Crack Detection System for Railway Track by using Ultrasonic and PIR Sensor

Sadhana Gawade[1]*
*[1]Assistant Professor,
Department of Electronics & Telecommunication, Dr. D.Y. Patil College of Engineering, Pune, Maharashtra, India

Sandhya Solunke, Supriya Nimunkar, Yogita Survase
Department of Electronics & Telecommunication, Dr. D.Y. Patil College of Engineering, Pune, Maharashtra, India

Abstract*: In this project we introduced the integration of ultrasonic and total station for railway track geometry surveying system. this project consist of GPS module, GSM modem, IR sensor, PIR sensor for application of communication purpose, crack detection and finding of human being present in the railway track. The GPS module and GSM modem help us to find and sending railway geometric parameter of crack detection to nearest railway station. In the present of days we are using the measurement of track distance by using high cost LVDT with less accuracy, but we use the less cost ultrasonic sensor for above process with high accuracy. We implement PIR sensor in this project to avoid manual checking of detection of presences of human being in recent trends of application. The importance of this project is applicable both day and night time detection purpose.*

Keywords— GPS module, GSM modem, IR sensor, PIR sensor, Ultrosonic distance meter.

INTRODUCTION:Transport is very important to carry the passengers and goods from one place to another. The better transport leads to more trade. Economic level is mainly depends on increasing the capacity and level of transport. This paper presents an implementation of an efficient and cost effective solution suitable for railway application.

In this paper we are going to use IR sensor to detect the crack in rail road, when the crack is detected its latitude and longitude values are send as a message to nearby station by using GPS and GSM service. Then Ultrasonic is used for the surveying process. Then other important component is PIR sensor it is used to detect the presence of humans in track.

2. Existing System:

2.1. Composite Detection System:

The composite detection system consists of a laser source, whose beam is collimated by a suited optic lens into a light plane, two 512X512 -pixel CCD cameras for complete optimum observation of the track, a digital processing system per camera, and a supervision system.

The laser beam focused by the cylindrical lens as a thin plane enlightens the upper part of the railway track orthogonally to the track surface. The intersection of the plane is therefore the track profile (in the laser beam plane it is a two-dimensional line) which is observed by the CCD cameras. Each digital processing system performs real-time profile filtering and extraction (in the CCD camera geometrical coordinates) by using a composite approach from images of the corresponding CCD camera. Besides, the profile is approximately lying in a linear direction, i.e., cutting the image in stripes. .

2. Existing System:

2.1. Composite Detection System:

The composite detection system consists of a laser source, whose beam is collimated by a suited optic lens into a light plane, two 512X512 -pixel CCD cameras for complete optimum observation of the track, a digital processing system per camera, and a supervision system.

The laser beam focused by the cylindrical lens as a thin plane enlightens the upper part of the railway track orthogonally to the track surface. The intersection of the plane is therefore the track profile (in the laser beam plane it is a two-dimensional line) which is observed by the CCD cameras. Each digital processing system performs real-time profile filtering and extraction (in the CCD camera geometrical coordinates) by using a composite approach from images of the corresponding CCD camera. Besides, the profile is approximately lying in a linear direction, i.e., cutting the image in stripes. Only one point of the profile belongs to each stripe. This characteristic allows for parallel processing since each stripe can be analyzed independently to reach 10 ms ..

2.2. Crack Detection using Rayleigh wave-like wideband guided Ultrasonic waves.

Ultrasonic inspection of rails is usually restricted to low speeds of around 20-30mph, which limits the viability of testing many tracks regularly. Furthermore many of the most serious defects that can develop in the rail head can be very difficult to detect using the currently available inspection equipment. One of the reasons for slow inspection speeds using conventional NDT is the need for coupling between the transducer and the track using either liquid or dry coupling materials. EMATs have been used 2,3 or suggested 4 to measure both rail tracks and wheels by other workers and the use of non-contact ultrasonic measurements are still being investigated by a number of international research groups.

In this method we discuss the use of EMATs on rail for longitudinal and transverse crack defect detection and depth gauging. Ultrasonic surface waves that are similar in behaviour to Rayleigh waves are an obvious candidate for surface breaking crack detection. If a defect lies between the Rayleigh wave generator and detector then it will to some degree block the Rayleigh wave. The amplitude of a Rayleigh wave displacement decays with depth into the sample and most of the energy associated with a particular frequency lies within a depth equal to one wavelength at that frequency. Almost all of the energy lies within a depth corresponding to two wavelengths. The different frequency components will effectively probe to different depths below the sample surface. In a measurement where we attempt to propagate a Rayleigh wave through a region containing a surface breaking crack, the crack depth can be estimated by the amount of Rayleigh wave energy or amplitude that is transmitted through or underneath that region. Closed or partially closed cracks can obviously complicate the analysis and increase the amount of Rayleigh wave energy transmitted through the crack compared to an open crack.

The EMATs used in this paper have been designed and built in the Department of Physics at the University of Warwick 13. In our initial tests we have used pitch-catch type geometry where one EMAT generates a Rayleigh wave that propagates down the length of the sample as shown in figure 1 or around the rail head as shown in figure 2, to be detected by a second EMAT. The EMATs are held fixed relative to each other providing a constant path difference between them on a flat surface.

2. Proposed System

Proposed System In proposed system our project are detect the rail road crack, measuring distance for two rail road and also measure the pursuing human in the railway track. when IR sensor are used for detect the crack in the track and ultrasound sensor measure the distance between the two track and also PIR sensor are used to detect human being pursuing in the track. If any crack are occurred in the track means longitude and latitude of the place are messaged to the nearest station and ultrasonic sensor are measure the distance between the

two track if any small variance means they detect and message to the nearest station using GPS and GSM modem. when PIR sensor are detect the human being and animals on the railway track, if any one pursuing on the track means they stop the surveying work after crossing rail road they are detect the track.

3. DESIGN:

The three main components used in the block is IR sensor, Ultrasonic, PIR sensor.IR sensor is used to detect the crack in railway track. Infrared (IR) transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other. When the signal is received by the receiver then it is taken as crack is detected. When the crack is detected the latitude and longitude value is send as a message to nearby station. Passive Infra-Red sensors (PIR sensors) are electronic devices which measure infrared light radiating from objects in the railway track. PIRs are often used in the construction of PIR-based motion detectors. Ultrasonic wave is used to measure the track distance. Then the LCD display is used to view the result.

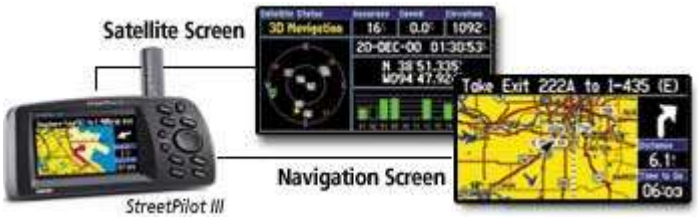
4. Required Components :

4.1. Microcontroller: ATmega162 The ATmega162 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega162 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

4.2 GPS: GPS stands for Global Positioning System. The GPS is used to receive the position data from the vehicles and display on a digital map. It too will have the interface to the communication link. Enhanced features include video features, trace mode, history track, vehicle database, network support. The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

4.2.1 How it works?

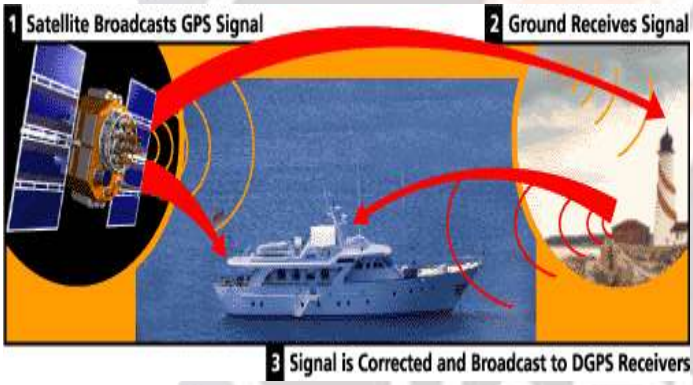
GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use rilateration to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map.



A GPS receiver must be locked on to the signal of at least 3 satellites to calculate a 2-D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3-D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, distance to destination, sunrise and sunset time and more.

4.2.2 How accurate is GPS?

Today's GPS receivers are extremely accurate, thanks to their parallel multi-channel design. Our 12 parallel channel receivers are quick to lock onto satellites when first turned on, and they maintain strong locks, even in dense foliage or urban settings with tall buildings. Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. Garmin GPS receivers are accurate to within 15 meters, on average.



Newer Garmin GPS receivers with WAAS (Wide Area Augmentation System) capability can improve accuracy to less than 3 meters on average. No additional equipment or fees are required to take advantage of WAAS. Users can also get better accuracy with Differential GPS (DGPS), which corrects GPS signals to within an average of 3 to 5 meters. The U.S. Coast Guard operates the most common DGPS correction service. This system consists of a network of towers that receive GPS signals and transmit a corrected signal by beacon transmitters. In order to get the corrected signal, users must have a differential beacon receiver and beacon antenna in addition to their GPS.

5.2.3 The GPS satellite system

The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles above us. They are constantly moving, making two complete orbits in less than 24 hours. These satellites are travelling at speeds of roughly 7,000 miles an hour. GPS satellites are powered by solar energy. They have backup batteries onboard to keep them running in the event of a solar eclipse, when there's no solar power. Small rocket boosters on each satellite keep them flying in the correct path.

Here are some other interesting facts about the GPS satellites (also called NAVSTAR, the official U.S. Department of Defense name for GPS):

- The first GPS satellite was launched in 1978.
- A full constellation of 24 satellites was achieved in 1994.
- Each satellite is built to last about 10 years. Replacements are constantly being built and launched into orbit.
- A GPS satellite weighs approximately 2,000 pounds and is about 17 feet across with the solar panels extended.

Transmitter pow

4.2.4 What's **the signal?**

GPS satellites transmit two low power radio signals, designated L1 and L2. Civilian GPS uses the L1 frequency of 1575.42 MHz in the UHF band. The signals travel by line of sight, meaning they will pass through clouds, glass and plastic but will not go through most solid objects such as buildings and mountains. A GPS signal contains 3 different bits of information - a pseudorandom code, ephemeris data and almanac data. The pseudorandom code is simply an I.D. code that identifies which satellite is transmitting information. You can view this number on your Garmin GPS unit's satellite page, as it identifies which satellites it's receiving. Ephemeris data, which is constantly transmitted by each satellite, contains important information about the status of the satellite (healthy or unhealthy), current date and time. This part of the signal is essential for determining a position. The almanac data tells the GPS receiver where each GPS satellite should be at any time throughout the day. Each satellite transmits almanac data showing the orbital information for that satellite and for every other satellite in the system.

4.2.5 How Does GPS Location work?

GPS is a network of several satellites that was originally developed by the United States military. These satellites continually orbit the Earth and transmit radio signals that receivers in devices can pick up. A receiver can tell how far away a satellite is based on these signals by using the time it took to receive the signal to determine the distance. At any given

time, a GPS device that contains a receiver can connect with at least four satellites to determine its location anywhere on the planet.

When a GPS receiver connects with the satellites, it calculates its distance from each satellite and then determines the radius around each satellite er is only 50 Watts or less.

4.3 GSM module :

- The GSM net used by cell phones provides a low cost, long range, wireless communication channel for applications that need connectivity rather than high data rates. It is used to send the SMS to mobile phone. GSM, which stands for *G*lobal *S*ystem for *M*obile communications, reigns as the world's most widely used cell phone technology. Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area.
- The origins of GSM can be traced back to 1982 when the Groupe Spécial Mobile (GSM) was created by the European Conference of Postal and Telecommunications Administrations (CEPT) for the purpose of designing a pan-European mobile technology. It is approximated that 80 percent of the world uses GSM technology when placing wireless calls, according to the GSM Association (GSMA), which represents the interests of the worldwide mobile communications industry. This amounts to nearly 3 billion global people.

Cell phone carriers T-Mobile and AT&T use GSM for their cell phone networks. Sprint, Virgin Mobile and Verizon Wireless use the competing CDMA standard.

4.4 IR sensor:

Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmittransmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other.

Installing a motion detector light is the first step to stopping intruders from approaching your home. As you may know, a motion detector is capable of detecting motion and that causes the internal switch to be made, turning on your light. You see, the hot wire goes into the motion detector and the other wire is connected to the lights. When the detector is activated from motion in the path of it's sensor, the switch is made and the lights go on. But did you know that the more sophisticated sensors detect body heat? Here's a look at the benefits of them and how they work.

Let's think about a regular motion sensor first. Yes, they detect motion and turn on lights. You can set the sensitivity so little things don't set them off. The problem I see with them it when things like tree limbs, tall grasses, heavy snow, heavy rain and the like, keep setting them off in the middle of the night. Is there anything better that can determine the difference between those instances and humans approaching? With the newer style sensors, they can actually check for body heat using infrared rays. When someone approaches, they turn on the lights. Now, you may ask about things like dogs, raccoons. and other small animals that also have body heat. In fact, they would set off the sensor if the sensitivity is set to the proper setting. You may want to know if a stray dog enters your yard, who knows? But for people, the sensitivity can be set to only detect larger humans, thus ignoring small creatures of the night.

The load limit on these devices is typically 500 watts, so choose your light bulbs wisely. The Typically, you would think that facing the sensor aiming straight toward the intended target, maybe an entrance sidewalk, would be the logical direction to face the unit. In fact, this is all wrong. You see, there is a dead zone in the area coming straight towards the sensor and someone could possibility walk right up to the house undetected! Instead, mount the sensor to the right or left of the area being monitored to cause a crossing area of coverage that someone would have to walk through, say a 10 degree angle. That way, people will walk through the

eceivelobes of detection, not between them. This should ensure great detection of oncoming people to the track

4.5 Passive Infrared Sensors (PIR) :

Passive Infra-Red sensors (PIR sensors) are electronic devices which measure infrared light radiating from objects in the field of view. PIRs are often used in the construction of PIR-based motion detectors, see below. Apparent motion is detected when an infrared emitting source with one temperature, such as a human body, passes in front of a source with another temperature, such as a wall.

PIR detectors measure heat and therefore can interpret any sudden changes in heat as motion. This can include sudden sunbeams (opening the curtains), nearby AC and heating units, and fireplaces. If you find your motion detector is giving too many false alarms, check its location for possible interference from these sources.

Passive sensors, on the other hand, have their own unique way of detecting movement. Called passive infrared sensors (PIR) and sometimes called pyroelectric detectors, they are used frequently in homes and businesses alike. They detect heat from the body of humans and animals alike. The sensor uses a photo detector which which coverts light in the wavelengths into electrical current that triggers an alarm in the minicomputer housed in the detector.

5. WORKING:

The proposed crack detection scheme has been tested by placing the robot on an actual rail track. The latitude, longitude and the nearest railway station will be sent as a message. IV RESULT When the crack is detected on the track the text message is send to the preferred number by using the GSM and GPS service. The text message contains the latitude and longitude value of the place where the crack is detected. The ultrasonic distance meter will verify the distance between two tracks. When the human or animal is on the track the PIR sensor will detect the presence and stop the checking process till they move on. After they moved on the track it will continue the process

6. CONCLUSION:

In this paper, we have presented the IR sensor based railway crack detection system and PIR sensor based presence of human detection system. The crack can be detected without only error. It does not give false output. The 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.

- 7. RESULT:

When the crack is detected on the track the text message is send to the preferred number by using the GSM and GPS service. The text message contains the latitude and lngitude value of the place where the
crack is detected. The ultrasonic distance meter will verify the distance between two tracks. When the human or animal is on the track the PIR sensor will detect the presence and stop the checking process till they move on. After they moved on the track it will continue the process.

REFERENCES:

[1] Qiao Jian-hua, Li Lin-sheng and Zhang Jinggang, “Design of Rail Surface Crack-detecting System Based on Linear CCD Sensor”, IEEE Int. Conf. on Networking, Sensing and Control, 2008.

[2] K. Vijayakumar, S.R. Wylie, J. D. Cullen, C.C.Wright, and A.I. AIShamma’a, “Non invasive rail track detection system using Microwave sensor”, Journal of App. Phy., 2009.

[3] M. Cacciola, G. Megali, D. Pellicanμo, S. Calcagno, M. Versaci, and F. C. Morabito, “Rotating Electromagnetic Field for Crack Detection in Railway Tracks", PIERS ONLINE , Vol. 6, NO. 3, 2010.
[4] Wojnarowski, Robert John Welles, Kenneth Brakeley Kornrumpf, and William Paul, "Electromagnetic system for railroad track crack detection and traction enhancement".
[5] Richard J. Greene, John R. Yates and Eann A. Patterson, "Crack detection in rail using infrared methods", Opt. Eng. 46, 051013, May 2007.
[6] Hartman, G.A., “Infrared Damage Detection System (IDDS) for real time, small-scale damage monitoring, Charlotte, North Carolina