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Robust Railway Crack Detection Using IRLED-Photodiode Assembly

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Abstract: *In India, most of the commercial transport is being carried out by the railway network and therefore, any problems in the same has the capacity to induce major damage to the economy-notwithstanding the societal impact of loss of life or limb. This paper proposes a cost effective yet robust solution to the problem of railway crack detection utilizing a method that is unique in the sense that while it is simple, the idea is completely novel and hitherto untested. The paper discusses the technical and design aspects in detail and also provides the proposed robust crack detection algorithm. The paper also presents the details of the implementation results of the RRCDS utilizing simple components inclusive of a GPS module, GSM Modem and LED-PHOTODIODE based crack detector assembly. The proposed scheme has been modeled for robust implementation in the Indian scenario.*

Keywords*: Gps module, LED photodiode, gsm modem .rf transceive, LCD, buzzer.*

1. INTRODUCTION

In today's world, transport is a key necessity because in its absence it would be impossible for products to be consumed in areas which are not in the immediate vicinity of the production centres. Throughout history, transport has been a necessity for the expansion of trade. Economic prosperity can be achieved by increasing the rationality and capacity of transport systems. The proper operation and maintenance of transport infrastructure has a great impact on the economy. Transport, being one of the biggest drainers of energy, its sustainability and safety are issues of paramount importance. In India, rail transport occupies a prominent position in quenching the ever-burgeoning needs of a rapidly growing economy [2]. However, in terms of the reliability and safety parameters, global standards have not yet been truly reached. Though rail transport in India growing at a rapid pace, the associated safety infrastructure facilities have not kept up with the mentioned proliferation. The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails.[3].

2. EXIXTING SYSTEM USING LED – LDR ASSEMBLY

The Indian railway network today has a track length of 113,617 kilometres (70,598 mi).over a route of 63,974 kilometres (39,752 mi) and 7,083 stations [1]. It is the fourth largest railway network in the world exceeded only by those of the United States, Russia and China. In the existing System the principle involved in crack detection is the concept of LDR (Light dependent Resistor). In this design, the LED will attach to one side of the rails and the LDR to the opposite side.

3. WORKING PRINCIPLE

The core of the proposed crack detection scheme consists of a Light Emitting Diode (LED)-Light Dependent Resistor (LDR) assembly that functions as the rail crack detector. The principle involved in crack detection is the concept of LDR. In the proposed design, the LED will be attached to one side of the rails and the LDR to the opposite side. Hence the LDR resistance is high. Subsequently, when the LED light falls on the LDR, the resistance of the LDR gets reduced and the amount of reduction will be approximately proportional to the intensity of the incident light.

As a consequence, when light from the LED deviates from its path due to the presence of a crack or a break, a sudden decrease in the resistance value of the LDR ensues. This change in resistance indicates the presence ofa crack or some other similar structural defect in the rails. In order to detect the current location of the device in case of detection of a crack, a GPS receiver whose function is to receive the current latitude and longitude data is used. To communicate the received information, a GSM modem has been utilized.The function of the GSM module being used is to send the current latitude and longitude data to the relevant authority as an SMS. The aforementioned functionality has been achieved by interfacing the GSM module, GPS module and LED-LDR arrangement with a microcontroller. The sensor driven circuit is used to maintain the sensor circuit at proper condition. From this circuit, the signal is transmitted through the radio link transmission. [1] Here are using wired antenna for transmission purpose. The same radio reception used at base station .at base station.

We use BUZZER circuit as well as liquid display unit (LCD) used to indicate the condition of the track. When compared to existing system, it is easy to design. Sensor placed at same side of the track. The advantages include less cost, low power consumption and less analysis time. By this proposed system the exact location of the faulty rail track can easily be located which will mended immediately so that many lives can be saved.

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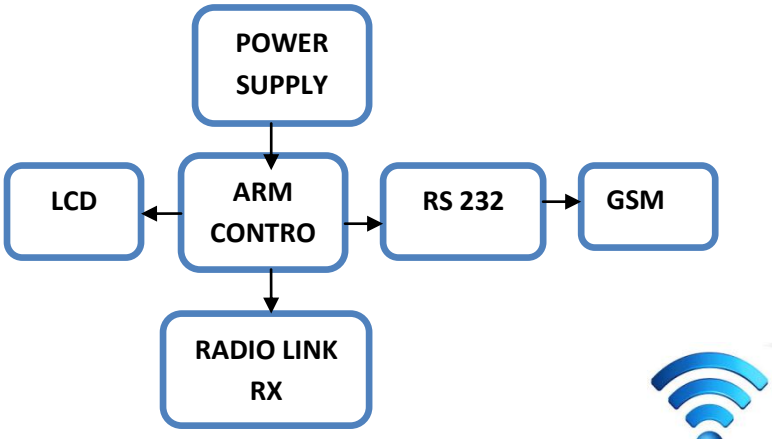
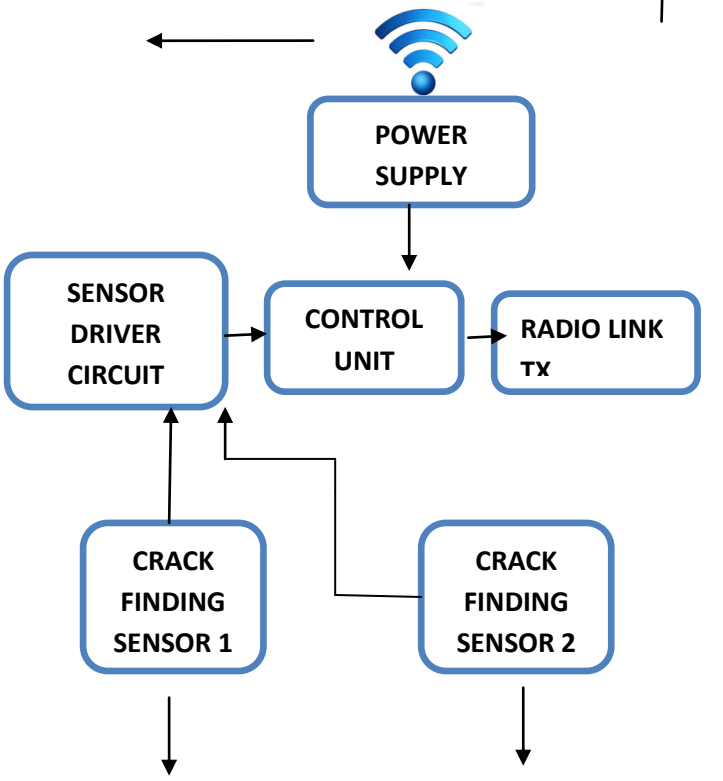
4. DATA SENDING METHOD

This method we are using conductive property of iron rod. We send binary data via track. That signal generated by the micro controller. That is connected to the one end of the rail. After the particular distance, the same signal received by another end of the rail.

5. BLOCK DIAGRAM



3.2.2.2. WORKING PRINCIPLE



The 5V binary data is send from the controller. It transmits through the track due to the conductive property of iron rod. After particular distance, the same data received by another rail.

CONDITION 1

At initial condition, there is no any damage on the track, light from the IR- LED falls on PHOTODIODE. It monitored by the controller. That sends information to the corresponding authority via GSM MODEM.

CONDITION 2

If any damage or crack present on the track, the data does not received by the micro controller at predefined time period. This controller sends the information to the corresponding authority via GSM MODEM.

2) GPS Module:

SR-92 GPS receiver has been used as the GPS module. SR-92 is a low-power, ultra-high performance, easy to use GPS smart antenna mo

The proposed rail track detection system architecture consists of ARM7 controller, GPS, GSM, LED-PHOTODIODE Assembly, GPRS.

B.OPERATION

This section explains the operation of modules present in the faulty rail track detection system architecture.

A) MICRO CONTROLLER:

The microcontroller used in this system is LPC2148 microcontroller that is based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded Fig trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. Due to their tiny size and low power consumption, LPC21418 are ideal for applications where miniaturization is a key requirement.

B) GPS Module:

SR-92 GPS receiver has been used as the GPS module. SR-92 is a low-power, ultra-high performance, easy to use GPS smart antenna module based on SiRF's third generation single chip. The 5-pin I/O interface is then connected to the main board with either connector or wire soldering. The main features of GPS module includes

- High tracking sensitivity of -159dBm
- Low power consumption of 40mA at full tracking
- Built-in backup battery allowing hot/warm starts and better performance
- Hardware power saving control pin allowing power off GPS.

C) GSM Module:

The SIM 300 GSM module has been chosen to achieve the SMS functionality. Featuring an industry-standard interface, the SIM300 delivers GSM/GPRS900/1800/1900Mhz performance for voice, SMS, data and Fax in a small form factor and with low.

6. SYSTEM ARCHITECTURE: ARM PROCESSOR

Atmel's SAM7X512/256/128 is a member of a series of highly integrated Flash microcontrollers based on the 32-bit ARM RISC processor. It features 12/256/128 Kbytes high-speed Flash and 128/64/32 Kbyte SRAM, a large set of peripherals, including an 802.3 Ethernet MAC and a CAN controller. A complete set of system

functions minimizes the number of external components. The embedded Flash memory can be programmed in-system via the JTAG-ICE interface or via a parallel interface on a production programmer prior to mounting. Built-in lock bits and a security bit protect the firmware from accidental overwrite and preserve its confidentiality. The SAM7X512/256/128 system controller includes a reset controller capable of managing the power-on sequence of the microcontroller and the complete system. Correct device operation can be monitored by a built-in brownout detector and a watchdog running off an integrated RC oscillator. By combining the ARM7TDMI processor with on-chip Flash and SRAM, and a wide range of peripheral functions, including USART, SPI, CAN Controller, Ethernet MAC, Timer Counter, RTT and Analog-to-Digital Converters on a monolithic chip, the SAM7X512/256/128 is a powerful device that provides a flexible, cost-effective solution to many embedded control applications requiring communication over, for example, Ethernet, CAN wired and Zigbee wireless networks.

7. BUZZER

The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers can be used alert a user of an event corresponding to a switching action, counter signal or sensor input. They are also used in alarm circuits. The buzzer produces a same noisy sound irrespective of the voltage variation applied to it. It consists of piezo crystals between two conductors. When a potential is applied across these crystals, they push on one conductor and pull on the other. This, push and pull action, results in a sound wave. Most buzzers produce sound in the range of 2 to 4 kHz. The Red lead is connected to the Input and the Black lead is connected to Ground.

8. PHOTODIODE

A photodiode is a p-n junction or PIN structure. When a photon of sufficient energy strikes the diode, it creates an electron, whole pair. This mechanism is also known as the inner photoelectric effect. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in electric field of the depletion region thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced. The total current through the photodiode is the sum of the dark current and the photocurrent, so the dark current must be minimized to maximize the sensitivity of the device. [4-5]

A) Photovoltaic mode

When used in zero bias or photovoltaic mode, the flow of photocurrent out of the device is restricted and a voltage builds up. This mode exploits the photovoltaic effect, which is the basis for solar cells – a traditional solar cell is just a large area photodiode.

B) Photoconductive mode

In this mode the diode is often reverse biased (with the cathode driven positive with respect to the anode). This reduces the response time because the additional reverse bias increases the width of the depletion layer, which decreases the junction's capacitance. The reverse bias also increases the dark current without much change in the photocurrent. For a given spectral distribution, the photocurrent is linearly proportional to the illuminance .
Although this mode is faster, the photoconductive mode tends to exhibit more electronic noise. The leakage current of a good PIN diode is so low (<1 nA) that the Johnson of the load resistance in a typical circuit often dominates.
Other modes of operation
Avalanche photodiodes have a similar structure to regular photodiodes, but they are operated with much higher reverse bias. This allows each *photo*-generated carrier to be multiplied by avalanche breakdown, resulting in internal gain within the photodiode, which increases the effective responsively of the device. Such as access control and point-of-sale. A blend of serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTs, SPI, SSP to I2Cs, and on chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low imaging, providing both large buffer size and high processing power.

9. CONCLUSION

The proposed broken rail detection system automatically detects the faulty rail track without any human intervention. There are many advantages with the proposed system when compared with the traditional detection techniques. The advantages include less cost, low power consumption and less analysis time.
By this proposed system the exact location of the faulty rail track can easily. So that many lives can be saved. We hope that their idea can be implemented in large scale in the long run to facilitate better safety standards for rail tracks and provide effective testing infrastructure for achieving better results in the future.

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