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Advanced Method to Detect Railway Track Damage Using Raspberry pie and Internet of Things

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ABSTRACT

The main objective of this paper is to make a simple, effective and portable robot for the identification of major railway track damages using Raspberry pie and Internet of things. It also uses a GPS system to get the exact location of the damaged track. A robot will move across the railway track with IR sensors placed on it to detect flaw on the track. Its location will be traced and will be transmitted to the main server. Many projects have been already done on this topic earlier using image processing but this paper mainly focuses on identifying the demarcated areas of track circuit on which there is no such arrangements are done to detect any flaw in the track with the help of latest technologies. It will also reduce the responsibilities of human to manually check the track damages.

Key words—Raspberry pie, Internet of Things, GPS, Sensors

1. INTRODUCTION

Railways are the principal mode of transportation for freight and passengers in India. Railways also make it possible to conduct multifarious activities like business, sightseeing, and pilgrimage along with transportation of goods over longer distances. Apart from an important means of transport the Indian Railways have been a great integrating force for more than 150 years. Railways in India bind the economic life of the country as well as accelerate the development of the industry and agriculture. But today I have to say with a grave sense of disappointment that this system is full of conventional stereotypes that have existed since the advent of railways in 1948, one such being the gruesome state of the employees who play a pivotal role in the lucid management and safety of this huge network. India may have risen up the ranks on terms of quantity (of passengers and revenue) but sadly not in technological advancements.

One caustic fact is that whole of railway network is largely dependent on man force rather than machines for track review and flaw detection in the tracks. No matter how deft there eyes are, humans do err, significantly more than machines. Moreover, the conditions in which these “gang-men’ have to live are quite grim, being constantly under the threat of wild animals during the nightfall at odd locations in addition to falling prey railway mishaps themselves. So this “Major track damage detection system” is an effort to ameliorate the present day scenario.

2. OBJECTIVE OF SYSTEM

Major Derailments occur in Railways due to track damage or fissures resulting in loss of life and property. At all the railway stations there is a particular demarcated area known as yard region, which is track circuited. Track circuiting is the electric wiring on the railway tracks. The area where track circuiting is done can be easily monitored by the station master at the control room. So any flaw in the track can easily be detected in its nascent stage and can be mended. But track circuiting can’t be done on each and every area covering railway lines(mid-section area).In the present scenario some gang men are assigned to monitor and do patrolling for the same, which sometimes prove to be ineffective due to negligence. Hence we have designed a compact automatic robot to monitor these areas (mid-section area) for any crack or fissure. Here, as soon as the robot detects the crack, exact location will be sent to the main server through gps and optimum actions can be taken further.

3. BLOCK DIAGRAM

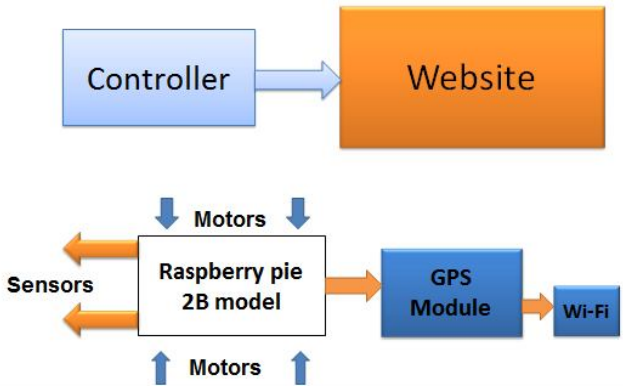
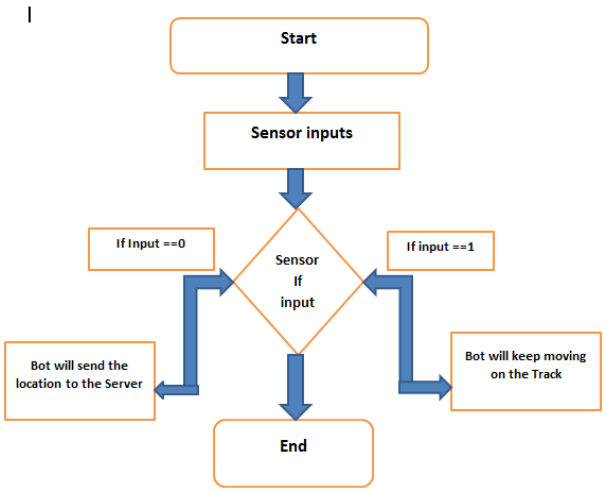


Figure 1: Block Diagram

4. WORKING



The mechanism works on a simple principle i.e. the robot will move on the railway track continuously and as soon as the IR sensors gets the input signal low, it will stops the robot and sends the exact location of that point to the server via Internet.

In the given flowchart given above the sensor inputs are connected to the GPIO pins of raspberry pie and follows the sequence when the input of the GPIO pins become low (i.e zero) the sensors goes out of the loop and sends the signal so that GPS trace the location the sends the coordinates to the raspberry pie script. Python script is written in such a manner that it gives the data value in latitude and longitude form. As soon as the coordinates are available the data again sends to over the internet to the server so that it should get updated over the website or over the client‘s python terminal. The data of coordinates are sent through the USB Wi-Fi dongle connected over internet. In the other condition in the flowchart if the input signal becomes high that means the inductive sensor still sensing the metal so it keeps on moving on the track for identifying the major cracks.

For doing so, a laptop is connected to router and the raspberry pie is also connected to the router so the IP address of the raspberry is obtain through the router’s detail configurations and after getting the IP address of the raspberry pie, put that IP address in TA software called “Putty”. The detail information about putty software is given below section , it is basically a secure shell software given an environment for working over a network. After putting the IP address login in the terminal using user id and password and doing this we need a graphical user interface to work on raspberry pie scripts in a user friendly way for doing so a software called VNC server is install on raspberry pie, again put the IP address on the VNC server and login in it. After login open python script and run the script written for the sensors and GPS and as soon the crack is identified by the sensor the coordinates are transmitted over Internet via USB Wi-Fi dongle connected to the raspberry pie. In this whole process the router act as a channel for transmitting the data and receiving the data through laptop and also providing the internet to both the devices.

For implementing the process over the internet there are two things which most important i.e. client and server in which the client is robot which is moving and sensing the input for damages and the server is the python terminal of the person who is monitoring the coordinates of GPS for cracks. There can be a two way communication between the client and server .For an example if a crack is identified and to prevent the robot to be damage the server side person gives the command to the robot move in reverser direction so that will not get damage. In the same manner locations can be send to the server. The data transmission speed may varies according to the internet speed of the router and it’s a wireless network the router which is used is a portable router of small size.

The major difference between the projects done so far on this issues are not stressed on the demarcated area is not fully connected to the railway station tracking region. So taking this point into consideration all the components are selected .

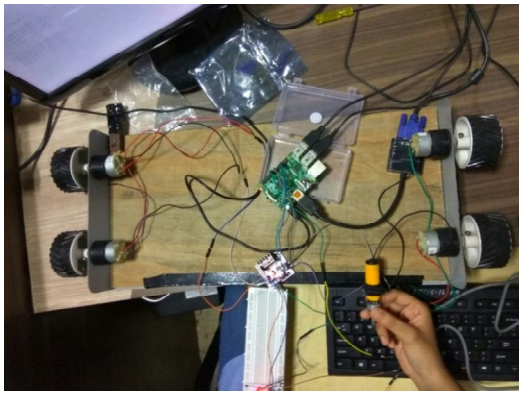


Figure 2: Actual Robot with IR sensor

5. SYSTEM COMPONENTS

The system contains both hardware & software components which are given as following:

Hardware Components:

A. *Raspberry pie:* Raspberry pie 2B model

- Broadcom BCM2837Arm7 Quad Core Processor powered Single Board Computer running at 900MHz
- 1GB RAM so you can now run bigger and more powerful applications
- Identical board layout and footprint as the Model B+, so all cases and 3rd party add-on boards designed for the Model B+ will be fully compatible.
- Fully HAT compatible
- 40pin extended GPIO to enhance your “real world” projects. GPIO is 100% compatible with the Model B+ and A+ boards. First 26 pins are identical to the Model A and Model B boards to provide full backward compatibility across all boards.
- Connect a Raspberry Pi camera and touch screen display (each sold separately)
- Stream and watch Hi-definition video output at 1080P

- Micro SD slot for storing information and loading your operating systems.
- Advanced power management:
- You can now provide up to 1.2 AMP to the USB port – enabling you to connect more power hungry USB devices directly to the Raspberry PI. (This feature requires a 2Amp micro USB Power Supply)
- 10/100 Ethernet Port to quickly connect the Raspberry Pi to the Internet
- Combined 4-pole jack for connecting your stereo audio out and composite video out

B. Global Positioning System (GPS):GlobalSat BU353 S4 USB Receiver

• Standalone GPS receiver Dimension: 22mmX30mm
• U-blox NEO-6M GPS module Height: 13mm
• Under 1 second time-to-first-fix for hot
• SuperSense ® Indoor GPS: -162 dBm tracking sensitivity Weight: 12g
• Anti-jamming technology
• Support SBAS (WAAS, EGNOS, MSAS, GAGAN)
• u-blox 6 50 channel positioning engine with over 2 million effective correlators
• Timepulse
• 5Hz position update rate
• Operating temperature range: -40 TO 85°C • UART TTL socket

Compatible with:
- Windows 10, 8, 7, Vista, XP
- MAC OSX 10.3 and above
- Android 3.1 and above

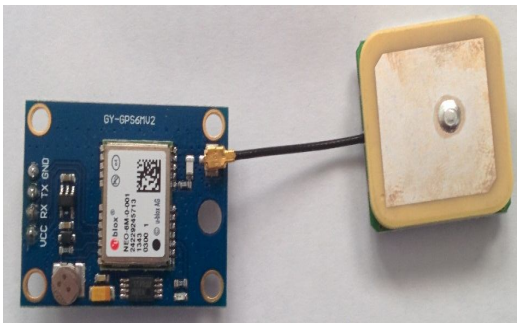


Figure 3: GPS module

C. *Industrial IR sensors:* Capactive PNP Sensors

- Capacitive proximity sensors use the face or surface of the sensor as one plate of a capacitor, and the surface of a conductive or dielectric target object as the other. The capacitance varies inversely with the distance between capacitor plates in this arrangement, and a certain value can be set to trigger target detection.
- This sensors measure the proximity of conductive as well as non-conductive objects with high resolution. Analogous to the function of an inductive proximity sensor, where a magnetic field is generated, a capacitive proximity sensor generates an electrostatic field at the face of the sensor. The sensor face is surrounded by a guard with equal potential so that the electric field will be focused towards the target. The capacitance varies inversely with gap distance and directly with the dielectric medium as well as the surface area of the target
- It can be tuned to detect a wide range of powder, liquid or solid materials. It is also possible to detect the presence or absence of materials within a barrier or package when the dielectric of the material is greater than the barrier or packaging. Capacitive sensors can also be used as a limit switch, for level detection, object detection and for counting purposes.
- PNP is a transistor output that switches the positive voltage to the load; load connected between sensor output and voltage supply common or negative.

Figure 4: Inductive Proximity Sensor

D. USB WiFi Dongle: Edimax ew-7811un

- Frequency Band : 2.4 GHz
- Interface (Bus) Type : USB 2.0
- Wireless Network Adapter
- Data Link Protocol : IEEE 802.11b, IEEE 802.11g, IEEE 802.11n
- Features : Green WLAN, Quality of Service (QoS), Wi-Fi Multimedia (WMM) support, Wi-Fi Protected Setup (WPS)
- Compliant Standards : IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, IEEE 802.1x, USB 1.1, USB 2.0, Wi-Fi CERTIFIED, Wi-Fi Protected Setup
- Data Transfer Rate : 150 Mbps
- Wi-Fi Bands : 2.4Ghz

E. *Motors :* Dc Geared 300 RPM Motors

- Motor Driver IC: L298N H-Bridge IC
- Driver: L298N

- Driver power supply: +5V~+46V
- Driver Io: 2A
- Logic power output Vss: +5~+7V (internal supply +5V)
- Logic current: 0~36mA
- Controlling level: Low -0.3V~1.5V, high: 2.3V~Vss
- Enable signal level: Low -0.3V~1.5V, high: 2.3V~Vss
- Max power: 25W (Temperature 75 Celsius)
- Working temperature: -25C~+130C
- Dimension: 60mm*54mm
- Driver weight: ~48g
- Other extensions: current probe, controlling direction indicator, pull-up resistor switch, logic part power supply.

Figure 5: USB WiFi Dongle

F. Router :

- JioFi Wifi Router

Figure 6: JioFi Wifi Router

Software Components:

A. Raspberry pie OS: Raspbian Jessie operating system .

- The Raspbian operating system is based on Debian Linux
- Advanced GUI
- Updated applications like Sense Hat
- More user friendly

*B. Programming language:*Python

The diverse application of the Python language is a result of the combination of features which give this language an edge over others. Some of the benefits of programming in Python include:

1. Presence of Third Party Modules:
The Python Package Index (PyPI) contains numerous third-party modules that make Python capable of interacting with most of the other languages and platforms.

2. Extensive Support Libraries:
Python provides a large standard library which includes areas like internet protocols, string operations, web services tools and operating system interfaces. Many high use programming tasks have already been scripted into the standard library which reduces length of code to be written significantly.

3. Open Source and Community Development:
Python language is developed under an OSI-approved open source license, which makes it free to use and distribute, including for commercial purposes.

Further, its development is driven by the community which collaborates for its code through hosting conferences and mailing lists, and provides for its numerous modules.

4.*Learning Ease and Support Available:*
Python offers excellent readability and uncluttered simple-to-learn syntax which helps beginners to utilize this programming language. The code style guidelines, PEP 8, provide a set of rules to facilitate the formatting of code. Additionally, the wide base of users and active developers has resulted in a rich internet resource bank to encourage development and the continued adoption of the language.

5. User-friendly Data Structures:
Python has built-in list and dictionary data structures which can be used to construct fast runtime data structures. Further, Python also provides the option of dynamic high-level data typing which reduces the length of support code that is needed.

6. Productivity and Speed:
Python has clean object-oriented design, provides enhanced process control capabilities, and possesses strong integration and text processing capabilities and its own unit testing framework, all of which contribute to the increase in its speed and productivity. Python is considered a viable option for building complex multi-protocol network applications.

C. Website: HTML based website for displaying locations.

D. Putty Software :

- It is a free and open-source terminal emulator, serial console and network file transfer application. It supports several network protocols, including SCP, SSH, Telnet, rlogin, and raw socket connection. It can also connect to a serial port.
- PuTTY was originally written for Microsoft Windows, but it has been ported to various other operating systems. Official ports are available for some Unix-like platforms, with work-in-progress ports to Classic Mac OS and macOS, and unofficial ports have been contributed to platforms such as Symbian, Windows Mobile and Windows Phone.
- IT supports many variations on the secure remote terminal, and provides user control over the SSH encryption key and dynamic port forwarding with SSH (including X11 forwarding).

6. ADVANTAGES

1. Track status will be available online on website.
2. Dependency on manual work will be reduced.
3. Robots embedded with temperature sensors can be useful to know the atmospheric conditions of certain location.
4. Railways become more relaible
5. Costing for implementing this concept will not cost much.
6. Speed of the Bot can be controlled online.
7. With some modification in the design it can be made aerial in emergency cases.
8. It does not require more electricity.

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