

AUTONOMOUS TRACK MONITORING SYSTEM

Field of the invention:

- 5 The present invention relates to a field track monitoring system and more, particularly, the present invention relates to autonomous track monitoring system, especially for railway track monitoring.

Background of the invention

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The Indian railway network today has a track length of 113,617 km (70,598 miles), over a route of 63,974 km (39,752 miles) and 7,083 stations. Specifically, India has fourth largest railway network in the world exceeded only by those of the United States, Russia and China.

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Good quality of railway tracks plays an important role in keeping this enormous rail network working effortlessly. However, the quality of the railway tracks depends on it's built in quality and its maintenance. For maintenance purpose, railways manually inspect railway tracks every day and if there is any issue with the track, the tracks are repaired. The manual inspection of the railway tracks is done by deploying engineers and workers on tracks.

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However, the track undergoing inspection need to be shut for time being, which leads hindrance to the trains and causes delays. Also in many cases, manual inspection fails to identify some potential defects such as internal cracks, which may lead to major failure and risk of accident.

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To overcome such drawbacks of the manual inspection of railway tracks automatic railway track monitoring devices have been tried in the past.

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One such device has been disclosed in US Patent No. 10029708. The US10029708 patent discloses a railroad scout vehicle system which includes a scout vehicle and a processing unit. The scout vehicle may include at least two wheels configured to engage a set of railroad tracks, a motor mechanically
5 coupled to at least one of the wheels, a speed controller, an electromagnetic sensor aimed at the set of railroad tracks, a positioning receiver, a local speed sensing device and a transceiver. The speed controller may be coupled to the motor and configured to control the speed of the scout vehicle in order to maintain an appropriate distance between the scout vehicle and a train traveling behind. The
10 processing unit may be configured to transmit the track status information via the transceiver, receive train speed and position signals from the train via the transceiver.

The device for railway track monitoring of the above US Patent sends signal to
15 locopilot who is driving the train on the same track if there is any defect in the track so that the locopilot can stop the train and thus avoids accident. However, the device mentioned in the prior art patent has to be removed from the track if the train is running on the same track on which the track monitoring device is and if there is no damage/defect in the track. This is the major drawback of the device of
20 prior art which halts the regular running of the train if the tracks are normal and thus renders the device for monitoring the tracks not useful.

Accordingly, there exists a need to provide a system for autonomous track monitoring, which overcomes above-mentioned drawbacks.

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Objects of the invention:

An object of the present invention is to avoid to manual search of the defects for track maintenance.

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Another object of the present invention is to avoid trains halts while the track monitoring is in process.

Another object of the present invention is to reduce cost of inspection for
5 maintenance significantly.

Yet another object of the present invention is to collect data of frequently failed rail track location with type of failures.

10 **Summary of the invention**

Accordingly, the present invention provides an autonomous track monitoring system (100) for inspection of railway tracks (50) and the like. The autonomous track monitoring system (100) comprises a chassis (10) having a front side (A), a
15 rear side (B), a first side (C) and a second side (D) and a sensor assembly configured on the chassis (10).

The sensor assembly comprises at least one image capturing unit (14) configured centrally on the front portion (A) and the rear portion (B) of the chassis (10), at
20 least two depth sensors (16) configured on either side of the front portion (A), and the rear portion (B) of the chassis (10), a vibration sensor operatively coupled to the horizontal linear actuator (22) and the vertical linear actuator (28) and a foldable image capturing unit (18) configured on the wheel assembly on either side for inspection of external side of the track;

25 The system further comprises at least one horizontal linear actuators (22) configured within the first side and the second side of the chassis (10), and a wheel assembly (20) attached to each horizontal linear actuators (20). The wheel assembly (20) is capable of being retracted and expanded through horizontal
30 linear actuators (22) and the wheel assembly (20) is configured to sit on the track when in expanded position.

The system furthermore comprises at least four vertical linear actuators (28) configured below the chassis (10) for lifting and lowering the chassis (10), a communication means configured on the chassis, a microcontroller for
5 controlling the sensor assembly and a power source for powering the microcontroller, and the sensor assembly.

Brief description of the figures:

10 The objects and advantages of the present invention will become apparent when the disclosure is read in conjunction with the following figures, wherein

Figure 1 represents an isometric view of autonomous track monitoring system, in accordance with the present invention;

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Figure 2 represents a side view of the autonomous track monitoring system of figure 1;

Figure 3 represents an isometric view of the autonomous track monitoring system
20 after gaining maximum height;

Figure 4 represents a side view of the autonomous track monitoring system when is lifted at its maximum height, its maximum height with fully stretched foldable arm position, its maximum height with fully stretched foldable arm position and
25 when resting on the rails using its wheels with the fully stretched foldable arm; and

Figure 5 shows a flowchart of working of the autonomous track monitoring system, in accordance with the present invention.

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Detailed description of the embodiments:

The foregoing objects of the present invention are accomplished and the problems and shortcomings associated with the prior art, techniques and approaches are overcome by the present invention as described below in the preferred
5 embodiments.

As used in the specification and the appended claims, the singular forms "a," "an" and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a sensor" includes combination of two or more
10 sensors and the like.

Referring now to figures 1-5, there is shown an autonomous track monitoring system (100) (hereinafter 'the system (100)') in accordance with the present invention. The system (100) of the present invention provides unmanned robotic
15 vehicle, which can run on the railway tracks and inspect the tracks for any irregularities, hindrances, cracks, stone density, deviation, angle of banking of tracks, encroachments and the likes. The track (50) referred herein is railway track (50). However, it may be evident to those skilled in the art to use the system of the present invention for monitoring of tracks such as tracks of the funicular railways,
20 metro and the like and the like.

The system (100) comprises a chassis (10), a sensor assembly configured on the chassis (10), at least two linear actuators (22), at least two wheel assembly (20), at least four vertical linear actuators (28), a microcontroller (34), a communication
25 means, and a power source (32) for powering the microcontroller (34), and the sensor assembly.

Figure 1 shows the chassis (10). The chassis (10) may be configured in a rectangular shape or hexagonal shape and includes a front side (A), a rear side
30 (B), a first side (C) and a second side (D). The chassis (10) is covered by a cover (12) so as to form cabin like structure. The chassis (10) includes at least one head

lights (12a) configured on front side (A) and rear side (B). In an embodiment, the chassis (10) is developed in such a way that it can take the load of self-retracting system and other electronic instruments needed for inspection. In an embodiment, the chassis (10) is made of aluminum, steel and the like. The sensor assembly is
5 configured on the chassis (10).

The sensor assembly comprises at least one image capturing unit (14) configured centrally on the front portion (A) and the rear portion (B) of the chassis (10) so that system (100) can work in both direction i.e. forward and reverse direction.

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In an embodiment, the least one image capturing unit (14) is camera. The sensor assembly further comprises at least two depth sensors (16) configured on either side of the front portion (A), or the rear portion (B) of the chassis. The images captured by the camera (14) and the depth sensors (16) gives most factual results
15 to the microcontroller (34) when used in combination. The depth sensors (16) act like complimentary to the camera (14).

The sensor assembly furthermore comprises a foldable image capturing unit (18), for example, a camera configured on a wheel assembly (20) on either side for
20 inspection of external side of the track. The folding of the mounting unit of the foldable camera (18) is done to reduce stroke length of both horizontal and vertical linear actuator, which eventually reduces overall size of robot which helps robot to hide in between tracks (50) while train passes over it. In an embodiment, the folding of the folding camera (18) is done by two rotary actuators (26)
25 mounted on wheel assembly (20).

Each horizontal linear actuator of the two horizontal linear actuators (22) is configured within the first side (C) and the second side (D) of the chassis (10). Specifically, the wheel assembly (20) is attached to each horizontal linear actuator
30 (22). The wheel assembly (20) is capable of being retracted and expanded through the horizontal linear actuators (22). In an embodiment, the linear actuators (22)

are operated by electro-mechanical switches (22a). Specifically, the microcontroller (34) gives signal to open or close to individual electro-mechanical switches (22a) of respective linear actuators (22), then these switches operate the linear actuator (22). These electro mechanical switches are part of the main PCB.

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In an embodiment, each wheel assembly (20) has two wheels (24) powered by two rotary actuators (26). In an embodiment, the rotary actuator (26) is a two way rotary actuator so that the system (100) can inspect tracks (50) in both reverse and forward direction. These rotary actuators control the speed and direction of the robot on the track (50). Specifically, the microcontroller (34) gives signal for forward movement or reverse movement to individual electro-mechanical switches of respective rotary actuators (26), and then these electro-mechanical switches operate the rotary actuators (26). These electro mechanical switches are part of main PCB.

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The wheel assembly (20) has collar from inside to keep wheels on the track (50) just like railway wheels. Specifically, the wheel assembly (20) is configured to sit on the track (50) when in expanded position by means of horizontal linear actuator (22).

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In an embodiment, the horizontal linear actuator (22) provides self-retracting mechanism to retract the system (100) from the track (50). Specifically, the system (100) hides itself under the rail height at the center of rails, so that the train can pass over it without needing to be taken out.

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The four vertical linear actuators (28) are configured below the chassis (10) lifting and lowering the chassis (10) as and when required.

In an embodiment, the system (100) includes a vibration sensor (not shown) configured on the chassis (10) and coupled operatively to the horizontal linear actuator (22) and the four vertical linear actuators (28). The vibration sensor

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- senses the vibration in the rail track (50) caused due to upcoming train. When train passes on the same track on which the system (100) is placed, the vibration sensor actuates the vertical linear actuator (28) to lift the entire chassis (10) so that the wheel assembly (20) is above the track (50) and then the horizontal linear actuator (22) retracts so that the wheel assembly (20) is at the center of the chassis. The vertical linear actuator (28) then again unlifts the entire chassis (10) so that train can pass over the system (100). Once, the train is passed, the system (100) get lifted itself by vertical linear actuators (28) and the wheel assembly (20) is pushed away from the centre of the chassis (10) to get the wheels on the track.
- The communication means is configured on the chassis (10). In an embodiment, the communication means is at least one foldable antenna (30) configured over the chassis (10) for seamless communication using internet or similar communication means.
- The communication means send the collected data from the sensors and cameras to the master computer on a cloud server. The master computer processes the data and gives the results in terms of type of failure and its magnitude with the exact location of the track (50)
- The microcontroller (34) controls the sensor assembly and a power source such as battery (32) for powering the microcontroller (34), the sensor assembly and other electronics of the system (100).
- Figure 5 shows a flowchart of working of the autonomous track monitoring system (100) in accordance with the present invention. The system (100) is placed in rest position in between the tracks (50) supported by the vertical linear actuators (28) on the track block (52).
- Thereafter, the system (100) is lifted by the vertical linear actuators (28) supported on the track blocks (52).

Then the system (100) extends the wheels assembly (20) using the horizontal linear actuators (22) over the track (50) wherein the system (100) is supported by vertical linear actuators (28) on the track blocks (52).

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The system (100) then unfold its communication antenna (30) and the external camera (18), wherein the system (100) is still supported by vertical linear actuators (28) on the track blocks (52).

10 Finally, the system (100) is supported by vertical linear actuators (28) on the track blocks (52) and also supported on the tracks (50) through the wheels assembly (20) as the wheels assembly (20) is expanded by means of horizontal linear actuator (22). Now, the system (100) is ready to move on the track (16).

15 Vice a versa, the system (100) can sense upcoming the train on the track (50) and can retract itself to the center of track (50), so that trains don't need to stop and passes over the system (100).

The system (100) of the present invention is capable of performing following
20 operations

1. The system (100) detects any fracture or any crack in the track (50).
2. The system (100) detects any kink or misalignment or dip in track (50).
3. The system (100) detects foreign elements on or off the tracks (50) which may affect transportation.
- 25 4. The system (100) detects any missing parts like fishplates, fish bolts and elastic rail clip or other missing parts in track (50).
5. The system (100) detects position of elastic rail clips.
6. The system (100) detects abnormalities at rail crossings.
7. The system (100) detects overflow of water, stagnation of water near track.
- 30 8. The system (100) detects condition of height gauges near crossings.

9. The system (100) immediately reports unsafe track condition to respective authority.

10. The system (100) raises an e alarm and stop the train or permit the train movement at reduced speed as per situations requirement.

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11. The system (100) has ability to detect health of power transmission wire of electric train.

The foregoing descriptions of specific embodiments of the present invention have
10 been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the present invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the present invention and its practical application, and to thereby
15 enable others skilled in the art to best utilize the present invention and various embodiments with various modifications as are suited to the particular use contemplated. It is understood that various omissions and substitutions of equivalents are contemplated as circumstances may suggest or render expedient, but such omissions and substitutions are intended to cover the application or
20 implementation without departing from the spirit or scope of the claims of the present invention.

We claim:

1. An autonomous track monitoring system (100) for inspection of railway tracks (50) and the like, the autonomous track monitoring system (100)
5 comprising:
 - a chassis (10) having a front side (A), a rear side (B), a first side (C) and a second side (D);
 - a sensor assembly configured on the chassis (10);
 - at least one horizontal linear actuators (22) configured within the first side
10 and the second side of the chassis (10);
 - a wheel assembly (20) attached to each horizontal linear actuators (20), the wheel assembly (20) is capable of being retracted and expanded through horizontal linear actuators (22) and the wheel assembly (20) is configured to sit on the track when in expanded position;
 - 15 at least four vertical linear actuators (28) configured below the chassis (10) for lifting and lowering the chassis (10);
 - a communication means configured on the chassis;
 - a microcontroller (34) for controlling the sensor assembly; and
 - a power source (32) for powering the microcontroller, and the sensor
20 assembly.
2. The system (100) as claimed in claim 1, wherein the sensor assembly comprises:
 - at least one image capturing unit (14) configured centrally on the front
25 portion (A) and the rear portion (B) of the chassis (10);
 - at least two depth sensors (16) configured on either side of the front portion (A), and the rear portion (B) of the chassis;
 - a vibration sensor operatively coupled to the horizontal linear actuator (22) and the vertical linear actuator (28); and
 - 30 a foldable image capturing unit (18) configured on the wheel assembly on either side for inspection of external side of the track;

3. The system (100) as claimed in claim 1, wherein the horizontal and vertical linear actuators (22, 28) are operated by electro-mechanical switches.

5 4. The system (100) as claimed in claim 1, wherein the chassis (10) includes at least one head lights on front side and rear side.

5. The system as claimed in claimed 1, wherein each wheel assembly (20) has two wheels (24) powered by the rotary actuators (26).

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6. The system as claimed in claim 1, wherein the communication means is at least one foldable antenna (30) configured over the chassis (10) for seamless communication.

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