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RAIL BRIDGE INSPECTION USING ROBOT CAR FOR CORROSION DETECTION.

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***Abstract*—Steel bridges constitute as one of the most important structures. Hence, it is essential to inspect them appropriately. The technique described in this, is a compliment for the conventional technique of inspection of bridges. A robot car is designed to monitor the inaccessible regions of the bridge, particularly the region underneath the bridge. The proposed design consists of a raspberry pi interfaced with a camera module. This enables to obtain high definition images and live streaming of the area to be inspected. The feed acquired in form of optical representation is further interpreted for repairs and necessary actions through wireless fidelity.**

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Keywords—Bridge inspection, Raspberry pi, Wireless fidelity.

Introduction

India comprises of around 1,20,000 steel bridges. Timely inspection of these structures is necessary for the optimal working and prevention from major damages. This aids in the work and the process required for maintenance and further processing.

The inspection of the bridges is done annually. The inspection is carried out by the Permanent Way inspector. He carries out the inspection of the structures before the monsoon. The readings are acquired and entered in the register. As the intensity of damage is gauged, the parts requiring recovery are repaired immediately. The engineer is notified when the larger defects are noticed. Succeeding the monsoon, an elaborative inspection is carried out by the Assistant Engineer. The following parts are observed and recorded:

- Protection works
- Bearings and expansion arrangement
- Steel works
- Sleepers
- Track
- Fatigue cracks
- Painting and patch painting
- Buckling and bending in members
- Greasing and oiling of bearings

Three types of inspection are mainly authorized. Namely, they are specified as visual, periodic and routine. Considering the type of structure, age they are timely investigated. The periodic inspection is undertaken by experienced and skilled professionals within duration of three to four years.

After the detailed inspection, rating is done for each part of the structure and the '**GRADING'** is made as follows:

Good	Rating 8&9	There are no repairs required. The working conditions are fine
Fair	Rating 5,6,7	The defects are considerable.
Poor	Rating 3,4	The performance of the bridge is unsatisfactory.
Critical	Rating 0 to 2	The bridge is heavily damaged and must be shut down. The repairs should be done immediately.

In this paper, we introduce a novel method, to inspect the underneath part of the bridge. This method implies use of robot car which captures images of the region to be inspected. Along with this, it also specifies the exact location of the damage detected. The method uses a track, a camera module wirelessly transmits the data to the monitoring station. Currently, the majority of bridge inspections are done manually by inspectors which require significant amount of human resources along with expensive and specialized equipment. Moreover, it is

difficult and time consuming for inspectors to inspect large bridges with high structures. In this project, we propose a new design and implementation of a robotic system that can be used for rail steel bridge inspection. Itis able to carry multiple sensors for navigation and mapping. Collected data are sent to the monitoring station for live monitoring as well as further processing. Hence this method ensures the safety of the workers carrying the inspection and enables secure working conditions. The frequency of the inspection process can be customized as per the age, condition and type of bridge.

Proposed design

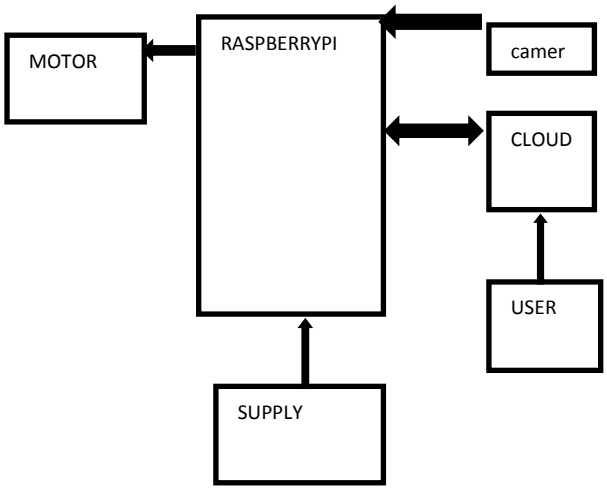


Fig. 1: Proposed Block Diagram

Implementation strategy

Design of bridge

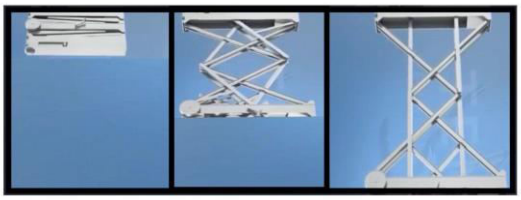
Generally, the rail bridges comprise of steel which are prone to corrosion and fatigue cracks. The components in the construction may get displaced due to external factors and various reasons. The rail track consists of girder which is placed above the pillars for support.

Fig.2

Design of auxillary track

The inspection track is placed beneath the girder. The track is made up of aluminium material which is non-corrosive and light weight in nature and provides support to the robot. Considering the construction of the bridge, the position of the track is determined.

For this purpose, a foldable track support mechanism is implemented. It is purely for safety purpose without affecting the strength of bridge. It can sustain the large stresses and vibrations that occur while there is movement of the train on the rail bridge. This arrangement is enclosed thus enabling the prevention of the robot track from the external environmental



factors.

Fig.3

Fig. Foldable mechanism to support track. This mechanism will come into effect only during the time of inspection. Otherwise, it will be embedded in the enclosure.

MONITORING STATION:

The dependency on the visual inspection can be modified further by using the modern electronic equipment. This in turn, restrains the severity of the fault to enlarge. The choice of sensors and electronic equipment to be used will differ as per the bridge parameters to be inspected. The analysis of the stream obtained will be preceded by the adequate measures to be taken for restructuring of the defected components.

Design of robot car

Robot car consists of following components:

Raspberry pi: The model used is Raspberry pi 3B. The raspberry is S.O.C circuit which works as a processor which enabling wireless LAN and Bluetooth connectivity.

Fig. Inspection robot

MOTOR :- **The motor used is Johnsons gear motor which runs at 200 rpm. The motor is supplied by a constant 12V 2A dc supply. This being a gear motor has a very high initial torque satisfying the requirments for bearing the load of the assembly.**

MOTOR DRIVER

The L298N motor driver facilitates the connection between the motor and the raspberry pi. It is a high voltage, high current bridge driver. Two enable inputs are allotted to enable or disable the device independently of the input signals. The operating voltage is usually high, up to 40volts. The output current is large and the instantaneous current can be up to 3A. It provides connection for two motors. The driver provides jumper connection for high current requirement motor operations which are greater than 12V.

CAMERA MODULE

Raspberry camera module aids in the recording, storing and transmission of static and dynamic images. The module uses a sensor which is capable of recording at full resolution. It is able to capture fine details efficiently. The raspberry pi camera v2 comprises of very high quality which consists of an 8mp SONY imx219 image sensor based. Capable of capturing 3280*2464-pixel static images, and it supports video compatibility of1080p30,720p60 and 640*480p60/90. The camera is attached to the raspberry through the ribbon cable of 15cmto the dedicated socket. A pan tilt mechanism is assembled to provide a wide-angle view and extra exposure.

FAULT LOCATING TECHNIQUE

The track placed for inspection consists of marking at equal intervals for locating the exact position of the robot when a fault is located while inspection.

Inspection process:

The track is installed on the site to be inspected the initial and the end points are first located. The robot traverses on the path and starts inspecting the bridge. The remote monitoring station are situated in the vicinity of the site of inspection. The operator initializes and further activates the robot and hence the process of examination starts. The position of the robot is controlled by VNC server by the operator. The visual inspection is done by operator by observing the live network stream transmitted by the robot. After the surveillance in case of detection of unfavorable condition of the bridge, adequate measures and repairs are undertaken. On the contrary, when no any faults are detected the process is terminated. And the examination is rescheduled. The footage is stored in the database for further comparison as a reference to obtain the magnitude of damages. The bridge is segregated in equal intervals considering the potential of the

sensor used. Therefore, with the aid of the separated sections, the inspection for the moving parts is proceeded.

Results

Figure shows inspection system using Robo for corrosion detection.

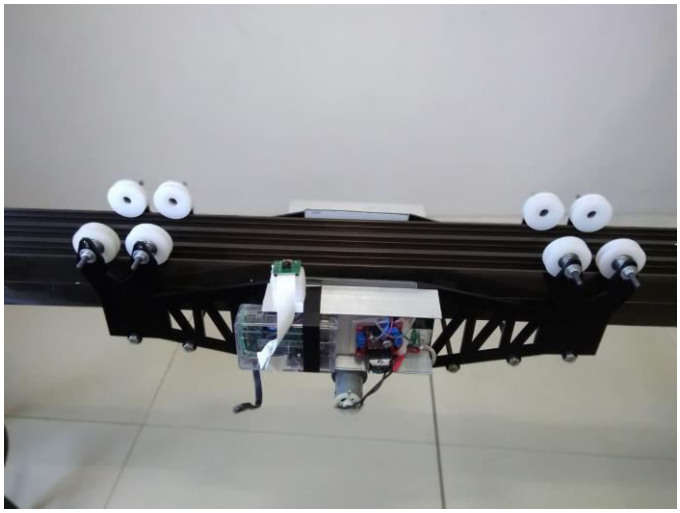


Fig. 3: Inspection robot on secondary track.

Conclusion

This paper has been presented in the urge towards achieving an efficient and safe inspection system for rail bridges. Image sensor used collects the data and sends it to the raspberry pi for further processing and transmission. The movement of the vehicle is controlled by a gear motor. The track provides the stability and path for the vehicle to conduct the process.

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