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Wireless Intelligent Accurate Bridge Deck Crack Inspection and Mapping

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Abstract: One of the important tasks for building maintenance is building deck crack inspection. However, the inspection result in human analysis is lowering accurate in nature. A crack inspection system that uses a camera-equipped mobile robot to collect images on the building deck. In this method, the Laplacian of Gaussian (Log) algorithm is used to detect cracks and a global crack map is obtained through camera calibration and robot localization. To clarify that the robot collects all the images on the building deck, a path planning algorithm based on the genetic algorithm is developed. by simulations and experiments, We validate our proposed system through both simulations and experiments. This work addresses crack detection and mapping on a building deck using a robotic system. Several challenges including coordinate transformation, robot localization and complete coverage path planning for the proposed robot system are tackled. This paper focuses mainly on the overall framework for such a robotic inspection system, therefore some of the techniques for handling shadows, paints, patches on buildings are not addressed. In real-world applications, these issues should be carefully incorporated into the design of the image processing algorithm. Also, there may be vibration caused by the passing traffic, which should be dealt with as well. The positioning of the ROCIM system is critical to crack mapping, hence more accurate robot localization techniques fusing various sensors such as differential GPS, Inertial Measurement Unit (IMU), etc. should be developed. It is also worth noting that the depth and severity of the cracks can be measured by employing advanced nondestructive evaluation (NDE) sensors, such as impact echo and ultrasonic surface wave.

Key words: robots, mapping systems, ROCIM system

I. INTRODUCTION

An autonomous robot is a robot that performs behaviors or tasks with a high degree of autonomy, which is particularly desirable in fields such as space exploration, cleaning floors, moving lawns, waste water treatment and delivering goods and services. Some modern factory robots are autonomous within the strict confines of their direct environment. It may not be that every degree of freedom exists in their surrounding environment, but the factory robot's workplace is challenging and can often contain chaotic, unpredicted variables. The exact orientation and position of the next object of work in the more advanced factories even the type of object and the required task must be determined. This can vary unpredictably at least from the robot's point of view. One important area of robotics research is to enable the robot to cope with its environment whether this be on land, underwater, in the air, underground, or in space.

A fully autonomous robots behavior can be explained. Gain information about the environment, Work for an extended period without human intervention, Move either all or part of itself throughout its operating environment without human assistance, Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications. An autonomous robot may also learn or gain new knowledge like adjusting for new methods of accomplishing its tasks or adapting to Changing surroundings. Like other machines, autonomous robots still require regular maintenance.

II. RELATED WORKS

Outlined herein are some of the research efforts made on automated crack detection of bridge images using image processing and pattern recognition techniques. Ehrig et al. (2011) introduced three different crack detection algorithms namely template matching, sheet filtering based on hessian eigen values, and percolation based on the phenomenon of liquid permeation. Their study focused on determining the suitability of each for crack detection. Subsequently, the percolation algorithm was modified using employing a sheet filter approach for application to three-dimensional images. It should be noted that the template matching technique was used to detect certain patterns. The latter was based on the physical model of liquid permeation, with each pixel considered to be either a crack or otherwise. As a result, the modified percolation algorithm, called 'Hessian driven percolation', verified its effectiveness in crack detection. It was found, however, that the Hessian- driven percolation was not suitable for thin cracks.

Abdel-Qadeer et al. (2003) compared edge detection algorithms in the context of bridge crack detection.

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Collections of 50 concrete bridge images were used. Four techniques were also employed for comparative analysis: fast Haar transform (FHT), fast Fourier transform (FFT), Sobel edge detection, and Canny edge detection. The output images were judged as containing cracks or no cracks based on a threshold, which was determined by the average value of the intensity of all pixels in the images.

The conclusion drawn was that the FHT performed significantly better than the other algorithms. Jahanshahi and Masri (2011) presented a feasibility study on a novel crack detection methodology for condition assessment of concrete structures. Such an assessment was performed in three steps including: (a) image acquisition; (b) image processing (segmentation and feature extraction); and (c) pattern recognition (classification). After the target images were collected, morphological operation and Otsu's thresholding method were adopted to the segmentation process. The purpose of the segmentation process was to reduce unnecessary data in the original image. The appropriate structure element size (in pixel) was also determined for a morphological operation based on camera focal length, the distance from the object to the camera, camera sensor resolution and size, as well as crack thickness. Following the process of image processing, five features were selected to feature extraction based on the Linear Discriminant Analysis (LDA). For comparative were used. Analysis results suggested that, Neural Network was better than the other techniques.

Mohajeri and Manning (1991) established a recognition system for segmented concrete crack images. The system uses directional filters to identify cracks in concrete. The crack can be identified to be longitudinal if there is a high concentration of object pixels in a narrow interval of x (transverse) coordinates, and to be transverse if there is a large number of object pixels in a narrow interval of y (longitudinal) coordinates. However, this system has been found to have difficulties in collecting accurate segmented crack images.

Tong et al. (2011) developed a new method of crack image processing for concrete bridges in order to collect high quality images. Their work recognized that images introduce noise such as irregular illumination, presence of moisture on concrete surfaces and shading. These problems induce unreliable outcomes of concrete crack detection. To minimize these problems, their method involves a preprocessing phase and then separates crack pixels from the background of the image through manipulation of grey level correction. However, this method is highly dependent on light conditions and it requires changing the average grey level of images.

A review of literature indicates that the abovementioned methods do not consider the images with difficult visual and are unable to process the bridge images with variable lighting conditions, random camera/view angle, and random resolution. Applying automatic visual bridge inspection method usually encounters difficulties in terms of the qualities of bridge images. How to automatically process the low quality bridge images and achieve reliable crack detection outcomes are vital in bridge condition assessment Whenever structural cracking and movement appear significant or significantly worsen, a qualified & licensed Structural Engineer should be consulted for further advice. Cracks occur when forces either externally, internally within a building, or as a result of chemical changes within the building's materials are greater than it can withstand. Cracking and movement can be structurally dangerous. Differential movement throughout a building may be a consequence of poor design, ageing or changing environmental conditions to which a rigid building cannot adapt without fracturing. The form and positioning of cracking depends upon the building's weak points, particularly around doors and windows and where floor and roof connect to walls. Other factors are the size, shape, and position of the crack, the age of the crack indicating repetitive movement, and crack widening suggesting settlement or support failure.

Sung-yul An, Jae-ho Jang, Chang-soo Han, and Pyung-hwa Kim [1] has presented an automated inspection system using a mobile robot that can detect concrete cracks in a tunnel employing an illuminator. In their system cracks are inspected vertically and horizontally. The mobile robot system consists of a CCD camera that can capture images of concrete structure and maximizes contrast distribution of cracks and non cracks. The camera usually require high power illuminator, a maximum of 1000 W halogen light is used. The numerical information of cracks are extracted and computed by crack detecting system which utilizes software

III. PROPOSED WORK

Crack monitoring should be started as soon as possible. The longer the crack monitoring period, the more data will be available for diagnosing the cause. The monitoring should continue throughout the data gathering, the investigation and the remedial work. It should continue beyond the completion of the remedial work in order to validate the performance of the remedial measures. Monitoring is important because a local authority was sued for the cost of foundation underpinning, but was held not liable because the structural engineer who recommended the under pinning had not monitored the cracks to establish if the movement was progressive.

To ensure that the robot collects all the images on the buildings deck, a path planning algorithm based on the genetic algorithm is developed. The path planning algorithm finds a solution which minimizes the number of turns and the traveling distance. Several challenges including coordinate transformation, robot localization and complete coverage path planning for the proposed robot system are tackled. Currently, building decks are inspected with very rudimentary methods in the form of visual inspection by a trained engineer. The inspectors usually walk through the buildings and measure the crack sizes and locations.

This manual approach has several disadvantages.

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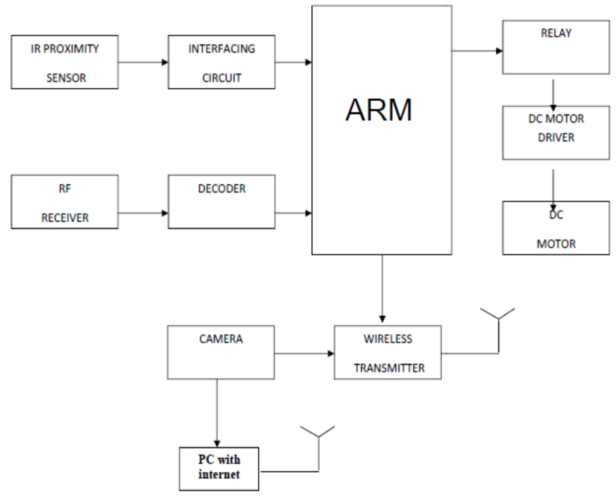

Fig.1 shows that the block diagram of the crack detection robot unit

Fig1 shows that the block diagram of the crack detection robot unit. The inspectors usually walk through the bridges and measure the crack sizes and locations. This manual approach has several disadvantages. Crack detection is to detect cracks on the bridge deck using computer vision, using E-MAIL platform we need to develop an effective edge detection algorithm to distinguish cracks and no cracks.

Since the cracks are detected in the image coordinate system, and have to map the crack locations from the image coordinate system to the global coordinate system. First fixed the Robot model to wall or pillar. In that Robot model having a wireless camera for detect the crack in the wall or pillar. Robot model drive with motor driver circuit and driver control is control via personal computer using E-mail tool. E-mail tool using for Robot control and taken images and compare the crack image via wireless sensor module Zig-bee. AM transceiver for receive the crack images from Robot model to pc and pc point out the crack images from which location. Zig-bee transceiver is sent the data‘s to controller for Robot model movements e.g. up, down, right, left, stop.

The Motor driver circuit using the l293d motor driver. In the diagram, can see that there is a microcontroller (MCU). Now, this MCU may/may not take in inputs as in from sensors, other digital inputs, etc. Next, as per our programming, the MCU will generate control signals. Please note that the MCU will generate signals in form of HIGH (Vcc = 5v) or LOW (zero). But this voltage is insufficient to drive a motor.

A motor driver always has a battery input Vs. In simple terms, what a motor driver does is that it directs the Vs voltage to the motors connected to it. Thus, the motors behave as per the control signals generated using the MCU with the excitation from the external battery voltage.

ARM may/may not take in inputs as in from sensors, other digital inputs, etc. The MCU will generate control signals.

A DC motor is an AC synchronous electric motor that from a modeling perspective looks very similar to a DC motor. Sometimes the difference is explained as an electronically-controlled commutation system, instead of a mechanical commutation system, although this is misleading, as physically the two motors are completely different. Three sub types are given as

□ the three-phase AC synchronous motor type has three electrical connections

□ the stepper motor type may have more poles on the stator.

□ the reluctance motor has all its poles on the stator, and a magnetic core on the rotor.

Mono wireless PTZ color camera complete 3 LUX minimum illumination and it focus manual adjustable from 30 mm to infinity, it view 50 degree horizontal angle. it support 8v dc – 12v dc or 9 volt single battery and it has 20gram weight, it has 1.2ghz operation frequency and 1.2 watt power consumption..

IV. PROPOSED SYSTEM

From the above studies we can propose automatic crack detection and mapping system which is capable of taking images, detects crack and provides a global crack map of bridge surface. Crack detection techniques require advancement, the system we develop will consist of mobile robot which will moves on the bridge surface, and we inspect half of bridge at a time while shifting traffic to other half. In this system we try to send images wirelessly to the laptop, where images will be processed through image processing techniques, we can employee edge detection techniques for crack detection and bounding box algorithm for localization of robot.

The entire project will be divided into following three modules.

A. Designing of Robot and Programming the Hardware

In this module we will select the different hardware component like microcontroller, a high resolution camera, RF module which can transmit captured images. Secondly Eagle software will be used for schematic creation & layout generation. After this we will be developing the algorithm for crack detection, path planning of robot and then program the microcontroller by the programmer. We will try to establish a wireless connection between the laptop and robot .We can also save the images to memory card.

B. Image processing on via email:

The images captured by robot are transmitted to the laptop/PC for image processing. Image processing is done in E-MAIL software. Any image contains extra irrelevant information which needs to be removed by preprocessing to facilitate the process of crack detection by making it more efficient and time saving.

We can employ the different techniques for image processing such as resizing the image, conversion of color image into grayscale, superimposing grayscale image with

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the original image, morphological operations etc. We will use different algorithm in image processing which can find out the edges in an image also we will implement such algorithm and techniques which can distinguish between cracks and non-crack. In this module we will create 2D-map which is essential and main aim of this work.

V. SENSOR PROGRAMS

```
INFRA RED SENSOR
Task main ();
{
taskcheck_sensors()
{
While (true)
{
If (INFRA SENSOR_1 == 1)
{
Acquire (mathematics);
OnRev (OUT_AC, 75);
Wait(500);
OnFwd(OUT_A, 75);
Wait(850);
Release (mathematics);
}
ULTRA SONIC SENSOR
Task main();
{
taskcheck_sensors()
{
While
(True)
{
If (ULTRA SENSOR_1 == 1)
{
Acquire(SENDMutex);
Wait(500);
OnFwd(OUT_A, 75);
Release(moveMutex);
```

VI. RESULT

In this project design and implementation of robotic crack inspection for bridge deck maintained based secure system for monitoring and control of accidents on bridge's using ARM 7 LPC2148 and sensor ultra-sonic was proposed implemented and deployed that successfully detected accidents in bridges and roads.

VII. CONCLUSION

The project has been successfully designed and tested. It has been developed by integrating features of all the hardware components and software used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using, ARM 7 LPC2148 Controller and with the help of growing technology the project has been successfully implemented.

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