ISSN 2348 – 9928
IJAICT Volume -1, Issue-3, July 2014 Doi:01.0401/ijaict.2014.01.13 Published Online 05 (05) 2014

IMPLEMENTATION OF TELEMATICS USING CAN IN ARM PLATFORM FOR LOCOMOTIVES PATH SURVEILLANCE

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Abstract— In India rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain needs of a rapidly growing economy. However, in terms of the reliability and safety parameters, we have not yet reached truly global standards. The main problem about a railway analysis is detection of cracks in the structure. Thousands of miles of railroad track must be inspected twice weekly by a human inspector to maintain safety standards. The project proposes a cost effective solution to the problem of railway track crack detection utilizing IR (Infrared) sensor assembly which tracks the exact location of faulty track which then mended immediately so that many lives will be saved. In this system, for continuous communication CAN (Controller Area Network) in ARM platform has been preferred. The data's and acknowledgement signals are handled by CAN.

Keywords— Crack detection, IR pair, CAN, ARM.

I. INTRODUCTION

Transport is a key necessity for specialization that allows production and consumption of products to occur at different locations. Transport has throughout history been a spur to expansion as better transport leads to more trade. In India, we find that rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain and quench the ever-burgeoning needs of a rapidly growing economy[1],[2].

The Indian railway network today has a track length of 113,617kilometers (70,598 mi) over a route of 63,974 kilometers (39,752 mi) and 7,083 stations. It is the fourth largest railway network in the world exceeded only by those of the United States, Russia and China. Despite boasting of such impressive statistics, the Indian rail network is still on the growth trajectory trying to fuel the economic needs of our nation. In terms of the reliability and safety parameters, we have not yet reached truly global standards.

The lack of safety and security monitoring of railway infrastructure runs the risk of train collision, train derailment, terrorist threats, failures etc. Today, the most common Non Destructive Testing (NDT) techniques used to detect cracks in rails is ultrasonic testing. These techniques are time consuming inspections, requiring the traffic to be interrupted during the testing. In addition, a technician with rail testing experience is required to analyze the results.

The IR Rail crack detector using CAN is designed to reliably detect cracks in train rails under harsh environmental conditions. Rail continuity is established by monitoring the presence of IR signals[3],[4]. If any damage occurs at any part of the rail line, the signal is transmitted through CAN network to get the exact location using GPS and received using GSM. The main advantage of using these techniques for rail inspections would be to ensure a real- time damage detection method. This avoids stopping traffic on the track and tedious examination.

1.1 Prevailing Methodologies

The defects in rails may be due to manufacturing deficiencies, defects arising during service or defects that occur either naturally or by human intervention[5]. So the testing is carried out at the time of installation and also at periodic intervals with the help of ultrasonic testing equipment having multiple probes covering entire cross-section of the rail.

In general, there exist three main categories of techniques currently used for damage identification and condition monitoring of Railway tracks. These include:

- Visual inspections
- Non-destructive testing (NDT) technologies such as acoustic emissions or ultrasonic methods, magnetic field methods, radiography, eddy current techniques, thermal field methods, dye penetrate, fiber optic sensors of various kinds.
- Computer Vision Testing.

1.2 Visual Inspection

Visual inspection is the primary technique used for defect identification in tracks, and is effectively used in specialized disciplines[6]. The successful implementation of this method generally requires the regions of the suspected damage to be known and be readily accessible for physical inspection. As a result, this method can be costly, time consuming and ineffective for large and complex structural systems such as the rail track.

1.3 Non-Destructive Testing

NDT techniques have resulted in a number of tools for us to choose from. Among the inspection methods used to ensure rail integrity, the common ones are magnetic field methods, dye penetrate ultrasonic inspection and eddy current inspection. Ultrasonic Inspections are common place in the rail industry in many foreign countries. It is a relatively well understood technique and was thought to be the best solution to crack detection[7]. The Ultrasonic Broken Rail Detector system is the first and only alternative broken rail detection system developed, produced and implemented on a large scale. By using ultrasonic Broken Rail Detector system railway operators will have the benefit of monitoring rails continuously for broken rails. Ultrasonic can only inspect the core of materials; that is, the method cannot check for surface and near-surface cracking where many of the faults are located.

II. COMPUTER VISION TESTING

Computer vision could potentially supplement the current manual inspection process due to its ability to objectively process large amounts of video and image data. Recently, a track cart has been developed to acquire track inspection video. This track cart, captures video of a railroad track with off the- shelf cameras, and records these data to a laptop. Railroad track inspection algorithms are developed to inspect the image and video data for defective track components. This method is costlier and is not reliable under bad weather conditions.

2.1 Unsupervised Crack Detection

The proposed system will overcome the limitations of both the traditional and the current system that are being used for detection of faulty tracks. It is a fully automated smart and intelligent robot for surveillance of railway track crack that uses wireless sensor networks. In this method the detection of Cracks can be identified using IR rays with the IR pair. IR receiver is connected to the microcontroller and CAN protocol is used for communication purpose[8]. GPS module finds the location and GSM transmits the message to authorized person and to the nearest station. RF transmitter and receiver are used for communicating with the upcoming trains.

It includes several advantages such as it replaces manual method of crack detection, automatic self test and error detection, much faster response time since ARM based microcontroller is used and IR is immune to noise. Since it is a robot model, the rail path can be surveyed anytime without affecting train schedules. Use of CAN makes it more reliable under noisy environment.

III. SYSTEM ARCHITECTURE

The System architecture includes two modules:

- The Surveillance Module that detects cracks which includes two microcontrollers, IR pair, GPS, GSM and RF Transmitter.
- The Train Module that represents a train which includes RF Receiver and a buzzer.

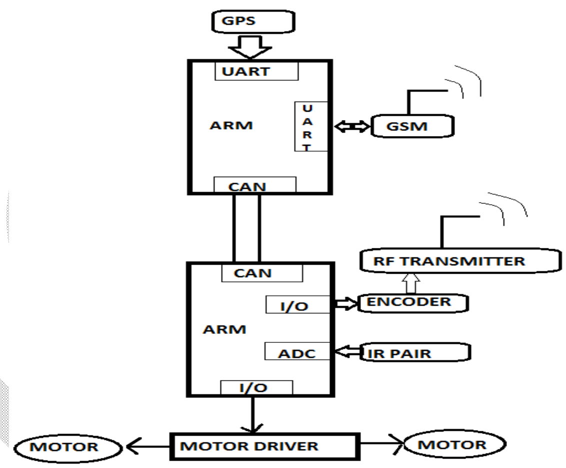

Fig.1: Surveillance Module Block Diagram

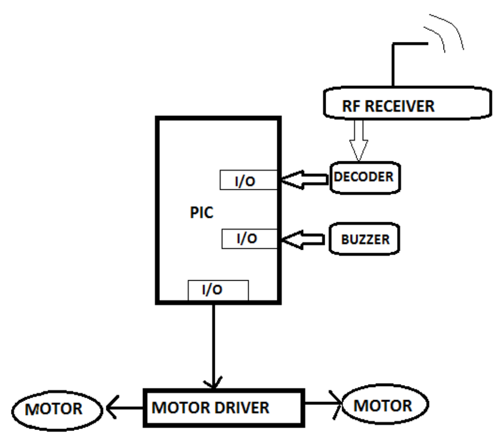

Fig.2: Train Module Block Diagram

3.1 LPC2129

The LPC2129 is based on a 32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, together with 256kB of embedded high-speed flash memory. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at maximum clock rate. For critical code

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size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty. With their compact 64-pin package, low power consumption, various 32-bit timers, 4-channel 10-bit ADC, two advanced CAN channels, PWM channels and 46 fast GPIO lines with up to nine external interrupt pins these microcontrollers[9] are particularly suitable for automotive and industrial control applications, as well as medical systems and fault-tolerant maintenance buses. With a wide range of additional serial communications interfaces, they are also suited for communication gateways and protocol converters as well as many other general-purpose applications.

3.2 PIC16F877A

PIC16F877A is a powerful (200 nanosecond instruction execution), easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller. The features are 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital(A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI) or the 2-wire Inter-Integrated Circuit(I²C) bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

3.3 INFRARED SENSOR

GP2Y0A02YK0F is a distance measuring sensor unit, composed of an integrated combination of PSD (position sensitive detector), IRED (infrared emitting diode) and signal processing circuit. The variety of the reflectivity of the object, the environmental temperature and the operating duration are not influenced easily to the distance detection because of adopting the triangulation method. This device outputs the voltage corresponding to the detection distance. So this sensor can also be used as a proximity sensor [10].

It has low power requirements and simple circuitry. Beam directionality ensures that data isn't leaked or spilled to nearby devices during transmission. There is relatively high noise immunity. It is cheaper in cost and faster in response time than ultrasonic sensors. Their inherently fast response is attractive for enhancing the real-time response of a mobile robot.

Fig.3: IR Sensor

3.4 Global System for Mobile Communications

The SIM 300 GSM module has been chosen to achieve the SMS functionality. Featuring an industry-standard interface, the SIM300 deliver GSM/GPRS900/ 1800/ 1900Mhz performance for voice, SMS, data and Fax in a small form factor and with low power consumption. The leading features of SIM300 make it deal virtually unlimited application, such as WLL applications, M2M application, handheld devices and much more. With a tiny configuration of 40mm x 33mm x 2.85mm, SIM300 can fit almost all the space requirement in your application.

The physical interface to the mobile application is made through a 60 pins board-to-board connector, which provides all hardware interfaces between the module and customers' boards except the RF antenna interface. The keypad and SPI LCD interface will give you the flexibility to develop customized applications. Two serial ports can help you easily develop your applications. Two audio channels include two microphones inputs and two speaker outputs. This can be easily configured by AT command.

Fig.3: SIM300 GSM Module

3.5 Global Positioning System

GPS-634R is a highly integrated smart GPS module with a ceramic GPS patch antenna. The module is with 51 channel acquisition engine and 14 channel track engine [11], which be capable of receiving signals from up to 65 GPS satellites and transferring them into the precise position and timing information that can be read over either UART port or RS232 serial port. Small size and high-end GPS functionality are at low power consumption. The smart GPS antenna module is available as an off-the-shelf component, 100% tested. The smart GPS antenna module can be offered for OEM applications with the versatile adaptation in form and connection. Additionally, the antenna can be tuned to the final systems circumstances.

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Fig.5 : GPS Module

3.6 RF Transmitter and Receiver

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Signals through RF can travel through larger distances making it suitable for long range applications [12]. RF signals can travel even when there is an obstruction between transmitter & receiver. RF communication uses a specific frequency which are unaffected by other emitting sources.

The RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs.

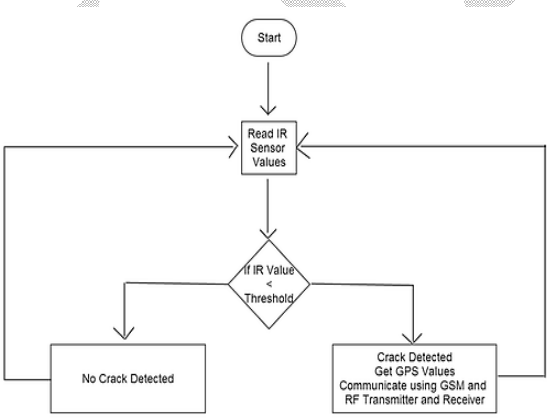

Fig.6: Flow Diagram

IV. CONCLUSION

The proposed system is IR based rail inspection system with CAN over ARM platform. There are many advantages with the proposed system when compared with the traditional detection techniques. This system is highly immune to noisy environment since IR and CAN are immune to noise and has fast response time due to ARM. The other 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 be mended immediately so that many lives can be saved. Future railroad track inspection technology should incorporate automatic detection to achieve a more robust system. This could lead to an autonomous system that could inspect thousands of miles of track without human supervision.

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