(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 687 419 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.01.2014 Bulletin 2014/04

(21) Application number: **13176568.7**

(22) Date of filing: **15.07.2013**

(51) Int Cl.:
B61L 23/04 *(2006.01)* ***B61K 9/08*** *(2006.01)*
B61L 15/00 *(2006.01)* *B61L 25/02* *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **20.07.2012 GB 201212935**

(71) Applicant: **SIEMENS PLC**
Camberley GU16 8QD (GB)

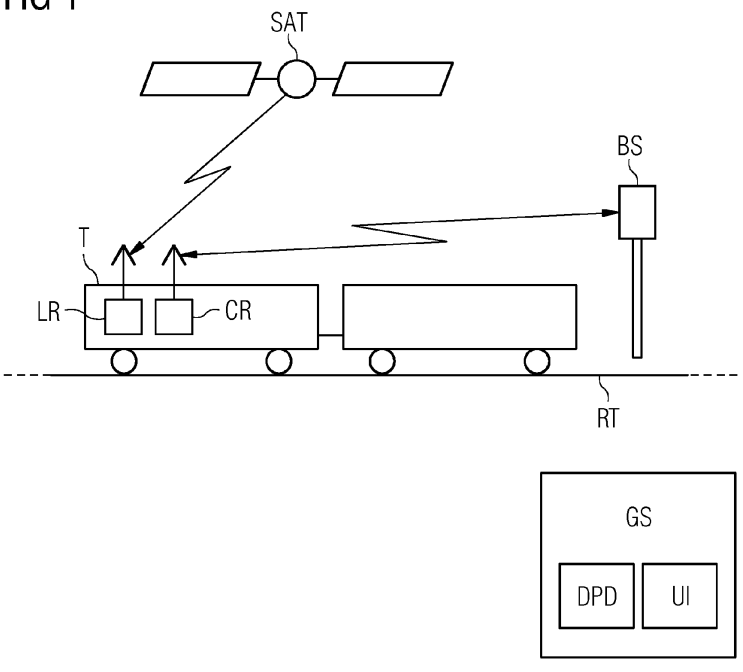
(72) Inventors:
- **Binstead, Joanna**
  Bournemouth, BH8 9AR (GB)
- **Edwards, Malcolm**
  Poole, BH18 9WA (GB)
- **Morris, Stuart**
  Poole, BH14 0RH (GB)
- **Parkinson, Gary**
  Bournemouth, Dorset BH8 9EW (GB)

(74) Representative: **Bruns, Olaf**
Siemens AG
Postfach 22 16 34
80506 München (DE)

(54) **Apparatus and method for monitoring the condition of railway tracks**

(57) According to the invention, a train borne cab radio is provided which comprises at least one sensor device for determining movement, a processing device for establishing a profile of a track taking into account at least data from the at least one sensor device and location data from a location device, and for comparing current data from the at least one sensor with the profile, and a radio communication device for communicating data relating to results derived from the comparison.

FIG 1



EP 2 687 419 A2

Description

[0001] The present invention relates to an apparatus, including a train cab radio, a module for a train cab radio, a ground station and a system as well as and method for monitoring the condition of railway tracks.

[0002] Currently, the overall track quality, affected for example by sleepers, ballast and underlying stability of prepared ground, and rail quality, dependent on the wear of actual rails and fittings, is monitored using a small number of specialist trains, see for example "New Measurement Train (NMT)" disclosed in http://www.rail-pro.co.uk/magazine/?idArticles=304 , and by visual inspection, e.g. by patrols walks along the track every couple of weeks. Such patrol walks, however, do usually not look out for track defects but for any potential infrastructure problem, caused for example by undergrowth etc. Furthermore, both approaches are costly and usually happen only at defined intervals. However, as defects may occur at any time between inspections, a continual inspection mechanism would be beneficial.

[0003] Several other proposals for monitoring the condition of railway tracks were proposed in the past. These are for example known from documents US 6570497, US 6044698, US 5987979 and EP 1180175.

[0004] An object of the present invention is to provide an automated and relatively inexpensive solution for monitoring the condition of railway tracks. This object is solved by the features of the independent claims. Further advantageous features of the invention are disclosed in dependent claims.

[0005] According to the invention, a train borne cab radio is provided which comprises at least one sensor device for determining movement, a processing device for establishing a profile of a track taking into account at least data from the at least one sensor device and location data from a location device, and for comparing current data from the at least one sensor with the profile, and a radio communication device for communicating data relating to results derived from the comparison.

[0006] One example of a typical cab radio for use in a rail traffic management system based on the GSM-R (Global System for Mobile Communications - Railway) standard is the Siemens SVR-400 train borne voice radio.

[0007] According to one embodiment of the invention, the at least one sensor device is at least one of a vibration sensor, an accelerometer and a gyroscope. Such sensors may be used to detect movement of the train as it travels on a rail track.

[0008] According to another embodiment of the invention, the radio communication device operates according to the GSM-R standard. Based on the well known GSM standard used for mobile communication, the GSM-R standard is an extension of this standard specifically developed for application in the railway industry. The GSM-R standard is inter alia defined in ETSI standards EN 301 515 and the technical specification ETSI TS 102 281.

[0009] According to another embodiment of the invention, the location device is realised as a receiver for GPS (Global Positioning System) or Galileo satellite navigation system. Depending on the performance of the receiver, the receiver determines its location with a certain precision, i.e. with a certain deviation from its real location.

[0010] According to another embodiment of the invention, the at least one sensor device and/or the location device are at least partly realised outside of the cab radio and connected to the cab radio via communication means, for example by cable or radio based communication using the Bluetooth standard (IEEE 802.15) for short range communication. If multiple sensors are used to determine movement of the train, one or several of these may be mounted outside the cab radio housing, for example at a specific location on the train. At least the antenna of a location device, for example a GPS receiver, is typically mounted on the outside of the train, to allow for optimal reception of signals transmitted by GPS satellites. But also, due to its high level of integration, the entire location device, for example a GPS receiver, may be fitted outside the cab radio.

[0011] According to another embodiment of the invention, the at least one sensor device and the processing device are realised on a module which is configured to be slotted into the housing of the cab radio and connected to a cab radio processor module. Such modular concept allows the addition of the condition monitoring feature to cab radios already installed in trains. By integrating sensor and processing devices into the module, no specific changes to the hardware of a cab radio need to be made. Also, the operation of the monitoring can be automated such that any intervention from for example the train driver would not be required.

[0012] According to another embodiment of the invention, the data relating to the results is communicated whenever current data from the at least one sensor device exceeds a predefined threshold value when compared to the profile data. Such predefined threshold may be used to trigger the sending of data relating to the results, so that for example only substantial variations of the current data from the profile data are reported.

[0013] According to another embodiment of the invention, the communicated data relating to the results comprises at least location information relating to the location at which the data provided by the at least one sensor device exceeded the threshold value. Using the location information provided by the location device, the exact or approximate location, for example defined by GPS coordinates, depending on the available precision of the location information, can be reported.

[0014] According to another embodiment of the invention, the data relating to the results is communicated to a central ground station. The central ground station can then process the received data further by correlating it with data received from at least one other train. The central ground station may then also comprise means to indicate to a person operating the rail system, for example

by prompting information on a display and/or emitting acoustic alarms, that a fault in the track has been determined, so that further actions can be taken by the operator.

[0015] According to another embodiment of the invention, the data relating to the results is communicated using a text message. Such text message may be configured according to the short message service used in the GSM-R standard, or according to any other means of sending data supported by the system.

[0016] According to another embodiment of the invention, the profile is generated based on multiple journeys of a train over the same stretch of rail track. The profile, which is subsequently used by the processing device in the cab radio for comparison with current measurement data provided by sensors, is "learnt" by the cab radio while the train travels several times along the same stretch of railway track. For example, for a commuter or passenger train doing the same run several times a day, such profile can be established within a couple of days. The profile itself may be realised as a movement profile of the train, based for example on measurements of shocks and/or vibrations made by the sensors. These measurements are linked to the current location or position of the train determined by the location device, to establish a typical profile of train movement over distance. Furthermore, the measurements may also be linked to the current speed at which the train is travelling. The speed of the train may be determined using information from the location device.

[0017] According to the invention, there is also provided a method for monitoring the condition of railway tracks, comprising the steps of determining movement using at least one sensor device, establishing, in a cab radio of the train, a profile of a track based on data from at least one sensor device and a location device, comparing current data with the profile, and communicating data relating to results derived from the comparison.

[0018] According to one embodiment of the inventive method, the data relating to the results is received and correlated with data received from at least one other train at a central ground station.

[0019] According to the invention, there is also provided a module for a train cab radio, comprising at least one sensor device for determining movement, a processing device for establishing a profile of a track taking into account at least data from the at least one sensor device and location data from a location device, for comparing current data from the at least one sensor with the profile, and for triggering communication of data relating to results derived from the comparison by a cab radio module, and connecting means for connecting the module to a cab radio module.

[0020] According to the invention, there is also provided a system for monitoring the condition of railway tracks, comprising at least one train borne cab radio, configured to determine movement of the train using at least one sensor device, to establish a profile of a track based on data from the at least one sensor device, and to communicate data relating to results derived from a comparison of data from the at least one sensor device and a location device with an established profile, and a central ground station, enabled to receive the data communicated by the train cab radio, to correlate the received data with data received from at least one other train.

[0021] According to the invention, there is also provided a train, comprising at least a cab radio as defined above.

[0022] According to the invention, there is also provided a ground station of a railway system, comprising means for receiving data from multiple train borne cab radios, wherein the data relates to results derived from a comparison of data from sensor devices with an established profile of a railway track, and means for correlating the data received from the multiple train borne cab radios.

[0023] Examples of the invention are further described with reference to the following figures, wherein

FIG 1 shows a simplified diagram of a railway track monitoring system, and
FIG 2 shows components in a cab radio.

[0024] FIG 1 shows an exemplary train T travelling along a railway track RT. The train T is equipped with at least a cab radio CR and a location receiver LR for receiving signals from satellites SAT of a satellite navigation system. The train borne cab radio CR comprises at least a radio communication module which allows it to send and receive signals from base stations BS of a mobile radio communication system, operating for example according to the GSM-R standard. The cab radio CR also comprises other components which are described in more detail with respect to FIG 2. Directly or indirectly connected to the mobile radio communication system is also a ground station GS of the railway system, to receive data sent by cab radios CR installed in trains. The ground station GS comprises at least a data processing device DPD for processing the data received from trains as well as a user interface UI for displaying information or alarms to a person operating the rail system or being responsible for maintaining the railway tracks.

[0025] FIG 2 shows an exemplary cab radio CR for installation in train cabins. The cab radio CR comprises at least one cab radio processor card CRPC which provides the functionality, i.e. hardware, software CS, protocols etc., required for communication within the railway system, i.e. with other entities in the system.

[0026] In order to enable monitoring of the condition of railway tracks, the cab radio CR is fitted with an additional processor/sensor card SC which comprises further devices. Such processor/sensor card SC can for example be realised as a module which slots or integrates into the housing of the cab radio and connects to other modules already mounted therein. The further devices consist of at least sensors SEN, for example at least one of a vibration sensor, a gyroscope and/or an accelerometer, to

measure movement, shock and/or vibration experienced while travelling along a track, and a processing device MP, for example one or several microprocessors, to process data provided by the sensors and the location receiver LR, and to generate from the data a profile over a number of runs of the train on the same track. The data and profiles are stored in at least one memory MEM, for example a non volatile and a RAM memory. Interfaces CMI, realised as hardware and software interfaces, on the processor card CRPC are adapted to exchange data with the processor/sensor card SC, to support the track condition monitoring function added to the cab radio CR.

[0027] Also, a location receiver LR, for example a GPS receiver mounted on the roof of the train, is connected to the cab radio CR. The location receiver LR provides data on the current location of the train on a periodic basis. In case the location receiver LR is connected to the processor card CRPC, location data locd is made available to the processing device MP on the processor/sensor card SC and/or stored in the memory MEM. Alternatively, the location receiver LR may also be directly connected to the processor/sensor card SC.

[0028] In operation, the cab radio CR first "learns" the shock/vibration profile of a track over a number of runs, using data from sensors SEN and the location receiver LR. Once the profile of a specific track or stretch of track is established and stored in the memory, this can be regarded as the "normal" signature of the track, the processing device MP compares current data from the sensors SEN with the profile data, i.e. previous records. Should the processing device MP detect any variation from the profile data which exceeds a certain predefined threshold, it initiates the transmission of a report to the ground station GS by the cab radio processor card CRPC. For this, the processing devices sends a request to send data rts to the processor card CRPC which triggers the transmission of the report, as well as data relating to results of the comparison done by the processing device MP. This report may comprise information relating to the location at which the sensor data exceeded the predefined threshold and/or the extend of the determined variation at this location.

[0029] After the cab radio processor card CRPC has received the request to send rts and the report rep, it sends a message to the ground station GS using for example the short message service (SMS) provided by the GSM-R communication system.

[0030] The ground station GS, after having received the message with the report from the cab radio CR of this specific train T, may correlate the information contained in the report with information received from other trains, thereby determining if other trains having done the same run also experienced the same or similar variations in the movements of the train. Any analysis or summary of this data, for example a summary of received messages by time and/or date, by train, record number or by location, is displayed or prompted in a different way to operators operating the railway system. This may then help the operator to identify potential locations or areas where maintenance of the track is required.

[0031] An exchange of determined profile data between trains or cab radios is in principle not foreseen or advantageous, because such profile can depend on a number of factors, for example on the exact position of where the cab radio is installed in the train, the train type or model etc. Instead, it is considered to be advantageous that every cab radio "learns" its own profile of a track once installed in the train or travelling a specific section of track for the first time.

Claims

1. Train cab radio for monitoring the condition of railway tracks, comprising

   - at least one sensor device for determining movement,
   - a processing device for establishing a profile of a track taking into account at least data from the at least one sensor device and location data from a location device, and for comparing current data from the at least one sensor with the profile, and
   - a radio communication device for communicating data relating to results derived from the comparison.

2. Train cab radio according to claim 1, wherein the at least one sensor is at least one of

   - a vibration sensor,
   - an accelerometer, and
   - a gyroscope.

3. Train cab radio according to any preceding claim, wherein the radio communication device operates according to the GSM-R standard.

4. Train cab radio according to any preceding claim, wherein the location device is a receiver for GPS or Galileo satellite navigation system.

5. Train cab radio according to any preceding claim, wherein the at least one sensor device and/or the location device are at least partly realised outside of the cab radio and connected to the cab radio via communication means.

6. Train cab radio according to any preceding claim, wherein the at least one sensor device and the processing device are realised on a module which is configured to be slotted into the housing of the cab radio and connected to a cab radio processor module.

7. Train cab radio according to any preceding claim, wherein the data relating to the results is communicated whenever the current data from the at least one sensor device exceeds a predefined threshold value when compared to the profile.

8. Train cab radio according to claim 7, wherein the communicated data comprises at least a location information relating to the location at which the sensor data exceeded the threshold value.

9. Train cab radio according to any preceding claim, wherein the data relating to the results is communicated to a central ground station.

10. Train cab radio according to any preceding claim, wherein the data relating to the results is communicated using a text message.

11. Train cab radio according to any preceding claim, wherein the profile is generated based on multiple journeys of a train over the same stretch of rail track.

12. Method for monitoring the condition of railway tracks, comprising the steps of

- determining movement using at least one sensor device,
- establishing, in a train borne cab radio, a profile of a track based on data from at least one sensor device and a location device,
- comparing current data with the profile, and
- communicating data relating to results derived from the comparison.

13. Method according to claim 12, wherein at a central ground station, the data relating to the results is correlated with data received from at least one other train.

14. Module for a train cab radio, comprising

- at least one sensor device for determining movement,
- a processing device for establishing a profile of a track taking into account at least data from the at least one sensor device and location data from a location device, for comparing current data from the at least one sensor with the profile, and for triggering communication of data relating to results derived from the comparison by a cab radio module, and
- connecting means for connecting the module to a cab radio module.

15. System for monitoring the condition of railway tracks, comprising

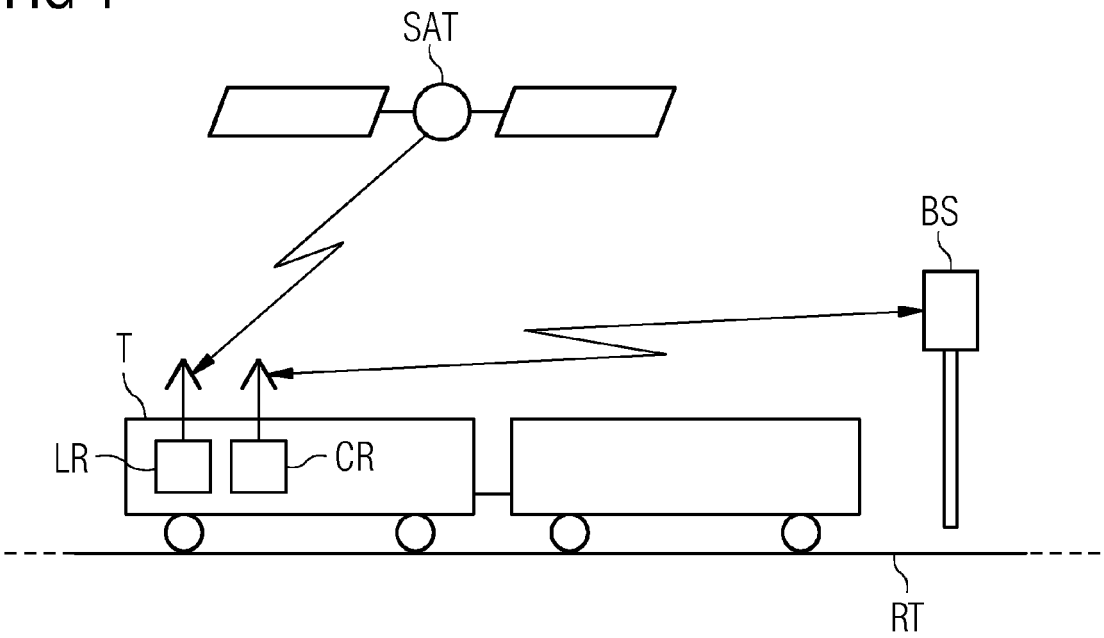
- at least one train borne cab radio, configured to determine movement of the train using at least one sensor device, to establish a profile of a track based on data from the at least one sensor device, and to communicate data relating to results derived from a comparison of data from the at least one sensor device and a location device with an established profile, and
- a central ground station, enabled to receive the data communicated by the train cab radio, to correlate the received data with data received from at least one other train.

16. Train, comprising at least a cab radio according to any of claims 1 to 11.

17. Ground station of a railway system, comprising

- means for receiving data from multiple train borne cab radios, wherein the data relates to results derived from a comparison of data from sensor devices with an established profile of a railway track, and
- means for and correlating the data received from the multiple train borne cab radios.

FIG 1



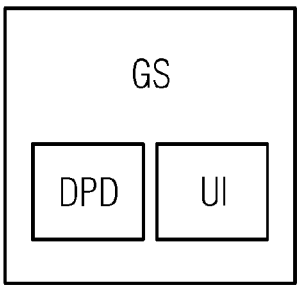
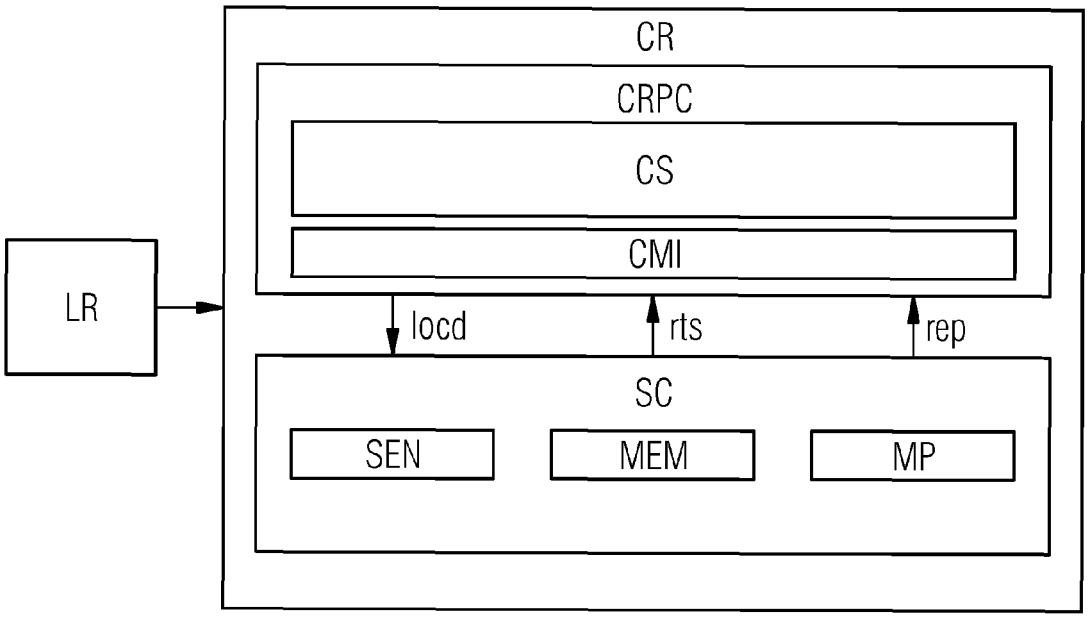


FIG 2



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 6570497 B **[0003]**
- US 6044698 A **[0003]**
- US 5987979 A **[0003]**
- EP 1180175 A **[0003]**