DETECTION AND MEASUREMENT OF CRACKS IN CONCRETE BRIDGES USING QUADCOPTER

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Abstract –*Nowadays, Drones have become an essential part for conducting various types of Inspections. Generally in Concrete bridges, Crack formation occurs over time which puts the bridge at risk. At present, the crack dimensions are measured by humans. In this Study, we propose a method which consists of Quadcopter attached with a Smartphone, node MicroContollerUnit and Ultrasonic Sensor to measure the dimension of the cracks. Here with the help of a Smartphone, the image of the crack is captured and its length is measured with the help of image processing techniques. Similarly by using the node MCU and Ultrasonic Sensor, the depth of the crack is measured. Finally the results were compared to those obtained by manual inspection.*

Key Words: Crack, Quadcopter, Smartphone, node MicroControllerUnit, Ultrasonic Sensor, Image Processing techniques

1. INTRODUCTION:

Concrete Structures are generally used in bridges due to its longevity. There are different types of Concrete bridges that are present all over the world namely Beam and Slab bridges. Over time, these Structures develop cracks, which put the safety of the bridge at risk. In order to maintain the safety of the bridge, the bridges have to be monitored periodically. Thus human inspections are done to monitor the cracks. It takes a lot of time and there may be some issues regarding accuracy, etc... .Thus in this system we use a Quadcopter [1] which is attached with a Smartphone, node MicroControllerUnit, and Ultrasonic Sensor to measure the dimension of the cracks and estimate its safety based on the results obtained.

2. PROPOSED SYSTEM:

In this System, we propose a method which consists of a Quadcopter which can be used for carrying out inspections at places where a human cannot reach. A Smartphone is attached with a Quadcopter in order to capture the image [2] of the crack. This captured image is then used to measure the length of the crack using image processing techniques which is done with the help of MATLAB software. The Quadcopter is also attached with node Microcontroller Unit and Ultrasonic Sensor [3] to measure the depth of the crack. The Block Diagram of the system is shown in Fig -1 below

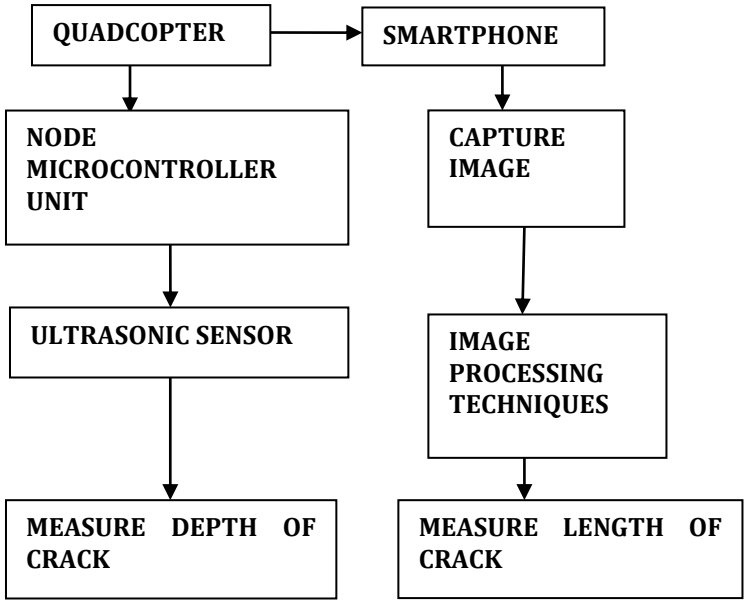

Fig -1: BLOCK DIAGRAM OF PROPOSED SYSTEM

Here the working model of the proposed system is shown in Fig -2 below

Fig -2: WORKING MODEL OF PROPOSED SYSTEM

For the construction of Quadcopter [4], four motors, four propellers, battery source, four electronic speed controllers, Flight controller, radio transmitter and receiver are used. Here the capacity of the battery determines the flight time of the Quadcopter. Electronic speed controller is used to adjust the speed of the motor. Radio transmitter is used to send user input which is received by the radio receiver.

3. RESULT:

As already mentioned, the length of the crack is measured by taking picture of a crack. This image is then processed by using morphological operations to determine the length of the crack. It is shown below

Fig -3: **ORIGINAL IMAGE**

Here original crack image as shown in Fig -3 is taken as input image in MATLAB software.

Fig -4: **GRAYSCALE IMAGE**

Then the input image is converted to grayscale image as shown in Fig -4 for further processing.

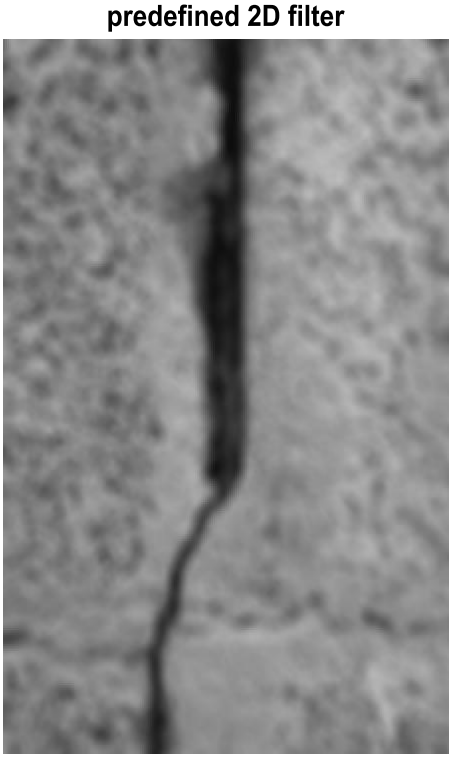

Fig -5: **PREDEFINED 2D FILTER**

Then the grayscale image is enhanced as shown in Fig -5 by using Predefined 2D filter.

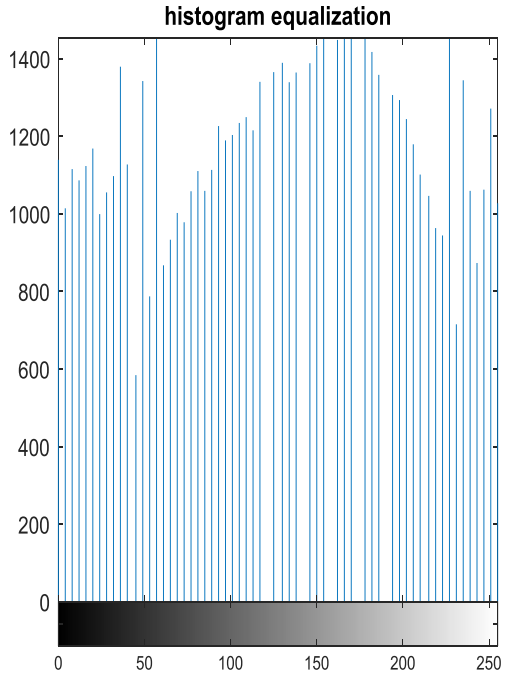

Fig -6: **HISTOGRAM EQUALIZATION**

The enhanced image is then subjected to histogram equalization as shown in Fig -6 for equalizing the intensity value of the pixels.

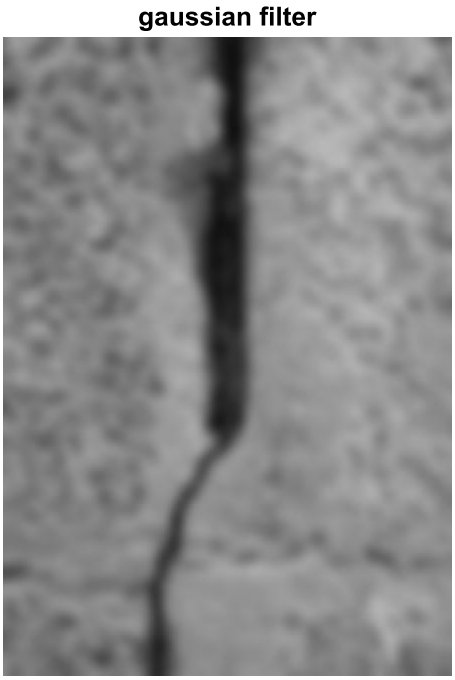

Fig -7: **GAUSSIAN FILTER**

The Gaussian filter as shown in Fig -7 is used to perform smoothing operation on an equalized image.

Fig -8: **BINARY IMAGE**

The smoothened image is converted to binary image as shown in Fig -8 to perform morphological operations.

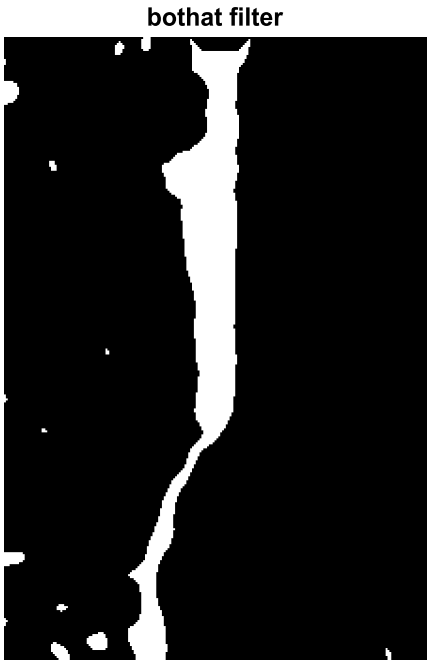

Fig -9: **BOTHAT FILTER**

Here bothat filter as shown in Fig -9 is one of the morphological operations performed on a binary image.

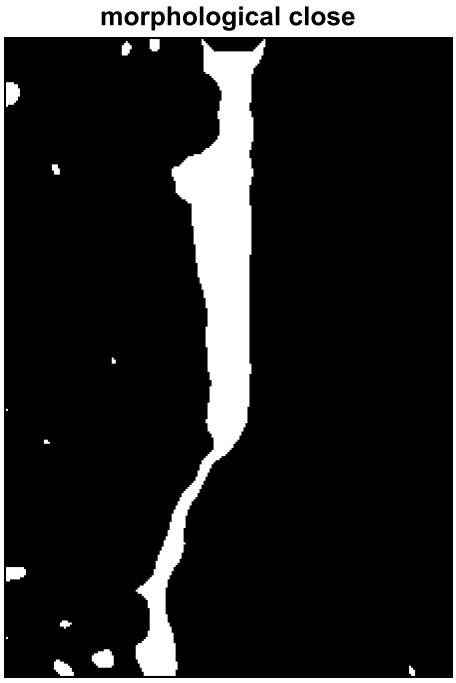

Fig -10: **CLOSE OPERATION**

Here the morphological close operation as shown in Fig -10 is used for performing binary closure.

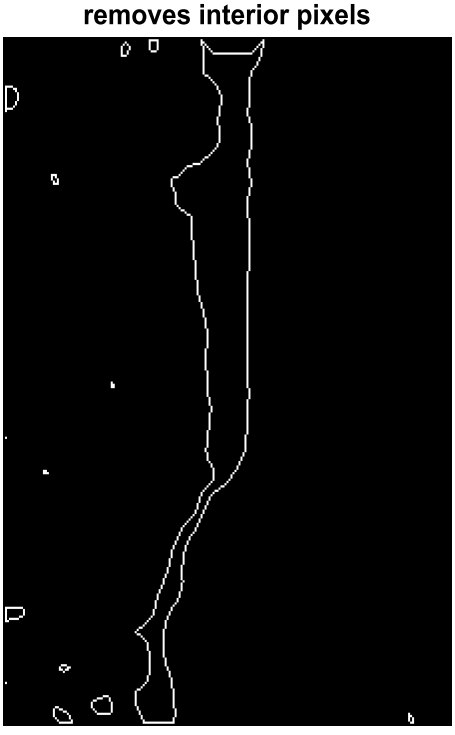

Fig -11: **REMOVE OPERATION**

Here the morphological remove operation as shown in Fig -11 is used for removing interior pixels.

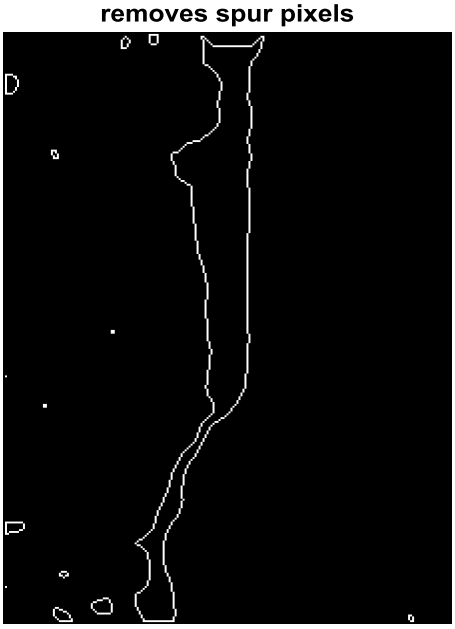

Fig -12: **SPUR OPERATION**

Here the morphological close operation as shown in Fig -12 is used for removing spur pixels. Here we have obtained the output as 678 pixels which is equivalent to 18 cm. The actual length of the crack is 20 cm. Thus we have obtained a 90% accurate result. Similarly the depth of the crack is measured with the help of Ultrasonic sensor and Node Microcontroller Unit. Here depth is calculated using Blynk Software.

Initially install the Blynk app and create a new project named ESP8266. It is shown in Fig -13.

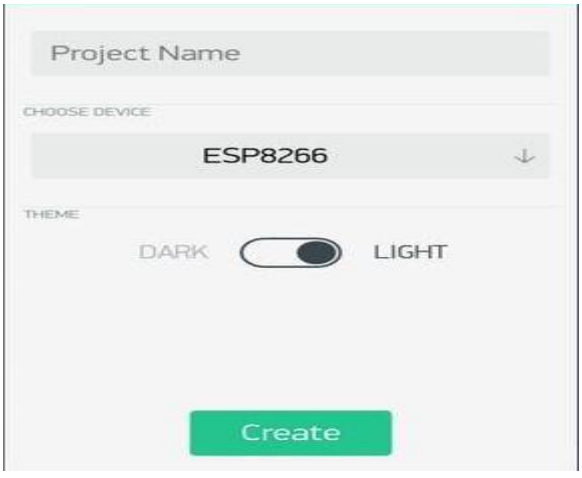

Fig -13: **CREATE NEW PROJECT**

After creating new project, click on add new widget and select LCD. It is shown in Fig -14.

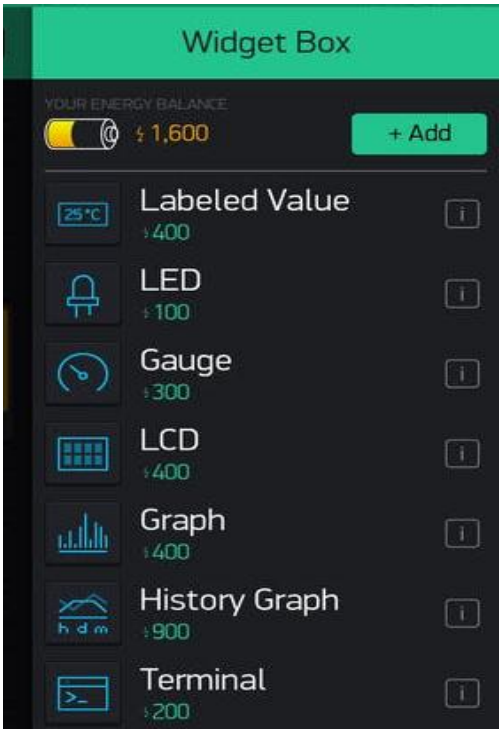

Fig -14: **ADD NEW WIDGET**

After adding LCD widget, set it to advanced and virtual V1 input. It is shown in Fig -15.

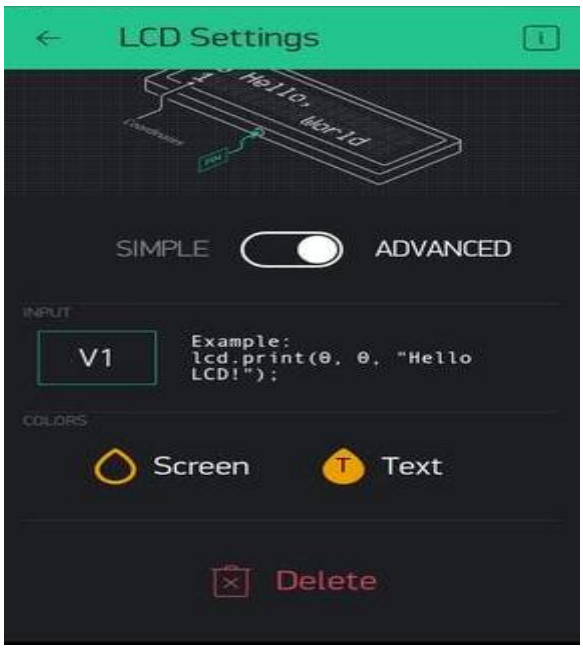

Fig -15: **SET V1 AS VIRTUAL INPUT**

After setting the virtual input, the Blynk library is installed in Arduino IDE and code is written. Finally the output obtained is shown in Fig -16.

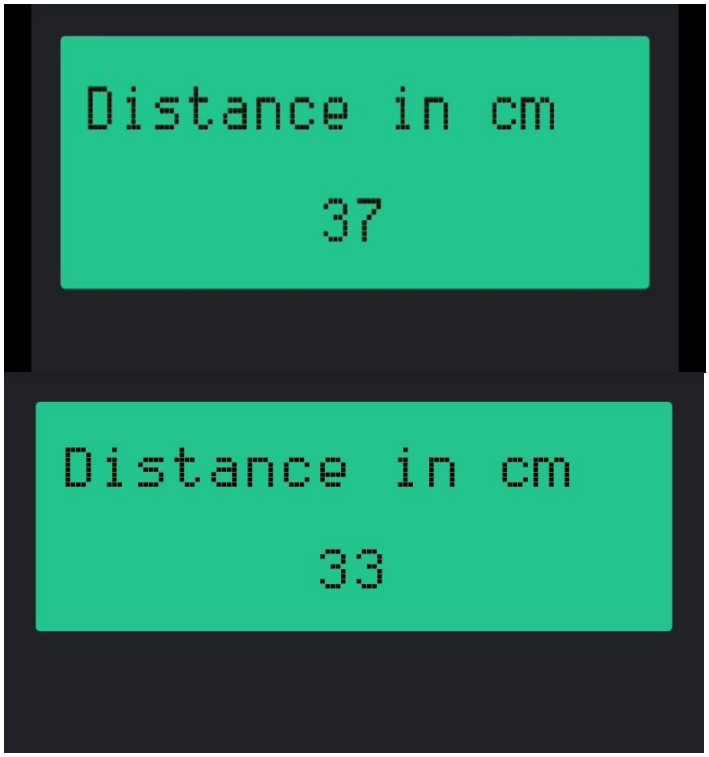

Fig -16: **FINAL OUTPUT**

Thus we can obtain the depth of the crack by calculating the difference between the 2 distances. The depth of the crack obtained is 4cm.

4. CONCLUSION:

This Paper presents a Human Controlled Quadcopter for detection and measurement of crack in concrete bridges. Here Smartphone is attached to a Quadcopter to take crack image. From the resulting image, length of the crack is obtained by performing morphological operations using MATLAB. Also the depth of the crack is computed by measuring distance using Node MCU and ultrasonic sensor with Blynk platform. Here results obtained are approximately 90% accurate. From the results, we can conclude that this system can be efficiently used in places where human beings cannot reach. In Future, with the development of AI Processors this system can be used with Autonomous Quadcopter [5].

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