ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 13, March 2018

SURFACE DEFECTS IDENTIFICATION AND PERFORMANCE BASED ANALYSIS USING NON – DESTRUCTIVE METHODS

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Abstract

Monitoring and analysing health of large structures like bridges, dams, buildings and heavy machinery is important in safety, economical, operational, making prior protective measures and maintenance point of view. Structural health monitoring systems have been used to monitor and has the potential to improve structure lifespan and improve public safety. In this paper non-destructive testing method (i.e., vibration analysis) is employed to monitor the structural health of the existing Vaigai Bridge which was constructed during 1886. The vibrations obtained due to the *interaction problem between moving vehicles and bridge structure* are monitored by vibration analysis using piezoelectric sensors. There are various other surface defects such as potholes, road cracks, ruts, crocodile cracking, bridge crack, and other minor surface cracks that ruins the structure. To overcome and repair these surface cracks, they should be identified first by image processing. This paper also Presents an innovative idea for the identification of such surface defects. An android application ***share app*** which geotags the location of defects, is created for the identification of surface defects in the road surface in an effective way and for the necessary repair strategies. The severity of the defects can be identified using ***Matlab*** codes which will be helpful in taking necessary preventive and predictive action. The scope of this work is limited to conduct vibration analysis using piezoelectric sensors and image Processing using Matlab in structural health monitoring.

1. INTRODUCTION

Structural health monitoring is helpful to assure the security of important structures such as large span bridges and high rise buildings. Reduction of inspection costs, research, with the possibility to better understand the behaviour of structures under dynamic loads, seismic protection, observation, in real or near real-time, of the structural response and of evolution of damage, so that it is possible to produce post-earthquake scenarios and support rescue operations, are the main advantages related to the implementation of such techniques.

2. SURFACE DEFECTS IDENTIFICATION

There are various surface defects such as potholes, road cracks, ruts, crocodile cracking, bridge crack, and other minor surface cracks that ruins the structure. To overcome and repair these surface cracks, they should be identified first. For the identification of these surface defects we have designed an app called ***share app***.

2.1 SHARE APP

An android application called 'Share app' was designed for taking photos of the cracks and pot-holes in an effective way. This app automatically shares the location of crack (or) pot-holes that are being photographed to the receiver through email. After entering all the required information, the picture of the surface defect is captured by clicking the option called take picture and share displayed at the bottom of the screen. The location sensor should be switched ON before sharing.

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Fig.1.Figure shows the Screen shot of 'share app'

Fig.2.Figure shows the various surface defects on the road surface captured through 'share app'

2.2. IMAGE PROCESSING USING MATLAB

The image processing is carried out using MATLAB. At first the image pre processing is carried out then is it is followed by image processing. The length and area of the surface defects aquired through 'Shareapp' is found out by image processing using the MATLAB codes.

2.3OUTPUT

Surface defects	Dimensions obtained t through '*Share app*' (Dimensions in mm)		Length of the Surface defects obtained through image processing using MATLAB (Length in Pixels)	Area of the Surface defects obtained through image processing using MATLAB (Area in Pixels)
	Length	Breadth		
app_inventor_1519713225177	400	300	2.47E+04	32990
app_inventor_1519713032359	850	500	2.11E+04	26690
app_inventor_1519712870925	1500	400	2.54E+04	35433
app_inventor_1519712837671	1400	400	2.59E+04	34218
app_inventor_1519712760941	700	200	8.59E+04	180327
app_inventor_1519712582278	850	200	4.60E+03	5541
app_inventor_1519712460515	1200	300	8.54E+03	11314
app_inventor_1519712334832	1500	200	6.72E+03	8694
app_inventor_1519709076696	650	350	6.93E+02	777
app_inventor_1519712070201	1400	300	2.98E+04	42766
app_inventor_1519709001727	600	250	6.40E+03	7375
app_inventor_1519708960377	600	400	4.17E+03	4681
app_inventor_1519711992679	1300	300	5.68E+04	80508
app_inventor_1519708776903	1200	500	3.00E+04	37145
app_inventor_1519708616824	300	20	3.30E+04	41685
app_inventor_1519711454836	1500	50	9.23E+03	12168
app_inventor_1519711376517	1500	250	9.43E+03	12733
app_inventor_1519711310238	300	250	5.11E+04	77585
app_inventor_1519711199745	1000	200	1.50E+03	1772
app_inventor_1519708508615	1400	30	1.83E+04	22849
app_inventor_1519711159581	500	200	6.01E+03	7429
app_inventor_1519711111213	350	150	9.65E+03	11328
app_inventor_1519711045647	1500	100	7.69E+03	10408
app_inventor_1519710968327	1500	100	1.21E+04	17389
app_inventor_1519708428465	1400	100	9.19E+02.	1052
app_inventor_1519708333353	900	30	1.40E+04	17052
app_inventor_1519708283087	950	300	2.11E+04	24561
app_inventor_1519708188871	550	100	1.82E+04	20540
app_inventor_1519706973402	750	50	1.51E+04	17457
app_inventor_1519706907984	400	200	9.51E+03	10649
app_inventor_1519706869599	950	200	1.43E+04	16058
app_inventor_1519706715861	400	150	4.83E+04	57694
app_inventor_1519706443278	1300	100	8.35E+03	9354
app_inventor_1519707104664	550	100	1.17E+04	15647
app_inventor_1519705795715	700	50	2.90E+04	33133
app_inventor_1519706742190	600	100	7.42E+04	108483

Fig.3.Figure shows output of image processing using matlab

Thus, we have developed an app that captures and shares through e-mail. These images contain the locations of the defects by geo-tagging. The severity of the defects can be identified using Matlab codes. So, it is helpful for taking preventive and predictive action earlier.

3. VIBRATION ANALYSIS BY USING SENSORS

Vibration is a common phenomenon in daily lives. Vibration is the motion of a particle or a device or system of connected devices scattered around the balanced position. The vibrations in the surface of the road are received by the piezoelectric sensors. The piezoelectric sensors change the *vibration motion into electrical energy* and then these values are displayed in the computer. Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board and a piece of software.

3.1. DESIGN OF PROTOTYPE

The prototype is designed in such a way that the vibrations received by the piezo-electric sensors are recorded through the Arduino board and displayed in computer.The Arduino board consists of both a microcontroller and a part of the software or Integrated Development Environment (IDE) that runs on your PC, used to write & upload computer code to the physical board.

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```
const int pin=A0;

void setup()
{
  Serial.begin(9600);
}

void loop()
{
  int piezoADC=analogRead(pin);
  Serial.println(piezoADC);
  delay(1000);
}
```

Fig.4.Figure shows the Arduino program for the prototype design.

The Arduino board is connected with the computer and is programmed with the Arduino software. The prototype is programmed in such a way that the piezoelectric sensor is connected in the A0 pin with the Arduino board.

The vibrations that are received by the piezoelectric sensors. The piezoelectric sensors change the *vibration motion into electrical energy* and then these values are displayed in the computer.

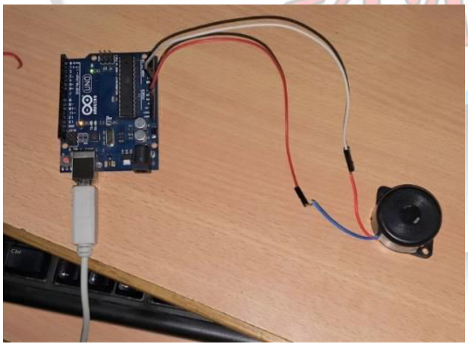

Fig.5.Figure shows the Arduino Uno R2 connected to the computer via. USB and Arduino Uno R2 connected with piezoelectric sensor

3.2. VIBRATION ANALYSIS OF VAIGAI BRIDGE BY USING PIEZOELECTRIC SENSOR

Vibration of bridges under moving vehicles and trains is of great theoretical and practical significance in civil engineering. During the last three decades, the *interaction problem between moving vehicles and bridge structures* has attracted much attention. The advent of high speed digital computers has made it possible to analyse the interaction problem with more sophisticated bridge and vehicle models. As, Mr.NitinGadkari, Road Transport and Highways Minister of India said that over 100bridges in different parts of the country are on the verge of collapse and need immediate attention. Since the Vaigai bridge had been constructed a century ago, it has become weak. In order to monitor the health of the bridge by a non-destructive testing method, the Vibration analysis of the Vaigai bridge should be carried out with the help of the piezoelectric sensors. The sensors should be made as a two parallel strips, such that each strip consists of 20 individual piezoelectric sensors connected in parallel. A resistor of 1 mega ohm is attached at the end of each strip.

Fig.6.Figure shows the Arduino program for vibration analysis of Vaigai bridge using piezoelectric sensor.

Then the strip is connected to the Arduino board through connecting wires. The Vibration of bridges under moving vehicles was recorded by two strip of sensors namely, sensor 1 and sensor 2. The interaction problem between moving vehicles and *bridge structures* has produced a lot of vibrations in the bridge. These vibrations are recorded by the sensor strips and the vibrations are then converted to electrical energy by piezoelectric sensors.

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3.3. SENSOR OUTPUT VALUES

The vibrations recorded by the piezoelectric sensor strips are converted to electrical energy due to *piezo electric effect*. The sensor vales obtained from the Vaigai bridge are displayed as analog readings. The readings are taken for a time period of fifteen minutes for the consecutive three hours Since, the vibration analysis is done for a 100-year-old bridge the analog readings obtained during the analysis are found to be exceeding the threshold limit. From these vibrations, it can be clearly inferred serviceable bridges within the lifespan has given data within the threshold limit. Hence, old bridges give more vibrations.

As said earlier, each vibration has two measurable variables that help to determine the vibration characteristics, how far (magnitude or intensity) and how fast (frequency) the subject is moving. Thus, Sensors were positioned to collect real time data and these data gives an idea about the condition of the bridge. Due to these vibrations, the bond between the reinforcement and concrete will reduce gradually and also there will be a reduction in the durability.

4. CONCLUSION

Thus, structural health monitoring systems have been used to monitor critical infrastructure such as bridges, high-rise buildings, and stadiums and has the potential to improve structure lifespan and improve public safety. This journal is about the Structural health monitoring systems, which is used to monitor the structural health and it also has the potential to improve structure lifespan and public safety. This concept is used to identify the severity of surface defects using image processing technique. The interaction problem between moving vehicles and bridge structure are monitored by vibration analysis using piezoelectric sensors.

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