Automatic Railhead Crack Detection And Distance Measurement

Biji Babu,Chaithra Balakrishnan,Jinisha Cheeran k,Savitha E,Rahul V

Abstract—Railhead inspection is a very important measurement method for rail track maintenance, because any deviation in geometry indicate where potential defects may exist. However, it is a challenge to inspect such discrete surface defects in a image acquisition system because of illumination inequality and the variation of reflection property of rail surfaces. This paper puts forward an illumination independent crack analyzing system for detect discrete surface defects and measure the distance to crack by DM algorithm using IR sensor fixed in the test train .The measured distance is texted to a base station via GSM modem .This proposed system measure the exact distance to the detected crack from the base station.

Index Terms— Illumination inequality,ATmega328,DM algorithm,Light Reflection Technique(LRT),LM358,VI algorithm,GSM module.

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1 INTRODUCTION

In all over the world railway is the largest transportation system.In the case of Indian railway the total length of track is about 115,000km (71,000 mi) and our economy is mainly depend on this. Recent statistics reveal that approximately 60% of all the rail accidents have derailments as their cause, of which about 90% are due to cracks on the rails either due to natural causes or due to anti-social elements.Discrete surface defects impact the riding quality and safety of a railway system. For the safe operation of railway systems, the quality of rails must be closely and frequently monitored. However, it is a challenge to inspect such defects in a vision system because of illumination inequality and the variation of reflection property of rail surfaces.

This paper puts forward a technique which will eliminate the problems above mentioned.Even a small defect will leads severe accidents.So it is essential to detect the defect periodically to avoid this.This paper introducing a new technique to detect crack periodically and measure the distance to that particular crack.

The human inspection of rail head is slow and dangerous. The limitations of human inspection led to the development of many advanced non destructive testing techniques.Modern non destructive testing techniques for rail inspection include the use of visual camera and the cracks can be detected using several algorithms.Here we deals with a sytem which will identifies the cracks using image processing and also detect the distance to crack location from the base station using DM algorithm.

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2 EXISTING SYSTEM

The finding of cracks in railhead by manual inspection causes human fatigue and also time consuming.It will effect correctness too.To overcome this, there are several nondestructive methods were introduced.

Ultrasonic inspection method has best performance to detect internal cracks.But its inspection speed is too slow and also it cannot detect the suface cracks.There are several methods proposed to improve inspection speed but it didn't achieve enough progress to detect the railhead defects.[5]

Eddy current testing identifies defects using magnetic field generated by eddy currents[9].Due to high inspection speed, it is widely combined with ultrasonics for rail inspection[10]. The sensor of eddy current is so sensitive to the lift-off variation that the probe should be positioned at a constant distance (no more than 2 mm) from the surface of the rail head.If any distructions occurs it will effects the proper working of the system.ie, it is very sensitive and complex.

The composite detection system consist of laser source. Track is observed by CCD camera.A digital processing system for each camera. The laser beam enlightens the upper part of the railway track which is observed by the CCD cameras. Each digital processing system performs real-time filtering and extraction of the crack.In this technique result were quite difficult due to inability to capture all the nonlinearities and distortions on the railhead.

Visual inspection has been developed in recent years with the great progress of computer vision techniques. Which consists a high-speed digital camera, which is installed under a test train, is used to capture images of a railhead as the train moves over the track, and then, the obtained images are analyzed automatically using an image processing software.Visual inspection has the advantages of high speed, low cost, and the most attractive technique for surface defect detection .This paper put forward crack inspection by visual inspection technique.But it has a challenge to inspect such discrete surface defects in a image acquisition system because of illumination inequality and the variation of reflection property of rail surfaces.

Rail images are captured by a camera installed under a moving test train in an open circumstance.The illumination in an image is ready to be changed because of natural light and the shake of the train.It degrades the quality of picture. Otherwise variation of reflection property of rail surfaces. The surface of a railhead does not always makes the same reflection property. For example, the center region is often smooth and reflects more light compare to surroundings, whereas some areas of periphery may be covered with rust and reflect less light by reflection.

3 PROPOSED SYSTEM

This paper proposed an illumination independent system for crack analysis and measure the distance to the crack by DM algorithm.A system with a light source which enlightens the railhead will eliminate illumination inequality as shown in fig(1).
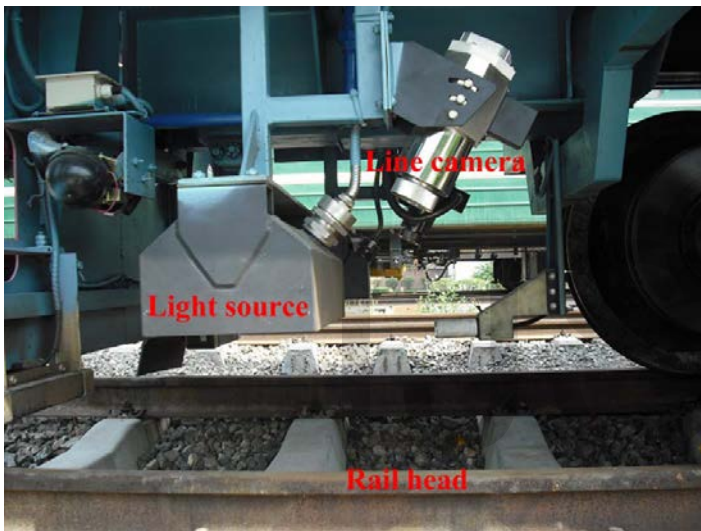

Fig(1)

This system consists of a vehicle section and processing section.Here vehicle section is a test train.The images are taken by a camera fixed in a test train.And it is processed by processing section.

Vehicle section mainly used for visual inspection.Camera will take the images and it will send to the prcessing section.The system is mainly for determining the severity of the crack.A DM algorithm is used inorder to calculate the distance.If svere crack is found then the measured distance send to base station. For proper detection images must be clear.For this,need a high definition camera like DALSA Spyder 3 CL line scan camera with camera link interface.Which have 3 times more responsivity and twice the speed,without impacting noise level .The camera's responsivity is particularly important in low lighting situation.The DALSA Spyder 3 CL line scan camera can accelerate applications with better image quality and higher throughput, boosting quality and efficiency.The camera's high responsivity to light enables precise inspection,even without optimal lighting,reducing both lighting and overall system costs.It has 68 kHz line rate for high speed and high productivity.

3.1 HARDWARE ARCHITECTURE

In this paper we are proposing an announcement system in which both hardware and software is essential This system is basically an embedded system in which the embedded part is placed in the test train and the software section deals in PC.Embedded part contains image acquisition unit and micro-controller section.
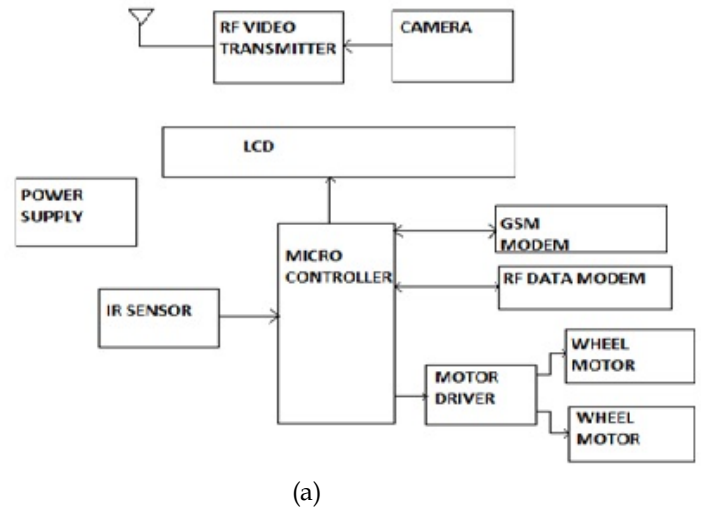
(a)
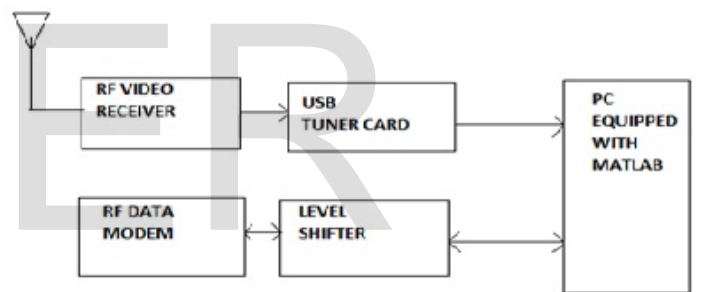
(b)

Fig(2) : (a) vehicle section (b) processing section

In acquisition unit camera captures series of images of a rail surface, and the latter is designed to detect defects from the images generated by image acquisition unit.Image acquisition unit is made up of several commercially available components.
The basic component is a Dalsa Spyder 2 line-scan camera, which has 1024 pixels of resolution and a maximum line rate of 65 000 lines/s. An illumination setup equipped with four LED light sources is installed in order to reduce the effect of natural light. The size of each generated rail image is 1200 $\times$ 512. RF Datamodem used for twoway wireless communication between acquisition unit and processing unit.

Here ATmega328 used as microcontroller. The ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR Enhanced RISC architecture. By executing powerful instructions in a sigle clock cycle, the ATmega328/P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. The LCD communicates wth the microcontroller using parallel communication of the data 5x8 dots with

cursor and 1/16 duty cycle . RF modem can be used for applications that need two way wireless data transmission.Distance is measured by the DM alogorithm.

DM Algorithm:

The RPM to Linear velocity formula is,

$$v=r*RPM*0.10472 \qquad (1)$$

Where v : Linear velocity in m/s
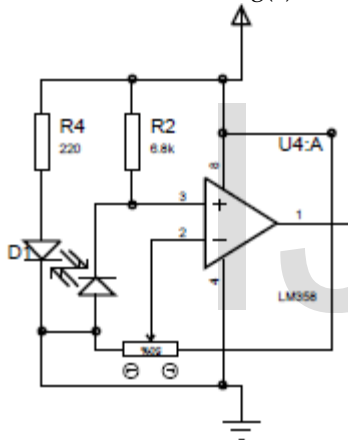 r: Radius in meter
 RPM: Angular velocity in RPM (Rounds Per Minute)

$$Distance\ x = v * t \qquad (2)$$

Where v : Linear velocity
 t : Time travelled

Here RPM of the wheel is taken by Light Reflection Technique(LRT).Here IR is placed near the wheel.The circuitory of LRT section is shown in fig(3).

Fig(3)

Here LM358 is used as comparator.It is a low power dual operational amplifier integrated circuit.It is used in detector circuit.This circuit are one of the most basic and popular sensor module.This circuit made using the following.

 1 .LM358 IC
 2. IR Transmitter and Receiver pair
 3. Resistors of the range of Kilo Ohms
 4. Variable Resistors.
 5. LED

The transmitter part of the sensor is an infrared(IR)LED which transmits continuos IR is to be received by an IR receiver.The output of the receiver varies depending upon its reception of IR rays.Since this variation can not be analyzed as such,Therefore this output can be fed to a comparator.Here operational amplifier(op-amp) of is used as comparator.When the receiver does not receive signal the potential at the inverting input goes than that that at non-inverting input of the comparator.Thus the output of the comparator goes low and the does not glow.When the IR receiver receives signal the potential at the inverting input goes low.Thus the output of

the comparator goes high and the LED starts glowing.Each high output counts rotation of wheel and the distance will be calculated by using DM algorithm.And the measured distance transmitted to the basestation via gsm module.

Processing section mainly based on the PC.Wchich is equipped with matlab software.The images taken by the image acquisition unit to be transmitted to the processing section through RF data modem.

3.2 SOFTWARE ARCHITECTURE

After a rail image is generated by the image acquisition system, it is processed by the processing section, which aims the efficiently detect possible defects in the image.It takes some steps for railhead defect localization. The first aim is to extract the railhead region from other fields. This is done bytaking mean of each row and comparing it with all other raw mean. According tothe characteristics of defect regions ofinterest, the following features are considered for defect identification:
1) The length of defect region in pixels.
2) Gray scaled version of the image
3) Gray scale comparison showing differences
4) The area of suspect defect region in pixels
Continuous video taken by the acquisition unit is send to the processing section.Here it is to be converted to snap shot.Fig(4) shows that the snapshot from the video.


Fig(4)

In processing , five frames are taken at a time.This RGB image is then converted into grey scale.The grey scale image format easiest to locate the crack in the railhead.
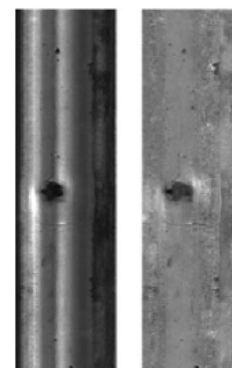
Fig(5)

The railhead region is extracted from the surroundings.This grey scale image is then converted to black and white image for deletion of cracks exists under a threshold value.Fig(6) shows the crack etraction of a railhead crack.
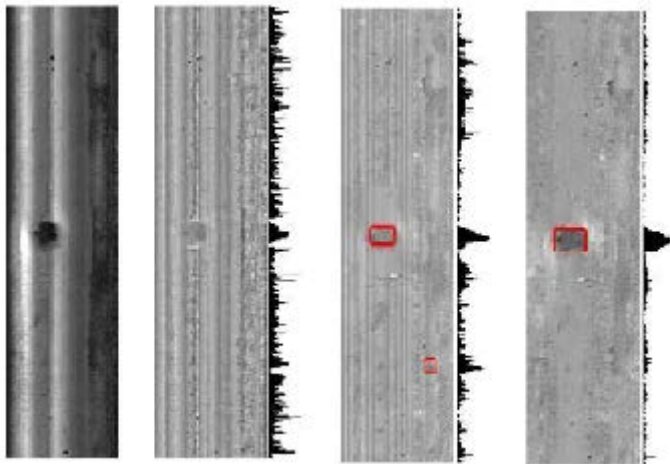
Fig(6)

First the image is converted to grey scale and railhead portion is extracted from the surroundings.Then it converted to black and white image for identification of severe cracks.finally set the boundary around crack where exists in the railhead image.Then send serial data to the vehicle section.

 VI Algorithm:

 Step0: start

 Step1: initialize camera Hardware

 Step2: Put camera on capture mode

 Step3: Processes each frames

 Step4: Get each frame

 Step5: Apply binarization

 Step6: Compare each frames

 Step7: Differentiate each component

 Step8: if crack found send serial data otherwise no serial data out

 Step9: Continue the loop infinitely

 Step10:stop

While moving the test train,the camera will take continuous image of the track.This images will be analyzed using VI algorithm and it will compare its value with presetted threashold.When the detection exceeds beyond the threashold value, an alerting message will send to the base station using DM algorithm.
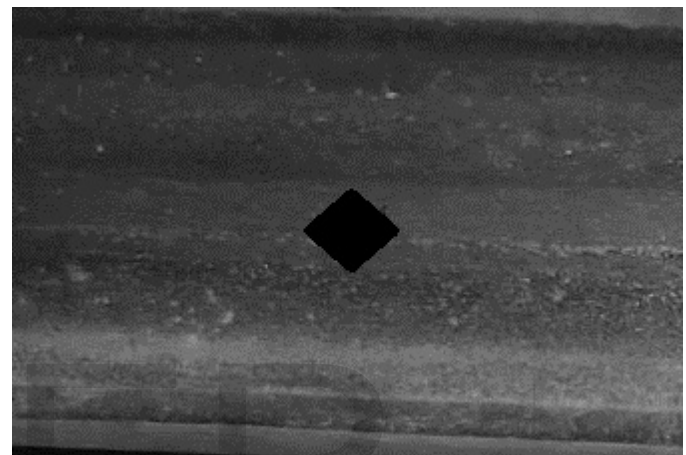
4 RESULTS AND DISCUSSION

Experiments are performed on an image as shown below. The image shows a rail track surface with a crack.
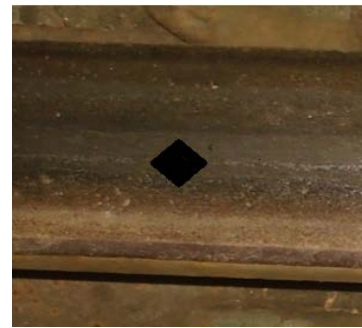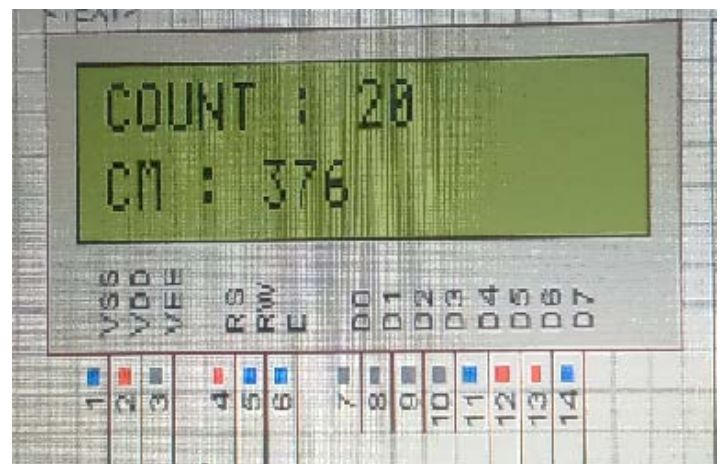

Fig(7a)

This image the track has to be extracted from the extra fields in the background.Thus the extracted track from the original image.

Fig(7b)

Then the grey scale image is converted to black and white image for deletion of cracks exists under a threshold value.After detecting the crack the measured distance in CM is send via GSM module.

Fig(7c)

The above figures shows the experimental result of this system.

5 CONCLUSION

The main problem faced by the railway is crack on railhead.There are somany method was introduced to detect the crack.The latest

technique was vision based system.The main problem deals with this technique was illumination inequality.In this paper, we have proposed an effective system to detect and locate a defect in railheads.Which is free from illumination inequality.DM algorithm is used for calculating the distance from the base station,also gIve the alerting message to the base station.

6 FUTURE SCOPE

In future this work can be extended by classifying the defect on the basis of depth and severity of the defect .The defect identification system can be further improved by adding a GPS module .This paper put forwards an effective way of localizing the defect, which is an illumination independent system.

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