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Bridge Crack Identification and Monitoring Using IoT

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Abstract: *The appearance and progression of cracks in a concrete bridge will negatively impact how safely people can use bridge structures. This paper developsan image pre-processing scheme combining multiple adaptive filtering and contrast enhancement based on the image processing technology of concrete crack, which can improve the removal effect of background noise and obtain the characteristic ininformation of tiny cracks. This approach can better meet the crack detection requirement. Then, in order to retrieve the information about the crack edge and increase the positioning accuracy of the crack border, we developed a local adaptivetechnique of Otsu threshold segmentation and merged it with a modified Sobel operator for removing isolated noise spots. The target crack is also recognized, classed, and the feature data is calculated in accordance with the image feature of the bridge crack edge. The case analysis findings demonstrate that the detection algorithm's data processing accuracy can satisfy the actual engineering criteria for concrete bridge crack detection by processing data to a precision of 0.02mm.*

Key Word: *Multiple adaptive filtering, Contrast enhancement, Background noise, Local adaptive filtering, Otsu threshold segmentation.*

I.INTRODUCTION

Engineering constructions, such as concrete surfaces and beams, are frequently subjected to fatigue stress and cyclic loading, which causes cracks to form on the surface of the structure. These fractures typically start at the microscopic level. The structure's cracks generate material discontinuities and a reduction in local stiffness. Early identification enables the implementation of preventative steps to stoppotential failure and harm. The practice of finding cracks in buildings using various processing techniques is known as crack detection. There are two techniques to identify cracks. These two types of testing are destructive and non- destructive. Surface condition issues are assessed using the visual inspection and surveying equipment. The aim of the type, number, breadth, and length of cracks on the structural surface reveals the concrete structures' bearing capability and level of early deterioration. Instead of slower subjective old human inspection processes, automatic crack detection has been created for quick and accurate surface defect analysis. Thus, a more secure survey approach is adopted. Non- destructive testing is particularly successful with automatic fracture detection. It is challenging to make an unbiased assessment of degradation by manual inspection. Several non-destructive testing methods, including I infrared and thermal testing, (ii) ultrasonic testing, (iii) laser testing, and (iv) radiographic testing, can be used for automated crack identification.

II.EXISTING SYSTEM

In this study, a technique to find surfacecracks in concrete bridge bottoms is proposed. It is based on digital image processing technology. As the technique is currently in the testing phase, the primary study topic is the image processing technology algorithm. There hasn't been a viable solution put out for the unique mechanical structure and control. It is not appropriate for edge detection and can only be used for offline crack detection. The process involves moving and scanning the area at the foot of the bridge, analyzing and determining whether there are cracks, automatically calculating various fracture characteristic values, and then saving thedata. The technique for fracture identification and classificationfor subway tunnels presented in this work is based on the use of CMOS line scan cameras. In the experimental part, a thorough explanationof the image processing methods and the ideal parameter values is provided. The suggested strategy is simple to use and efficient. Although not limited to use inunderground tunnels, the suggested image processing approach for fracture identification and classification may beappropriate for various state monitoring applications. Moreover, various uses of pattern recognition may be appropriate for the suggested distance-based form descriptor.

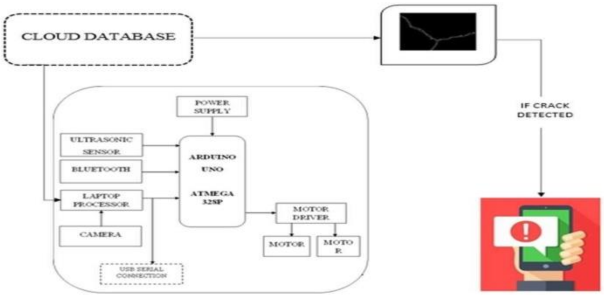
This study described a technique for detecting road cracks that offers fully autonomous road distress evaluation. Two-line scan cameras, a laser illumination system, and acquisition HW-SW areinstalled ina vehicle that will also storethe digital pictures that will be utilized inan off-line procedure to locate road fractures. In order to make the identification procedure easier, pre- processing is first carried out to bothimprove the linear characteristics that may match with cracking and smooth out thepavement's texture. In order to do that, a histogram analysis is carried out, producing a reduced size picture. Next, non-crack features detection is used to distinguish regions of the pictures that include joints, sealed cracks, and white painting, which frequently result in false positive cracking. For backup purposes, the system transmits real-time monitored data to both a cloud server anda system server. Users and administrators can enter into the system using a login interface. The sensors that are installed on different parts of the bridge keep an eye on the relevant parameters. When a threshold number is exceeded, the communication system alerts the management centre by setting off an alarm.

A PIC microcontroller collects all of the bridge's parameters and sends them to the user control centre. ZigBee is a communication technology. Utilizing water level sensors, bridge flooding is discovered. fissure detection is carried out using image processing, and the responsible authority is informed if the fissure diameter is discovered to be greater than the predetermined threshold. According to the researchthat was doneusing the created model, we can quicklyidentify any cracks in the structure. The product from our model can be kept in storage for a very long time. Thus, we can draw the conclusion that bridge crack detection using image processing is an effective method for crack detection. The GUI will display the image with the crack size outlined by a contour. Barricade and indication status also provideus with the right results.

III.PROPOSED SYSTEM

In order to better satisfy the crack detection requirement, this paper comesup with an image preprocessing scheme combining multiple adaptive filtering andcontrast enhancement based on the image processing technology of concrete crack, which can improve the removal effect of background noise and obtain the characteristic vein information of tiny cracks. Then we designed a local adaptive algorithm of threshold segmentation and integrated with modified Sobel operatorfor removing isolated noise spots, so as to extract the crack edge information and improve the positioning accuracy of the crack boundary.

IV.PROPOSED SYSTEM BLOCK DIAGRAM



V.HARDWARE USED

- Arduino Uno
- Atmega 328 P
- Bluetooth Module
- Ultrasonic Sensor
- Motors

1. Arduino Uno

Arduino/Genuino Uno is a microcontroller board based on ATmega328P. It features 14 digital I/O pins(6 of which can be used as PWM outputs), 6 analog inputs, a 16MHz crystal, a USB connector, a power jack, anICSP header and a reset button.

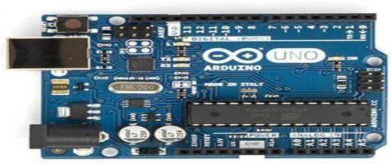


Figure 4.1 Arduino board

2. ATMEGA 328 P

The ATMEGA 328, which is advantageous for handling all hardware and software programming for bridge crack detection. Moreover, the Arduino is being used. There is no need to choose one of the more expensive microcontrollers because ATMEGA328 meets our requirements. A built-in analogue to digital converter is also provided, which will assist us in smoothly converting sensor data from analogue to digital.

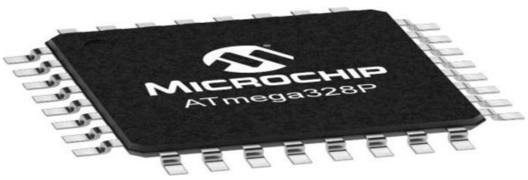


Figure 4.2 Atmega 328P

3. Bluetooth Module

The red LED on the HC-05 shows the connection state, whether Bluetoothis active or not. This red LED continually and irregularly blinks before being connected to the HC-05 module.On 3.3V, this module operates. Since the module contains a built-in 5 to 3.3 V regulator, we may also connect a 5V supply voltage. There is no need to change the transmit level of the HC-05 Bluetooth module because it has a 3.3V level for RX/TX and the microcontroller can detect that level. Nevertheless, we must change the microcontroller's transmit voltage level to the HC-05 module's RX.

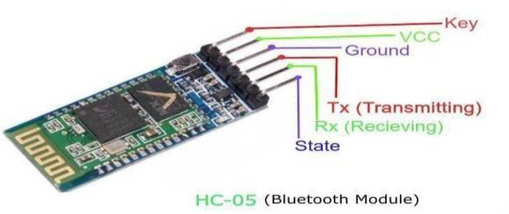


Figure 4.3 Bluetooth Module

4. Ultrasonic Sensor

The name suggests that ultrasonicsensors use ultrasonic waves to calculate distance. An ultrasonic wave is emitted by the sensor head, and it is then picked up by the target after being reflected back by it. By calculating the delay between emission and reception,ultrasonic sensors calculate the distanceto the target.

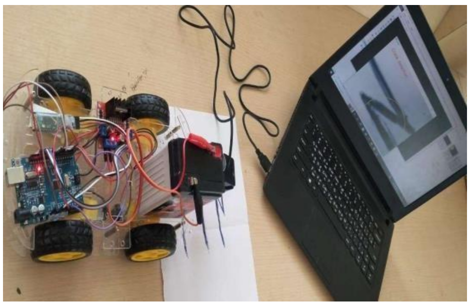
Figure 4.4 Ultrasonic Sensor

5. Motors

Between the motors and the control circuits, motor drivers serve as an interface. While the controller circuitoperates on signals with minimal current, the motor requires a considerable quantity of current. Motordrivers' job is to convert low-current control signals into higher-current signals that can drive motors. An electronic tool that aids in thetransformation of electrical energy into mechanical energy is a motor. We have a wide variety of electric motors.

VI.RESULT AND DISCUSSION

The case study analysis findings in the paper indicate that the suggested detection algorithm can achieve high data processing precision of up to 0.02mm, which satisfies the actual engineering criteria for concrete bridge crack detection. Overall, this study offers a fresh andefficient method for identifying and analyzing cracks in concrete structures,which can help prevent accidents and guarantee the safety of bridge users. As such, it appears to be a significant contribution to the fieldof concrete bridge inspection and maintenance.



VII.CONCLUSION AND FUTURE ENCHANCEMENT

The suggested method works well when visual inspection is required in places that are difficult for humans to access. The study shows that open cv methods can detect both cracks and blocks (ormasonry units) with a high level of accuracy. The effectiveness of thebinarized output has also been evaluated,and the results demonstrate that, even for clear images, the CNN output is superior than simple image-processing techniques. Particularly in light of the fact that basic image- processing software does not distinguish between identified elements and background or openings. Also, by expanding the dataset used for training and validation, deep learning techniques enable the model to be improved.

VIII.FUTURE ENCHANCEMENT

Expanding the dataset used for training and validation, deep learning techniques enable the model to be improved.

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