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Automatic Crack Detection of Railway Track by using Ultrasonic Waves and GSM System with Mobile Operated Robot

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***Abstract*— In countries like India, the most widely used and common mode of transport for the peoples is railway transport. We often observe in news that Railway accidents are quite common in now days. It has been seen that approximately 50% of the rail accident cause due to the derailment, and 90% of this accident is cause due to the cracks on the rail track. Those cracks are unnoticed by the Track-man of railway department who walks 16 km/day along with the railway track for the inspection of the track. This method of inspection is quite unreliable. The aim of our research is to automize the process of detecting cracks on a rail track using cellphone operated vehicle to reduce the human effort. This method for the detecting the cracks uses ultrasonic waves, which propagate through rail track and it detect the cracks and defects on the track and hence preventing the rail accident.**

***Keyword:*-- Railway transport, Railway accident, Derailment, Crack, Track-man, Cellphone, Ultrasonic waves, Automize.**

I. INTRODUCTION

In India, there are more than 80% families are middle class or lower middle class. Those families are mostly use railway as transportation. But some analysis says that in India 1000 people died every year and more than 2000 people are injured due to rail accident. The main reason for that rail accident is derailment and this derailment occurs due to present crack on the rail track.

To find crack on railway track, Indian railway uses ultrasonic testing in the railway track and find the rail crack. But this process is not fully automatic process because this test is performed by human being manually on track and due to human error some time crack are unnoticed, that results the rail accident occurs. Fig. 1 shows that how track inspection is done on railway track.

To prevent those rail accidents, we should automize the process of crack detection, when the crack or any defect found on the track at that instant the crack detecting vehicle will automatically stop moving on track and finds the crack inside the railway track.

Fig 1: Crack in Railway Track

The aim of this research is to automize the crack detection process, and reduces the work of the track-man. To achieve this purpose we made a crack detecting vehicle/robot which will move on the rail track and it can control by cell phone which is very new method for detecting the cracks in railway track. We attached the ultrasonic sensor which will detect the cracks on and inside the rail track. Whenever the crack/flow has detected at that time detecting vehicle will stops with the help of microcontroller. So, the work of the track-man has reduced with the use of the cell phone controlled crack detecting vehicle.

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Fig 2: Manual Railway Track Inspection

II. CRACK DETECTION

The detection of the crack on rail track is very important. Detection work must be done efficiently because if the crack on rail track remains unnoticed then it results in a major rail accident. The crack detection is been done using the ultrasonic technology. Ultrasonic waves are high frequency sound waves which is not audible by human ear. The frequency of ultrasonic wave is in between 20 KHz – 25 MHz. The main features of ultrasonic waves is that, it give us the ability to "see through" solid/opaque material and detect surface or internal flaws without affecting the material adversely [3].

Fig 3: Track-man walking on Railway Track

It is possible to use ultrasonic waves to find flow as well as the crack on the rail track. Flow is the internal defect in the rail track, whereas the crack is the defect which can be seen on outer surface of the track, every flow will may result in crack. To find the flow in rail track, we need high frequency ultrasonic waves in terms of MHz because in the process of finding the flow we need to penetrate the ultrasonic wave in the track.

On the other hand for finding the crack on rail track we didn't required high frequency ultrasonic wave and the reason for that is crack is present on the outer surface of the track that is why it is not necessary to penetrate ultrasonic wave in track, So low frequency ultrasonic wave in range of KHz is used for finding the crack on rail track.

To find the crack/flow on surface in any material with ultrasonic waves we have to transmit ultrasonic wave in the material and receive back this waves and measure the time between the transmitting and receiving of the waves, and this time is used to find the detail of the crack/flow. Fig 2 shows how ultrasonic wave propagate in rail track.

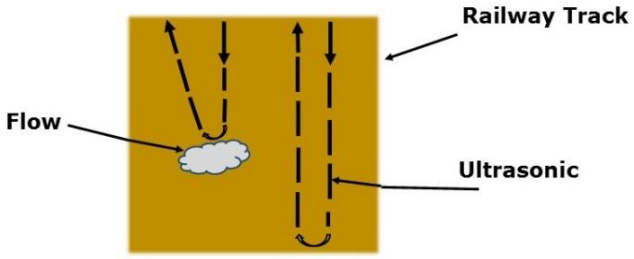

Fig 4: Ultrasonic wave propagation [03]

There are two different methods for transmitting and receiving the ultrasonic waves [3].

1. Pulse echo method
2. Phase measurement method.

In pulse echo method, transmitter and receiver are in the same module, while in phase measurement method separate module for transmitter and receiver with different phase angle is use.

In our model, we used ultrasonic transducer HC-SR04 for finding the crack on rail track. Ultrasonic transducer HC-SR04 can transmit and receive the ultrasonic wave of frequency 40 KHz. In HC-SR04 the transmitter and receiver are on the same module [5].

Ultrasonic transducer has transmitter and receiver, and it includes four pins i.e. TRIGER, ECHO, VCC, GND. For transmit the ultrasonic wave it is essential to give 10uS pulse to trigger pin.

At instant after applying 10 uS pulse to trigger pin, transmitter transmits eight consecutive cycle of ultrasonic waves with frequency of 40 KHz. After eight consecutive cycles of ultrasonic waves echo pin goes high, and when crack detected echo pin goes low. In condition when there is a no crack present on rail track echo pin will automatically

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goes low after time period of 38 ms. Fig 5 shows the timing diagram of ultrasonic sensor.

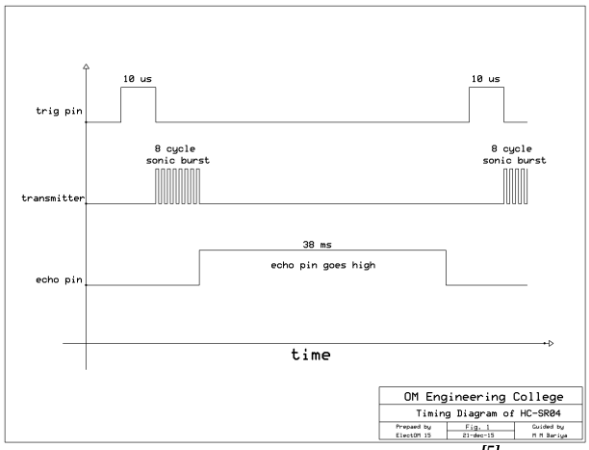

Fig 5: Timing diagram of HC-SR04 [5]

Time duration for how long echo pin was remain high that is calculated by timer of microcontroller. From the value of timer we can locate crack on the rail track. For the get the depth of crack in millimeter the timer value is divided by 5.4, which is accurate for the 11.059 MHz crystal of microcontroller.

Fig 6: Components assemble

By following this process we can find the cracks on the rail track. Similarly we can find flow in rail track by using high frequency ultrasonic transducer.

III. CELLPHONE CONTROLLED VEHICLE

The main advantage to introduce this method to find crack in rail track is that we can use this ultrasonic detection technique through wireless robot which is cellphone controlled & can be operated from any location in the world. As we know that for inspection of the rail track, track-man from railway department has to walk 16km/day in all-weather condition. For reducing the work of the track-man we introduced a cellphone controlled vehicle. Instead of walking on track, track-man can easily move the vehicle on rail track by using cellphone controlled vehicle by seating in the control room. Fig 4 shows track-man waking on track. This cell phone controlled vehicle is operated on DC battery with two DC motor. We can control this vehicle by cell phone and perform the task like moving forward, moving backward on rail track. The main advantage of this vehicle is that we can control this vehicle from any place within the coverage area of cellular service provider. So track-man can control this vehicle from control room and detect the crack/flow on track and send the information of crack/flow by using GPS module but as per the railway norms "any unman vehicle not permitted to move on railway track" but those norms forms before two or three decades ago, but as per current scenario of 21st century automation is needed in every area of work, so for future need we made this cellphone operated vehicle. In order to giving respect the railway norms we does not send our vehicle without man we send this vehicle with track-man, but in future it is able to find the cracks on rail track without man.

Cell phone is become an important part of people's life in 21st century and all the peoples are familiar with the use of cell phone, in a cell phone we all use a keypad for dialing a number for make a call to other phone, when we press any key from the keypad a tone of certain frequency is generated, this frequency is made up with two different frequency and it generate a tone this tone is called "dual tone multi frequency" which is audio signal.

This dual tone multi frequency also can generated by calling from one cell phone to other cell phone and if any key is pressed from any one end of a call a tone corresponding to key pressed is generated at the other end of call in cell phone.

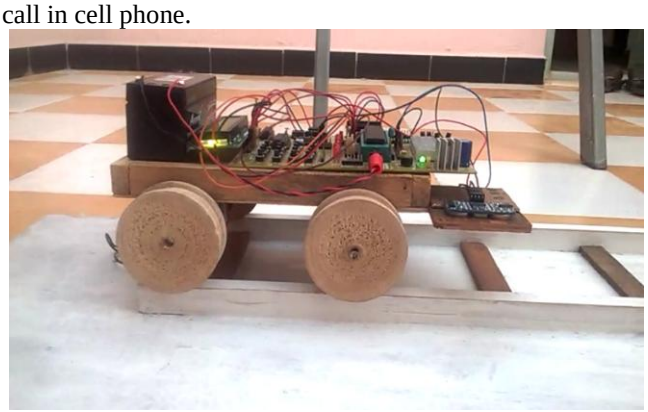

Fig 8: Working Model on Crack Railway Track

Dual tone multi frequency is depends on the key matrix of keypad. The cell phone keypad is made of 4x3 matrix. In the 4x3 matrix the row consists of low frequency

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and the column consist of high frequency. Table 1 show the row and column frequency of 4x3 matrix.

Table 1: keypad frequency [6]

		Column frequency		
		1209 Hz	1336 Hz	1477 Hz
Raw frequency	697 Hz	1	2	3
	770 Hz	4	5	6
	852 Hz	7	8	9
	941 Hz	*	0	#

As shown in table 1, if we press key 1, according to it a tone of certain frequency generated which will be the modulated frequency of row and column frequency corresponding to key pressed. Similarly, when any other key pressed a tone is generated according to the table shown. This tone is pure audio signal and with the use of demodulator IC we can convert this audio signal into Digital signal.

Fig 9: LCD Display indicate Crack has been detected

In our model we use demodulator which gives 4 bit digital outputs. These four bits are given to the microcontroller and we can get the controlled output from microcontroller.

Fig 10: LCD Display indicate to Stop Robot

The output current of microcontroller is not enough to drive the DC motor so we use decoder IC to drive motors at higher current which is able to give peak current up-to 2A.

Fig 11: LCD Display indicate Distance in mm

This output current is enough to drive DC Motor. The complete Block diagram of this Cellphone control vehicle is as shown in fig. 12

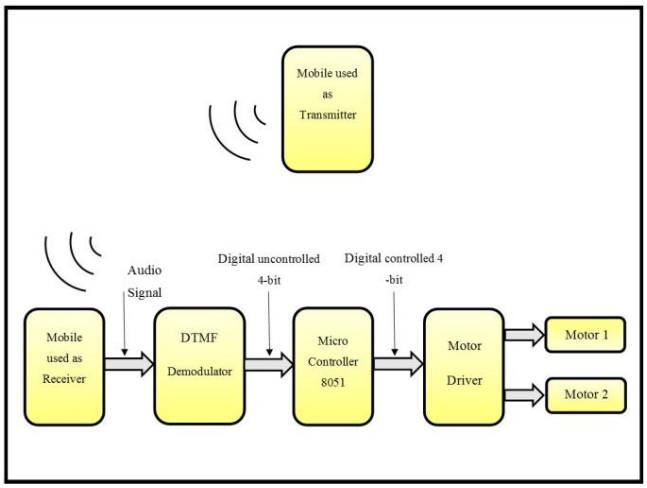

Fig 12: Block diagram of cellphone controlled vehicle

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The output of demodulator IC corresponding to key press is shown in table 2.

Table 2: Demodulator 4-bit output [6]

Digit	Q4	Q3	Q2	Q1
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*****	1	0	1	1
#	1	1	0	0

The main task of the cell phone controlled vehicle is moving on railway track forward and reverse. To drive this vehicle forward & reverse we used two DC motors. We get 4-bit as output from demodulator, but this output is not a controlled output as per requirement to drive DC motor. So output of the demodulator is given as an input of microcontroller. Microcontroller gives controlled output as 4-bit pattern, this 4-bit output can be used as per the application, i.e. forward movement, backward movement.
For the movement of vehicle our programming logic is as given below in table 3

Table 3: Programing Logic

Digit	Demodulator output / µC input				µC output & Input of				Task
	Q1	Q2	Q3	Q4	Motor 1		Motor 2		
2	0	1	0	0	1	0	1	0	Forward
8	0	0	0	1	0	1	0	1	Backward
5	1	0	1	0	0	0	0	0	Stop

By using above programing logic and making program in C embedded language we are performing the desired task of our vehicle like moving in forward direction, backward direction on railway track and by using this vehicle track-man does not needed walk 16km/day. So by using very basic techniques we can do such major task of not moving 16km a day and reduce the human error to detect track.

IV. CIRCUIT CONNECTION

In our project we required two port one port as input port and other port as output port. So we select port 2 as input port and port 1 as output port. We have 4 bit at the output of DTMF demodulator. Which will give to the input of microcontroller port 2. So those 4 bit is Q1, Q2, Q3 and Q4 is connect with P2.0, P2.1, P2.2, and P2.3 respectively. And we get controllable output bit at the port 1's pin P1.0, P1.1, P1.2 and P1.3. We all know that to operate microcontroller we required one crystal. Which will connect at the pin no 18 and pin no 19. To use the reset facility of microcontroller we connect resistor and switch as shown in figure: 13.

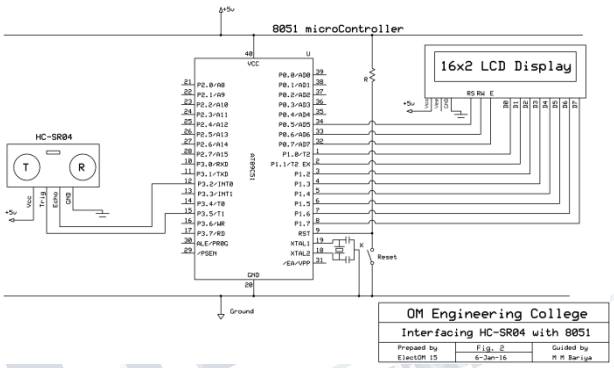

Fig 13: Interfacing of HC-SR04 & LCD display with 8051

Fig 14: Working Prototype

V. CONCLUSION

The method we proposed in this paper can be used for find the crack/flow in rail track. By using this technique for rail track inspection, the work of the track man is reduced. Track man walks 16km/ day for inspection of rail track instead of using traditional method this method is very much effective. The crack detection can be sent or acknowledged via sms of cellular system. We can also notify the crack to the train and control room automatically with exact location of the flow by gps system cell phone controlled vehicle.

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BIBLIOGRAPHY

1) C. Campos-castellanos, Y. Gharaibeh, P. Mudge, V. Kappatos "The Application of long range ularasonic testing (LRUT) for examination of hard to access areas on railway tracks." IEEE paper present in 5th IET conference on Railway condition monitoring and NDT.

2) Shankar Kumar J, Rakshith Kaushik T R, Priyanka B, Sandhya Rani N, Shruthi P. "Automated railway track tracking system using ultrasonics" Department of Electronics & Communication in C.I.T, Tumkur, India and Department of Electronics & Communication in G.S.S.I.T, Bangalore, India. National Insruments tutorial on "Fundamentals of Ultrasonic Imaging and Flaw Detection" published on Feb. 11, 2010.

3) Abdiweli Abdillahi Soufi, Abdirasoul Jabar Alzubaidi "Remote control system through mobile and DTMF" Information Technology College, Open University of Sudan Electronics Engineering School, Sudan University of Science and Technology. Elec Freaks "Ultrasonic Ranging Module HC - SR04". "Integrated DTMF receiver MT8870D/MT8870D-1" by MITEL.

4) Indian Railways Facts sheet on Indian railways – Safety Performance 2013 present in lok Shabha by Ministry of Railways, Government of India.

5) M. Pradeep, K. Naganarasaiah Goud "Damage detection of railway track by sensor using advanced RISC machine" Department of E.C.E,Annamacharya Institute of Technology & Sciences, Rajampet, A.P, INDIA.

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