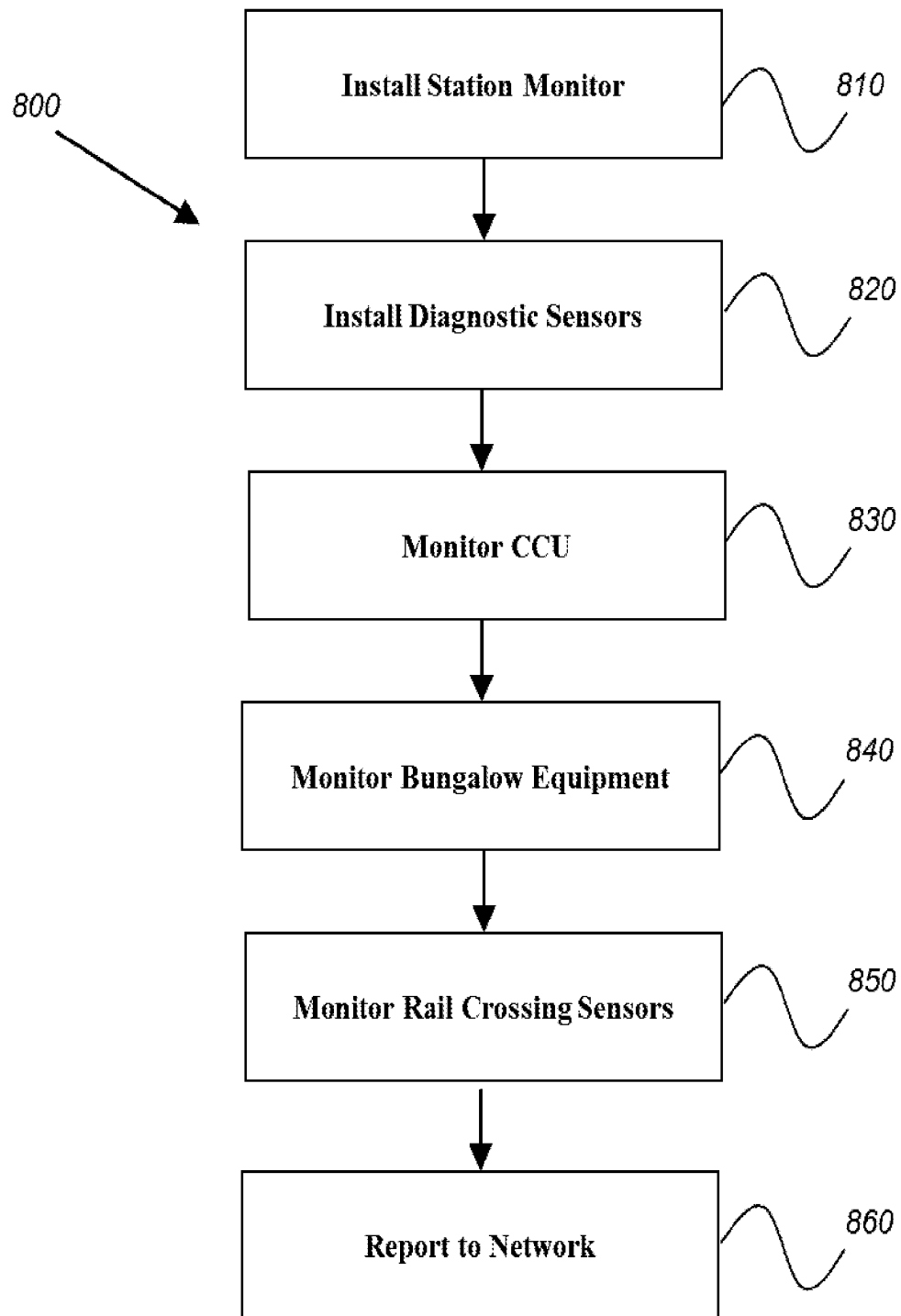


FIGURE 7

**FIGURE 8**

RAIL CROSSING REMOTE DIAGNOSTICS

RELATED APPLICATIONS

[0001] This application makes reference to, and claims priority to U.S. Provisional Patent Application No. 61/686,231 filed on Apr. 3, 2012 by Richard C. Carlson, titled "Rail Crossing Remote Diagnostics." U.S. Provisional Patent Application No. 61/686,231 is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] Railroad companies are responsible for maintaining proper operation of the functions and features at rail crossing stations, i.e., locations where a section of rail intersects a section of road. These responsibilities include monitoring and ensuring proper the operation of rail crossing warning systems and related equipment. The rail crossing stations often include a warning system, which can include a warning light assembly, a gate assembly, and an audio warning, such as a bell, a horn or a siren, for example, and various sensors and/or detectors that trigger the warning system. The rail crossing stations also often include a bungalow or other enclosure that contains the control equipment, electronics and other hardware operating the functions of the rail crossing station.

[0003] To ensure safe operation of the rail crossing, it is important that the rail crossing warning systems are continually working properly. As a result, railroads typically have each rail crossing station manually inspected on a regular interval. For example, railroad companies may be required to send personnel to manually inspect each railroad crossing station at least once every 30 days. These inspectors manually inspect the equipment located at the rail crossing station including, for example, the sensors and detectors, the warning systems, and the equipment located in the bungalow, to ensure that the rail crossing station is operating in a safe and effective manner.

[0004] This manual inspection procedure can be a time consuming and expensive process, and it can also be prone to error. Moreover, if and when a manual inspection discovers a defect in the system, such a defect must be manually reported to the railroad, which may take a significant amount of time. This can result in an increase in the risk of accidents occurring as a result of an inoperative system while the defect is being reported. Additionally, because manual inspections cannot continually monitor the rail crossing stations, issues that may arise in between inspections can go undiscovered for several days or weeks.

SUMMARY

[0005] The present technology generally relates to rail crossing remote diagnostics ("RCRD") systems. In certain embodiments, the RCRD system can include a rail crossing station monitor installed in a bungalow at a rail crossing station. The station monitor has a communication module, such as a wireless transceiver, an ethernet or other internet connection, a cellular transceiver, a telephone connection, or a modem, for example. The RCRD system also includes one or more diagnostic sensors installed at the rail crossing station. The diagnostic sensors are adapted to communicate with the station monitor. For example, the diagnostic sensors may be wired to the station monitor, or connected to it wirelessly.

The station monitor automatically monitors at least one device installed at the rail crossing station and generates rail crossing diagnostics reports.

[0006] The present technology also relates to rail crossing diagnostics networks ("RCDN"). The RCDN includes one or more RCRD systems installed at a rail crossing station. The RCRD systems include a station monitor with a communication module installed in a bungalow at the rail crossing station. The RCRD system also has one or more diagnostic sensors installed at the rail crossing station. The diagnostic sensors are adapted to communicate with the station monitor. The RCDN also includes a network hub that is in communication with the RCRD systems. The station monitor automatically monitors at least one device installed at the rail crossing station and generates rail crossing diagnostics reports. Further, the network hub allows for remote access to the at least one rail crossing station diagnostics system. In certain embodiments, the RCDN will include at least two rail crossing station diagnostics systems, and the network hub will provide remote access to each of the RCRD systems.

[0007] The present technology also provides methods for automatically monitoring the operation of a rail crossing station. The methods include monitoring equipment within a bungalow that has been installed at a rail crossing station using a station monitor that is installed in the bungalow. The operation of at least one rail crossing station sensor is also monitored using the station monitor and one or more diagnostic sensors installed at the rail crossing station, where the diagnostic sensors are in communication with the station monitor. The station monitor is used to generate a diagnostics report. Certain embodiments of the present technology may include the additional step of using the station monitor to transmit a diagnostics report over a network. Certain embodiments also include steps that execute station monitor functions or functionality based on remote commands received over a network. In certain embodiments, methods can also include the step of executing a backup control operation when the station monitor detects a problem at the rail crossing station.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 depicts an example of a rail crossing station with various rail crossing station equipment.

[0009] FIG. 2 shows the relationship among internal components of a bungalow installed at a rail crossing station.

[0010] FIG. 3 shows the relationship among components of a bungalow and other equipment at a rail crossing station.

[0011] FIG. 4 is a modular diagram of a bungalow equipped with a station monitor.

[0012] FIG. 5 shows the relationship among a station monitor installed in a bungalow and other equipment at a rail crossing station.

[0013] FIG. 6 shows the relationship among components of a RCRD system that may be installed at a rail crossing station.

[0014] FIG. 7 shows a RCDN that includes multiple rail crossing diagnostics systems.

[0015] FIG. 8 is a flow diagram of a method for automatically monitoring the operation of a rail crossing station.

DETAILED DESCRIPTION

[0016] The presently described technology relates generally to systems and methods for monitoring rail equipment. More specifically, the present disclosure describes systems

and methods for automatically monitoring the equipment at a rail crossing station. Even more specifically, the present disclosure discloses systems and methods that automatically monitor the operation of a rail crossing controller unit and the related warning systems and sensors at a rail crossing station, and that can remotely communicate diagnostics reports over a network.

[0017] The presently described technology can reduce or alleviate the need for periodic manual inspections of rail crossing stations, or decrease the amount of work required by such manual inspections, because it employs a system of one or more remote sensors that automatically monitor many of the parameters that otherwise have to be inspected manually. Using the information obtained from this automatic monitoring process, the present technology system can identify predictive trends that allow for certain rail crossing station equipment to be replaced before they fail.

[0018] The present technology also allows for rail systems to connect and comply with new rail system standards, such as positive train control ("PTC"). That is, the present technology can provide automatic monitoring of crossing conditions and equipment functionality and operation in a manner that can be integrated within the PTC requirements framework.

[0019] FIG. 1 depicts an example of a rail crossing station that can utilize the presently described technology. For example, FIG. 1 depicts a rail crossing station that implements various sensors, detectors and other equipment that can be used in accordance with or as a part of the present technology. As shown in FIG. 1, a rail track 10 intersects a road 20 at a rail crossing 100. Because a rail crossing can be a dangerous intersection if traffic is not properly stopped on the road when a train is crossing, rail crossing stations often employ warning signals to notify oncoming vehicles when a train is arriving. This typically involves use of a warning system 30, which can include warning lights and sounds, and a crossing gate that drops down to block the rail crossing in all intersecting directions. It is important that the warning signals generated by the warning system 30 are activated early enough before a train arrives to ensure that traffic is completely stopped when a crossing train arrives, but not so early that the warning system 30 unnecessarily obstructs traffic that could otherwise safely pass the crossing. For these and other reasons, rail crossing stations can employ a variety of sensors, detectors and other equipment to ensure that the warning signals are operating properly. The presently described technology provides systems and methods for monitoring these sensors, and also provides additional sensors and equipment to help ensure the safe operation of a rail crossing station.

[0020] As shown in FIG. 1, a rail crossing station may employ a sensor station 50 that may include one or more sensors. For example, in certain embodiments of the present technology, sensor station 50 can include ambient light sensors, warning light sensors, gate tilt sensors, gate light sensors, gate integrity sensors, optical light sensors, current sense sensors, and accelerometer/tilt sensors, for example. These sensors can be used to ensure that the lights of the warning signals are visible, that warning signal noises are audible, that the gate is lowering and/or tilting to the proper angle, and that the gate is still in tact, for example. The rail crossing station can also include sensors and detectors 60 that are built into or placed on the rail track 10 itself. For example, the sensors and detectors 60 may include wheel detectors that detect the presence of a train wheel on the track, equipment temperature sensing equipment, a dragging equipment detec-

tor that detects when a passing train is dragging equipment along the track, a shunt system or other sensors that detect the location and/or velocity of an oncoming train, sensors that monitor the time it takes a train to pass over the crossing station, and sensors that monitor the time it takes from the gate to lower until the train arrives at the crossing.

[0021] Additionally, certain embodiments of the present technology may provide, or operate with a crossing station that incorporates one or more video cameras 70 that record video footage of the rail crossing station. The video cameras 70 can record the rail crossing warning system 30 to ensure that the gates and lights are operating properly when a train is crossing, for example. The video cameras 70 can also be used to ensure that all of the lights along the gate are operating properly, or to determine whether one of the lights may have burned out.

[0022] A train crossing station can also include weather sensors 80 that record and monitor various weather conditions such as the temperature, precipitation levels, and wind speed, for example. Information about the weather conditions from the weather sensors 80 can be used to anticipate potential problems with the crossing warning system 30 (e.g., it may anticipate that ice buildup may cause issues with the gate), or to control the timing of the warning systems 30 itself (e.g., the warning system 30 may be activated earlier when the weather sensors 80 detect that the roads may be wet or slippery), for example.

[0023] FIG. 1 also depicts a bungalow 200, which can be a housing, a box structure, or another enclosure that houses equipment used at the rail crossing station. The bungalow 200 houses the controlling equipment for the rail crossing station. As shown in FIG. 2, the bungalow can house a crossing controller unit 250 ("CCU") that controls the operations of the rail crossing station. The CCU can control the function of the gate or the warning lights of the crossing warning system 30. The CCU 250 can include an operating interface 254 that allows a user to access and control the CCU and the related functions that it controls. The CCU 250 may also comprise a data log 256 that obtains and makes records of rail crossing events. For example, the data log 256 may keep a record of the time that a warning gate is lowered, the time that the train crosses the station, or any problems that may have occurred with the with the crossing warning system 30. Typically, a manual inspector can obtain information stored in the data log 256 by using the operating interface 254.

[0024] The CCU 250 may also operate in connection with a grade crossing predictor 252. The grade crossing predictor ("GCP") 252 can be connected to sensors or detectors on the rail track, and can notify the CCU when to turn on the warning signals. For example, using sensors and detectors on the train track itself, the GCP 252 may detect the location and/or velocity of an oncoming train. When the GCP 252 predicts that the oncoming train will be passing the crossing in a predetermined amount of time, the GCP 252 may notify the CCU 250 to execute the crossing warning signals.

[0025] The bungalow may also include a power system 210, which can be an alternating current power source, for example. The power system 210 may also include a backup battery 212 that allows the CCU to continue operating in the event of a power outage. The backup battery 212 can maintain a full charge from the power system 210, so that the backup battery 212 is maximized with full power in the event that a backup power source is needed.

[0026] The bungalow may also include a variety of other equipment. For example, the bungalow may include a security system 220 that inhibits intruders from breaking into the bungalow 200 to steal the equipment or otherwise manipulate the rail crossing station.

[0027] The bungalow 200 may also include a gate trigger backup control 230. The gate trigger backup 230 can be used to operate the crossing gate in the event that the CCU 250 is unable to operate the crossing gate. For example, the gate trigger backup 230 may be a mechanical override that sets the gate to the default “down” position in the event that the CCU 250 is having difficulty operating the gate.

[0028] The bungalow may also include a shunt interface 240, which monitors the signal integrity of the gate trigger system. For example, a shunt system uses the rail tracks as a circuit, and continually monitors the voltage and current across the circuit to determine the location and/or approaching speed of a train. The shunt interface 240 operates with the CCU 240 to properly operate the various functions of the rail crossing station based on the detected presence and/or velocity of an oncoming train.

[0029] In certain embodiments of the present technology, the bungalow 200 can include a remote access link 260. The remote access link 260 allows the CCU 250 and other bungalow equipment to communicate remotely with a network. The remote access link 260 may include antennae or other hardware and equipment that allow the CCU 250 to communicate external to the bungalow 200. In this manner, a user can remotely access the CCU and other equipment to ensure its safe and proper operation, and make adjustments or operational modifications if desired. The bungalow may also include other bungalow equipment 270, such as clock or timer, an input device such as a keyboard or keypad, lights, and additional sensor input connections, for example.

[0030] The bungalow 200 is connected, either via a wire connection or a wireless connection to the various sensors, detectors and equipment located at or around the rail crossing station. FIG. 3 demonstrates the connection between the bungalow and various equipment located at or around a rail crossing station. As depicted, the CCU 250 can communicate with the warning system 30, the sensor station 50, the various rail sensors and detectors 60, the video cameras 70 and the weather sensors 80. The CCU can also be connected to a communication and data network 300 via a remote connection, for example, via the internet, via a cellular connection, or by another connection. The CCU 250 is also connected to other bungalow equipment 280 within the bungalow 200, which can include, for example, the equipment depicted in FIG. 2. In this manner, the CCU 250 can obtain and record all necessary information from the sensors both internal and external to the bungalow 200, and use the information to operate the rail crossing warning system 30 and other functionality. The CCU 250 can also generate data reports and other information that can be transmitted to the communication and data network 300. Additionally and/or alternatively, the data reports can be viewed manually by an inspector at the bungalow 200, for example, via the CCU operating interface 254.

[0031] FIG. 4 depicts one embodiment of a bungalow 200 employing an RCRD system of the present technology. As shown in FIG. 4, the bungalow 200 includes a CCU 250 and the other equipment depicted in the bungalow 200 of FIG. 2. FIG. 4 also includes a station monitor 400 that interacts with the CCU and the other bungalow equipment. The station

monitor 400 can be a sensor communication hub and/or another controller unit. The station monitor 400 can monitor the function of the equipment at the rail crossing station, perform diagnostics on the rail crossing station equipment, and can serve as a backup control source for the rail crossing station. In certain embodiments, the station monitor 400 can automatically perform many or all of the functions that are typically provided by a manual inspector.

[0032] FIG. 5 depicts another embodiment of a rail crossing station that shows the relationship among a station monitor 400 and other equipment at a rail crossing station. As shown, the station monitor 400 interacts with the rail crossing station equipment, including the warning system 30, the sensor station 50, the rail track sensors and detectors 60, the video cameras 70, and the weather sensors 80, for example. The station monitor 400 is also in communication with a communication and data network 300. In this manner the station monitor 400 can generate diagnostics reports and transmit the reports and other information to a remote user through the communication and data network 300. That is, the station monitor 400 can promptly notify a railroad company main office through the communication and data network 300 when a problem is detected. For example, the station monitor may transmit a diagnostics report or otherwise generate a signal through the communication and data network 300 when the station monitor recognizes that the crossing station warning system 30 is not operating in the most effective manner.

[0033] FIG. 5 also depicts diagnostic sensors 450 located at or around the rail track 10 on or near the rail crossing 100. In certain embodiments, the diagnostic sensors 450 can serve as backup sensors to those already in place at the rail station. For example, the diagnostic sensors 450 can serve the same or similar functions to the sensors located in the sensor station, the rail track sensors and detectors 60, the video cameras 70 or the weather sensors 80. In this manner the station monitor 400 and the diagnostic sensors 450 can operate together to monitor the operation of at least one sensor installed at the rail crossing station. That is, the diagnostic sensors 450 may communicate information to the station monitor 450 that can be compared with the information transmitted to the CCU 250 to operate and control the rail station. The station monitor 400 can compare the information from the diagnostic sensors 450 with the CCU 250 information to ensure that the rail crossing station equipment is operating effectively, accurately and/or efficiently. For example, the RCRD of the present technology may employ a diagnostic sensor 450 at or around the wheel track that uses a shunt operation to monitor the location and/or velocity of an approaching or present train. This information can be communicated to the station monitor 450 and compared with the information used by the CCU 250 to determine when to execute the rail crossing warning system 30. In other words, if the information obtained from the diagnostic sensors 450 differs significantly from the information used by the CCU 250, the monitor may recognize a problem with at least one of the rail station crossing equipment or the CCU 250, and generate a diagnostics report or other signal accordingly. And using the communication and data network 300, the RCRD of the present technology can promptly notify railroad personnel of the problem.

[0034] In certain embodiments, the diagnostic sensors 450 can be installed external to the bungalow 200 as shown in FIG. 5. Additionally and/or alternatively, the diagnostic sen-

sors **450** can also be installed inside of the bungalow **200**. For example, the diagnostic sensors **450** can include a wheel sensor, a gate tip sensor, a dragging equipment sensor, a wind speed monitor, an equipment temperature sensor, a video camera sensor, an ambient light sensor, a light signal sensor, a backup gate sensor, a sound sensor, a power source sensor, a timing sensor, a shunt sensor, a shunt interface sensor, a communication module sensor, and/or a security system sensor. The diagnostic sensors **450** and the station monitor **400** can operate together to create an RCRD that monitors the performance of various crossing station functionality. For example, the RCRD can monitor the performance of signal roundel lights, gate lights, gate tilt, gate integrity, time between the gate lowering and train arrival, time the train is in the crossing area, power integrity into the bungalow, power level of bungalow backup battery, bungalow date and time, signal integrity of gate trigger system, and the status of backup gate activation systems. The RCRD can relay information obtained from monitoring these features to a user via the communication and data network **300**. Certain embodiments of the present technology may employ diagnostic sensors **450** installed both external to the bungalow **200**, and internal to the bungalow **200**.

[0035] As shown in FIG. 5, the station monitor **400** also continues to interact with the CCU **250** and other bungalow equipment **280** located inside the bungalow **200**. For example, the station monitor may automatically monitor the power level of the backup battery **212** of the power station **210** within the bungalow **200**. Similarly, the station monitor can automatically monitor the proper operation of the security system **220**, the gate trigger backup **230**, the shunt interface **250**, the remote access link **260**, or other bungalow equipment **270**, for example.

[0036] The station monitor **400** can also monitor the accuracy of the CCU **250** reporting information. For example, using the diagnostics sensors **450**, the station monitor may generate its own data reports. The monitor may also compare its data reports with the data reports stored in the data log **256** of the CCU **250**. If the station monitor recognizes significant differences between the information in the CCU **250** data log **256**, and the information recorded and generated by the station monitor **400** itself, the station monitor **400** may generate a diagnostics report or signal to transmit over the communication and data network **300**. Alternatively and/or additionally, the station monitor **400** may take action to correct the issues. For example, if the station monitor **400** recognizes that certain events recorded in the station monitor data log correspond to events recorded in the CCU **250** data log, but those events are marked as occurring at different times, the station monitor **400** may take steps to coordinate the internal clock of the CCU **250** with an appropriate time.

[0037] FIG. 6 depicts a diagram of the station monitor **400** and its interaction with the diagnostic sensors **450**. As shown, the station monitor **400** may comprise a number of components, modules, programs or other equipment. For example, the station monitor **400** may include an operating interface **410** that allows a user to interact with and otherwise operate functionality of the station monitor **400**. The operating interface **410** may include a keyboard and a monitor, or a touch-screen interface, for example. Additionally and/or alternatively, the operating interface **410** of the station monitor may be accessed remotely via the internet. In this manner a user

can log into the station monitor through the communication and data network **300** to read diagnostics reports and execute station monitor functionality.

[0038] In certain embodiments of the present technology, the station manager **400** also includes a communication module **420** that allows it to interact with the communication and data network **300**. The communication module **420** can be a cellular device, a modem, an ethernet or internet hub, a wireless communication device, or a telephone, for example. Via the communication module **420**, a user can remotely access the station manager **400** via a communication and data network **300** and obtain information or execute station monitor **400** functionality.

[0039] The station monitor also includes its own monitor power system **430**. The monitor power system **430** can be an alternating current power source that is connected to the grid. The monitor power system **430** can also include a battery backup **432** that can continue to operate the station monitor and/or all the equipment in the bungalow **200** in the event of a power outage. For example, the station monitor battery backup **432** may serve to keep the CCU **250** and other bungalow equipment **280** operating during a power outage after the bungalow power source backup battery **212** has been depleted.

[0040] The station monitor may also include a data recorder **440** that maintains a data log, for example. As noted above, the station monitor **400** may use the data recorder **440** to generate diagnostic reports or to compare with the data recorded by the CCU **250**, for example. The station monitor **400** can transmit data and other information recorded by the data recorder **440** over the communication and data network **300** via the communication module **420**, for example. In certain embodiments, the data recorder **440** can record the events of the CCU **250** on a recording loop over a period of time (e.g., several hours). The data recorder **440** can be controlled by an interface, and may even require a security feature before the data maintained by the data recorder **440** can be accessed.

[0041] In certain embodiments, the station monitor may include one or more redundant backup controls **470**. The redundant backup control **470** can operate at least one rail crossing station function when the station monitor detects a problem at the rail crossing station. For example, the station monitor **400** can execute the redundant backup controls if and when the CCU **250** or other crossing station equipment is not operating as designed. Where the station monitor recognizes that the crossing gate is not lowering a sufficient amount of time before the arrival of an oncoming train (e.g., because of a problem with the CCU shunt interface **240**), then the station monitor **400** may execute one or more redundant backup controls **470** to override the CCU **250** gate control, or to resort to a default "gate down" setting. In this manner the station monitor can assist the crossing station to default to a fail-safe mode.

[0042] The station monitor **400** may also include an internal timekeeper **460**, which can be a clock or other device that maintains time independent from that maintained by the CCU **250** or other equipment in the bungalow or at the crossing station. In certain embodiments, the internal timekeeper **460** may receive an atomic clock signal to continually ensure that the station monitor internal time is relatively accurate. Using the internal timekeeper **460**, the station monitor can ensure

that the CCU 250 is also maintaining an accurate time, and can take steps to adjust the CCU 250 internal time when necessary.

[0043] The station monitor 400 can also comprise a series of sensor inputs 480. These sensor inputs can be, for example, a sensor communication hub that allows the station monitor to connect to the CCU 250 and/or one or more of the station sensors, including the diagnostic sensors 450 installed as a part of the RCRD. By including additional sensor inputs 480, the station monitor 400 allows room to monitor additional sensors and crossing equipment that may be installed at the crossing station after the station monitor is installed into the bungalow 200, for example.

[0044] The station monitor 400 can also comprise or operate in connection with a controller area network ("CAN") 500. The CAN 500 allows the station monitor 400 to interface and connect with the CCU 250. For example, the CCU 250 may either contain all of the interface connections required for the individual sensors or may be constructed such that the sensor interfaces stack or nest with the CCU 250. In this manner, the connections between the components can use a common bus structure like the CAN 500 so that any number of sensor nodes may be connected to the CCU 250, the station monitor 400, or both, for example.

[0045] The station monitor 400 may also include additional equipment not depicted in FIG. 6. For example, the station monitor 400 may include a bungalow intrusion alarm that operates independently from any security system of the bungalow 200. Further, the station monitor 400 may also include one or more video cameras that record video footage within the bungalow. In this manner, a user may remotely operate the station monitor 400 to view the inside of the bungalow to view certain visual signals or readings. For example, a user can access a video camera of a station monitor 400 to obtain a remote visual reading of a power meter connected to the bungalow power source 210, or to view various lighting signals that may be installed inside of the bungalow.

[0046] FIG. 7 shows a network, i.e., an RCDN that includes multiple rail crossing diagnostics systems. For example, an RCDN may include more than one RCRD such that each RCRD on the network can be accessed via the communication and data network 300. FIG. 7 depicts three separate RCRD's connected to the communication and data network 300, but it should be understood that the RCDN of the present technology is not limited to a particular number of RCRD's. For example, in certain embodiments, the RCDN can include all of the RCDN's installed at all of the rail crossings along a particular railroad. In this manner, a railroad office 600 can access, interface and operate the various station monitors 400 and CCU's at each crossing station in the network via the communication and data network 300. Alternatively, in certain embodiments, an RCDN may include as few as one RCRD.

[0047] As shown in FIG. 7, each RCRD 700 includes a bungalow 200 which is installed at a rail crossing station. The bungalow 200 comprises a station monitor 400, a CCU 250 and bungalow equipment 280, which can include, for example, the bungalow equipment described with respect to FIGS. 2-5. Each RCRD 700 also includes at least one diagnostic sensor 450, which is used in connection with the station monitor 400 to monitor the safe and functional operation of the sensors, detectors and other equipment at a rail crossing station. Each RCRD 700 is remotely connected to the communication data network 300. The RCRD's 700 may be con-

nected to the communication and data network 300, for example, through the internet or via a cellular communication, which can be facilitated by a communication module or a remote access link located in the individual station monitors 400 or bungalows 200. Through the communication and data network 300, a user can log in and access each RCRD 700 to obtain station monitor 400 readings, CCU 250 readings, or diagnostic reports, for example. In certain embodiments, the users may also be able to log in to execute certain controls or functionality. For example, in certain embodiments, a station monitor at one RCRD 700 on the RCDN may recognize that the sensors at the crossing station are faulty, and generate a signal to the railroad office 600 via the communication and data network 300. A user at the railroad office 600 can then log into the network and access the station monitor 400 and/or the CCU 250 at that particular crossing station, and correct the problem, or execute functionality (e.g., trigger a default fail-safe mode) without having to send personnel out to the crossing station directly.

[0048] In operation, the present technology provides for automatic monitoring of the systems, sensors, detectors and other rail crossing station equipment, and their performances. For example, the RCRD of the present technology is capable of automatically monitoring at least the following rail crossing station equipment: signal roundel lights, crossing gate lights, crossing gate tilt, crossing gate integrity, the time between the gate lowering and train arrival, the time a train is in the crossing area, the power integrity going into control bungalow, the signal integrity of the crossing gate trigger system (i.e., shunt), the power level of backup battery power in the bungalow, the status of any backup crossing gate activation systems, the status of any bungalow intrusion alarms, additional sensor inputs for alternate bungalow configurations, video cameras that record crossing activity, and/or a CCU data recorder that records data on a storage medium.

[0049] The information and data obtained by the RCRD of the present technology can be remotely accessed through one or more communication technologies, such as cellular modems, remote radio links, ethernet connections or a hard wired link.

[0050] As the RCRD gathers information, it can collect and display the information in a custom database that provides input into the rail crossing station operation status. For example, the database can provide an overall view of the control bungalow operation with options to open specific detailed sensor nodes so that a user can check on an individual sensor performance. The RCRD can also log and display trends that can provide for accurate and beneficial predictions. For example, the RCRD can detect trends that may be able to predict when certain sensors or equipment will fail using performance degradation techniques. Based on these predictions, the RCRD may be able to provide predictive notifications in advance of actual failures.

[0051] The RCRD of the present technology can also utilize a plurality of sensing technologies. These sensing technologies can include, for example a combination of electrical current sensors, optical sensors, and ambient light sensors that can be combined and compared to monitor proper operation of lighting equipment. Moreover, the RCRD can also utilize gate lowering and integrity sensors including, for example, a wired or wireless system with an accelerometer and/or a tilt sensor that reports when the gate is in its level position. Such sensors can also recognize and report when the

gate is tipped on an unnatural axis signifying that the gate has been dislodged from its normal operating position.

[0052] Additionally, the RCRD of the present technology can also automatically monitor the crossing station's ability to measure the time between gate lowering and train arrival, the time that a train takes to pass the crossing station, or the time that the train remains on the island of a crossing station. These measurements can be checked by either monitoring existing signals present in the control hardware (e.g., the CCU), or by supplementing the measurements by installing additional rail-based sensors that detect the presence of the train.

[0053] The RCRD of the present technology can also automatically monitor bungalow power levels by connecting to existing power lines in either the bungalow primary and/or backup power systems. The present technology can also include a separate battery backup system as a part of the RCRD.

[0054] The RCRD of the present technology can also provide ways to monitor signal integrity of gate trigger system, or the shunt. In this manner, the present technology can automatically monitor multiple items that otherwise require manual inspection. For example, the present technology can monitor the rail crossing signal strength to ensure that the signal strength is near 100% when the track is empty, i.e., when no train is approaching. The present technology can also monitor the rail crossing signal strength to ensure that it properly reduces down from 100% as an oncoming train approaches. In certain embodiments, the present technology can also monitor the shunt phase as an indicator of the integrity of the gate trigger system.

[0055] Certain embodiments of the present technology can automatically monitor existing (or previously installed) bungalow intrusion alarms using either an existing alarm system, or by using a separately installed system, such as a motion detector system, for example.

[0056] The present technology may also implement alternate sensor inputs that can be used to monitor external sensors such as detection systems, wind speed monitors, dragging equipment sensors, equipment temperature measuring devices or other rail measuring devices, for example.

[0057] The RCRD of the present technology can also automatically monitor a variety of rail crossing station events that otherwise require manual inspection. For example, the RCRD can be configured to monitor the amount of time that a train takes to cross a rail crossing station. Trains that take longer than a predetermined period of time, (e.g., 10 minutes or longer) can result in fines issued by local traffic authorities. The present technology can remotely determine whether any train crossing stations are experiencing or have experienced trains that take more than a predetermined period of time to pass through the crossing by monitoring the output from the CCU. The RCRD can then report this issue to the railroad and/or the proper authorities so that the issues can be addressed accordingly.

[0058] The RCRD can also monitor whether crossing gates are appropriately lowering within a predetermined amount of time before the arrival of a train. For example, the FRA may require that crossing gates should be lowered at least 20 seconds before the train arrives. In certain embodiments of the present technology, the RCRD can automatically monitor the crossing gate lead time at a crossing station by comparing the CCU output against a track sensor. The RCRD can report

this information to the railroad, to the FRA, or to other parties that may have an interest in this information.

[0059] Certain embodiments of the present technology can also automatically monitor whether a crossing gate is stuck in a certain position. In particular, the present technology can monitor whether a crossing gate is stuck in the up position, and not capable of being automatically lowered. Without automatic monitoring of this feature, such an issue may only be noticeable when a train is approaching, which can create a dangerous situation resulting in high risk of accidents. Using the present technology, such a gate-stuck-up issue can be detected before a train ever approaches the crossing station by comparing the CCU output against a gate tip sensor. Any issues can thereby be reported to the railroad over a network and addressed before a train crosses the crossing station. Similarly, the RCRD of the present technology can monitor a gate-stuck-down feature, by comparing CCU output against gate tip sensor readings, for example. Moreover, the present technology can also monitor whether the gate is damaged using the output of a sensor

[0060] The RCRD of the present technology can also automatically monitor whether the crossing station or bungalow main (AC) power is out or not working using a line power feed into the station monitor. The RCRD can also detect when the backup battery or batteries are low. For example, many backup batteries are lead-acid batteries that have established patterns of battery voltage and temperature that can allow for the current state of the battery charge level to be predicted or determined. Moreover, certain railroads may utilize a bank of single cells that are chained together. In such an embodiment, the RCRD could be employed to detect and/or identify a single bad cell without requiring individual probes into each cell. In certain embodiments, the RCRD can monitor the battery banks to ensure that two or more separate banks of batteries with different charges are properly isolated.

[0061] The present technology can also be used to detect if and when lights have burned out, turned off, or are otherwise not visible. For example, for traditional incandescent bulbs, this can be accomplished by monitoring the electrical continuity across the filament of the bulbs. However, this technique may not work where the lights being checked are LED lights, or where the lights are not visible because they are dirty, or covered with mud. In such a situation, the present technology may use one or more light sensors or video cameras to monitor whether the lights at a crossing station (e.g., the lights along a crossing gate) are operating properly.

[0062] The RCRD of the present technology can also automatically monitor a smart bell operation of a crossing station. For example, certain train crossing stations employ a speaker or a bell that may be mounted to the railroad crossing sign, for example, to duplicate the sound of a train horn or bell so the actual train does not have to blow its horn. The present technology can automatically monitor the operation of such a smart bell, for example, by using a microphone in connection with the station monitor.

[0063] The present technology can also be used to obtain and reference crossing logs from a crossing station. For example, crossing stations CCU's may have a recorder interface module that logs and/or records when various signals have changed. These logs often provide a time stamped history of events, such as when a train was detected and when gate was lowered, for example. The present technology can ensure that the time stamps on these logs is accurate by automatically monitoring the internal clock of the CCU.

Additionally and/or alternatively, the station monitor of the present technology can maintain its own data log as a backup, or a secondary comprehensive log.

[0064] The present technology can also automatically monitor grounding issues at a crossing station. For example, a railroad may experience difficulties when a current surge flowing into a ground connection temporarily causes the ground voltage to move away from zero, because this can cause intermittent faults in the crossing station circuitry. The RCRD of the present technology could automatically monitor the ground voltage level, for example, by wiring the ground connection into a voltage sensor and monitoring the voltage at the ground. If and when this ground voltage level fluctuates away from zero, the RCRD can generate a notification, or take preventative steps as necessary.

[0065] In certain embodiments of the present technology, the RCRD may monitor the proper operation of crossing station redundant circuit boards. For example, a typical crossing predictor system typically has two banks of circuit boards, a primary and a backup. The present technology can monitor whether any of the circuit boards have faulted, and cause the system to switch over to the unused bank if necessary.

[0066] Certain embodiments of the present technology also present methods for automatically monitoring the operation of a rail crossing station. FIG. 8 is a flow diagram of a method **800** for automatically monitoring the operation of a rail crossing station. In certain embodiments, at step **810**, the method includes installation of a station monitor at a rail crossing station. For example, the station monitor can be installed at a bungalow and connected to a CCU and/or other crossing station equipment.

[0067] At step **820**, diagnostic sensors are installed. The diagnostic sensors can be installed external to the bungalow, for example, on or around the train track, and on or near the crossing station. For example, the diagnostic sensors can include a wheel sensor, a gate tip sensor, a dragging equipment sensor, a wind speed monitor, an equipment temperature sensor, a video camera sensor, an ambient light sensor, a light signal sensor, a backup gate sensor, a sound sensor, a power source sensor, a timing sensor, a shunt sensor, a shunt interface sensor, a communication module sensor, and/or a security system sensor. The diagnostic sensors and the station monitor can operate together to create an RCRD that monitors the performance of various crossing station functionality.

[0068] At step **830**, the operation of the crossing station CCU is monitored. This can be done, for example, by the station monitor. For example, the station monitor monitors the CCU to ensure that it is operating properly by running comparative analyses, by obtaining measurements from the diagnostics sensors.

[0069] At step **840**, other bungalow equipment is monitored. For example, a station monitor can monitor bungalow equipment such as the power supply source and the backup power supply. Additionally and/or alternatively, the station monitor can monitor any or all of the bungalow equipment as depicted in FIGS. 2 and 4.

[0070] At step **850**, rail crossing warning systems, sensors, detectors and/or other equipment are monitored. This may be performed by the station monitor, the diagnostic sensors, and/or a combination of the two. For example, the station monitor and/or the diagnostic sensors may monitor the crossing station sensors to ensure that the measurements obtained are accurate and reliable.

[0071] At step **860**, a diagnostics report is generated and reported to a network. For example, the station monitor can generate a report that identifies any and all issues with the crossing station equipment, and transmit that report or another signal to a network.

[0072] In certain embodiments of the present technology, a method may include the steps of monitoring equipment within a bungalow installed at a rail crossing station using a station monitor installed in the bungalow. The method may also include the step of monitoring the operation of at least one rail crossing station sensor using the station monitor and one or more diagnostic sensors installed at the rail crossing station, where diagnostic sensor is in communication with the station monitor. The method may also involve generating a diagnostics report using the station monitor and transmitting the diagnostics report or otherwise communicating signals or other information over a network.

[0073] The present technology has now been described in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains, to practice the same. It is to be understood that the foregoing describes preferred embodiments and examples of the present technology and that modifications may be made therein without departing from the spirit or scope of the invention as set forth in the claims. Moreover, it is also understood that the embodiments shown in the drawings, if any, and as described above are merely for illustrative purposes and not intended to limit the scope of the invention. As used in this description, the singular forms “a,” “an,” and “the” include plural reference such as “more than one” unless the context clearly dictates otherwise. Where the term “comprising” appears, it is contemplated that the terms “consisting essentially of” or “consisting of” could be used in its place to describe certain embodiments of the present technology. Further, all references cited herein are incorporated in their entirety.

- 1) A rail crossing remote diagnostics system comprising:
 - a station monitor installed in a bungalow at a rail crossing station, the station monitor having a communication module; and
 - a diagnostic sensor installed at the rail crossing station, the diagnostic sensor adapted to communicate with the station monitor;
 wherein, the station monitor monitors at least one device installed at the rail crossing station and generates rail crossing diagnostics reports.
- 2) The rail crossing remote diagnostics system of claim 1, wherein the station monitor automatically monitors at least one device installed in the bungalow.
- 3) The rail crossing remote diagnostics system of claim 1, wherein the communication module transmits the rail crossing diagnostics reports to a network via the communication module.
- 4) The rail crossing remote diagnostics system of claim 1, wherein the communication module allows the station monitor to be operated remotely via a network.
- 5) The rail crossing remote diagnostics system of claim 1, wherein the station monitor further comprises at least one redundant backup control, the redundant backup control operating at least one rail crossing station function when the station monitor detects a problem at the rail crossing station.
- 6) The rail crossing remote diagnostics system of claim 1, wherein the station monitor and the diagnostic sensor operate together to monitor the operation of at least one sensor installed at the rail crossing station.

7) The rail crossing remote diagnostics system of claim 1, wherein the diagnostic sensor is installed at the rail crossing station external to the bungalow.

8) The rail crossing remote diagnostics system of claim 1, wherein the diagnostic sensor is installed at the rail crossing station inside of the bungalow.

9) The rail crossing remote diagnostics system of claim 1, further comprising two or more diagnostic sensors installed at the rail crossing station, each the diagnostic sensor adapted to communicate with the station monitor.

10) The rail crossing remote diagnostics system of claim 1, wherein the diagnostic sensor comprises at least one of the following: a power source sensor, a gate tip sensor, a dragging equipment sensor, a wind speed monitor, a shunt sensor, an equipment temperature sensor, a video camera sensor, an ambient light sensor, a light signal sensor, a backup gate sensor, and a sound sensor.

11) The rail crossing remote diagnostics system of claim 1, wherein the station monitor monitors the performance of at least one of the following: signal roundel lights, crossing gate lights, crossing gate tilt, crossing gate integrity, time between gate lowering and train arrival, time that a train is in the crossing area, power integrity into the bungalow, power level of a bungalow backup battery, bungalow date and time, signal integrity of a gate trigger system, and status of backup gate activation systems.

12) The rail crossing remote diagnostics system of claim 1, wherein the station monitor further includes at least one of a bungalow intrusion alarm and a data recorder.

13) The rail crossing remote diagnostics system of claim 1, wherein the station monitor further comprises a station monitor power system that includes a station monitor backup battery.

14) The rail crossing remote diagnostics system of claim 1, wherein the station monitor is connected to a crossing controller unit installed in the bungalow.

15) A rail crossing diagnostics network comprising:

at least one rail crossing remote diagnostics system installed at a rail crossing station, the rail crossing remote diagnostics system comprising:

a station monitor installed in a bungalow at the rail crossing station, the station monitor having a communication module; and

a diagnostic sensor installed at the rail crossing station, the diagnostic sensor adapted to communicate with the station monitor; and

a network hub in communication with the at least one rail crossing diagnostics system;

wherein, the station monitor automatically monitors at least one device installed at the rail crossing station and generates rail crossing diagnostics reports, and further wherein the network hub provides remote access to the at least one rail crossing remote diagnostics system.

16) The rail crossing diagnostics network of claim 15, further comprising at least two rail crossing remote diagnostics systems, wherein the network hub provides remote access to each of the at least two rail crossing remote diagnostics systems.

17) A method for automatically monitoring the operation of a rail crossing station comprising the following steps:

monitoring equipment within a bungalow installed at a rail crossing station using a station monitor installed in the bungalow;

monitoring the operation of at least one rail crossing station sensor using the station monitor and one or more diagnostic sensors installed at the rail crossing station, where the one or more diagnostic sensors are in communication with the station monitor; and

generating a diagnostics report with the station monitor.

18) The method for automatically monitoring the operation of a rail crossing station of claim 17, further comprising the step of using the station monitor to transmit a diagnostics report over a network.

19) The method for automatically monitoring the operation of a rail crossing station of claim 17, further comprising the steps of using the station monitor to execute a function based upon a remote command transmitted over a network.

20) The method for automatically monitoring the operation of a rail crossing station of claim 17, further comprising the step of using the station monitor to execute a backup control operation when the station monitor detects a problem at the rail crossing station.

* * * * *