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Crack Detection for Civil Engineering Structures

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Abstract - Structural Health Monitoring (SHM) is one of the emerging fields in which smart technology is used to inspect the civil engineeringstructure components to prevent from failure. SHM will detect the fundamental properties such as cracks in the structure and expedite needed repairs, and thus increase the useful life of those components.The safety measures related to civil engineering structures with respect to age of the structure, structural damage, climatic conditions like flood, heavy rains, earthquake, etc. is the prime role of the concerned authorized engineers. In the development of economy and society, many structures have been built which should meet the requirement of the serviceability, safety and sustainability during the operation stage throughout its life cycle. But due some reasons the structure gets weak and cracks starts developing within the components. Gradually the crack expands which leads the structure to collapse. To avoid the failure of structure the cracks must be detected at early stage and this could be done by using piezoelectric film. Using IoT ,the piezoelectric film shows the crack detection on bridge. This was major concern in our findings due to which we have made an ideology in our research to overcome this problem and to bring up safety majors in our real-life problems.

Keywords - Structure Health Monitoring, Crack Detection, Piezoelectric film, Stress, Safety, Real Time Monitoring

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1. INTRODUCTION

In today's world, civil development is at its peak. Due to increasing development, thousands of new buildings, bridges, tunnels, highways, and much more challenging and complex structures are being made day by day for suiting the increasing demands of people. India is a country that has many old heritage monuments, and buildings that belong to the government or people. These heritage buildings are still standing despite thousands of years and the natural environmental conditions. It is one of the remarkable signs of integrity. Between 2010 and 2014, around 13,178 died due to the collapse of the civil structure according to NCRB.

Bridges are always at risk of failure due to corrosion of steel bars in engineering structures, increased traffic, deterioration, aging, or simple decay.Bridges deteriorate due to poor design and construction, as well as unintentional damage, resulting in loss of the load-carrying ability of bridges. As a result, many of these structures require reinforcement, repair, or replacement, yet public finances are in short supply. It is not always possible to replace or build new structures.

A major traffic artery is a concrete bridge.It will unavoidably be subjected to severe winds, rain, snow, earthquakes, and frigid temperatures. Overloading and hitting can also cause damage to bridge piers. Cracks are difficult to spot among bridge deterioration, putting the bridge's safety in jeopardy. Large cracks can quickly jeopardise a bridge's structural integrity, causing carbonization of concrete, corrosion of steel bars, peeling of protective layersand even bridge collapse.As a result, proper measures for monitoring and preventing bridge fractures, which are vital to bridge traffic safety and smooth operation, are required.Mechanical monitoring, on either hand, relies heavily on inspector expertise, which might lead to errors.

Visual detection is one way to detect all the crack detecting procedures. By automatically processing and analysing an enormous number of photos, a computer image processing system can detect a crack in a bridge. But this method doesn't give real-time crack detection and this may lead to structural failure.

For this reason, we are going to use a wireless sensor network for crack detection using dielectric

film which will monitor the structure at every time, instant with date and time.

2. LITERATURE REVIEW

Crack detection is crucial for monitoring of bridge health to prevent any further damage to structure and to make structure safe. The primary task for maintenance on bridge desk is detecting small cracks at early stage. For long span bridges site inspection is time consuming, costly, inaccurate in some cases. Due to expansion of infrastructure industry the crack detection techniques have attracted wide attention in past few years for lowering cost, efficient work and managing time. In previous works, the cracks in the bridges are determined by using various methods. The three categories can be made are deep learning-based methods, computer vision-based methods, and combined methods. The strategies for deep learning are as follows: Crack detection was performed using 1D-CNN-LSTM, AlexNet, VGG, GoogleNet, and ResNet [1-8]. Conventional Neural Networks (CNN) a basic method in deep learning requires a large set of data for processing.Another vision-based approach, histogram of pixels, was used to automatically detect spalling and transverse fractures using an expert system [9-11]. To identify edges and, as a result, fractures in the pictures, standard signal processing methods such as Sobel, Canny, Fourier Transform, and Fast Haar Transform are utilised [12-14].

First, the Vision-based Convolutional Neural Network detects concrete fractures using a deep architecture of CNNs rather than the conjugation of IPTs to compute the faulty features. Nondestructive techniques also help in analyzing crack on surface and deep inside the bridges [5]. Cracks can also be detected by using sensors with iot embedded system. Using different sensors, the parameters like cracks, acceleration, strain, water level are being found out. Sensors are placed at end of bridge or at a fixed point. Acceleration pickup detects cracks in concrete structures and Laser Displacement sensor identifies the surface cracks. Hence detection of cracks at early stages in crucial with proper technique which may take less time, is accurate and is budget friendly[6-7].

3. PROPOSED TECHNIQUE

This paper aims to present an automated system for crack detection on bridges. This system is developed using smart material referred to as a piezoelectric film. Piezoelectric film is a lightweight, strong, and flexible material made of plastic, which comes in a different range of thicknesses and areas. As a transducer, the piezoelectric film can be moulded into various designs as per need and it can also be glued with commercial adhesives [9,15]. This property of the film helps to attach the piezoelectric film under the bridge.

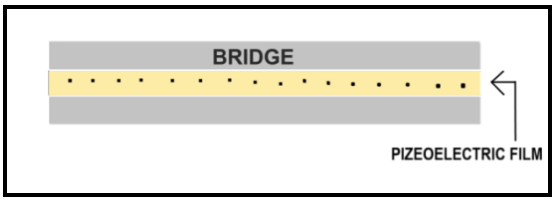

Fig.1. Bottom View of Bridge with Piezoelectric Film

The piezoelectric film will give stress values on the measuring screen [7,16]. Initial stress values include unwanted noise and external vibrations which needed to be neglected. This value on monitoring screen is set as standard zero level value.If the readings on the piezoelectric film dramatically increase, this indicates that cracks have begun to form in the structure. As a result, the detection of fractures using a piezoelectric film is monitored.

4. RESULT

When certain stress applied to piezoelectric film, it produces a potential difference of some magnitude of force. So, it is used to convert mechanical energy into electrical energy. Piezoelectric film generates an analogy output voltage.

A threshold value is set to the circuit so that the sensor is not activated for vibrations less than the threshold. We can set the threshold value according to suitable conditions. Using this, we can neglect unwanted vibrations and noise. When the output voltage generated by sensor element is greater than the threshold value the LED changes its state i.e. if it is in the HIGH state the buzzer rings. Also using IoT, with the help of GSM module the SMS is sent to admin, generating an alert. If the value is lower than the threshold LED doesn't change its state and remains in its stable state. Hence, the structure is safe.

5. CONCLUSION

In this paper, the real time detection of cracks in civil engineering structures using piezoelectric film is monitored. Earlier crack detection methods are inaccurate, costly and some uses a lot of images which need time to process. Also, earlier sensors were placed at a fixed point on structure but this method allows us to monitor using whole strip.With varying stress on the bridge and also due to the ageing of the bridge we can exactly know Where the cracks pertainand we can take immediate action on how to close those cracks. Cracks at early stage are predicted which helps in preventing the structure failure and minimizing the accidents.This practice is not done in many places but the urgency of this is needed everywhere.It would be beneficial

in the field of Structural Health Monitoring if we implement the proposed method in future.

REFERENCES

[1] Yu, T.; Twumasi, J.O.; Le, V.; Tang, Q.; D'Amico, N. Surface and Subsurface Remote Sensing of Concrete Structures Using Synthetic Aperture Radar Imaging. J. Struct. Eng. 2017, 143, 04017143..

[2] Meghana, R. K., Apoorva, S., &Chitkara, Y. (2017, October). Inspection, identification and repair monitoring of cracked concrete structure–an application of image processing. In 2017 3rd International Conference on Communication and Electronics Systems (ICCES) (pp. 1151-1154). IEEE.

[3] C. Zhao and A. Basu, "Dynamic deep pixel distribution learning for background subtraction", IEEE Transactions on Circuits and Systems for Video Technology, pp. 1-1, 2016.

[4] F. Yang, L. Zhang, S. Yu, D. Prokhorov, X. Mei and H. Ling, "Feature pyramid and hierarchical boosting network for pavement crack detection", IEEE Transactions on Intelligent Transportation Systems, 01 2016.

[5] Cha, Y. J., Choi, W., &Büyüköztürk, O. (2017). Deep learning-based crack damage detection using convolutional neural networks. Computer-Aided Civil and Infrastructure Engineering, 32(5), 361-378.

[6] Fujimoto, H., Miyoshi, S., Okamoto, M., & Tanaka, S. (2009). High Accurate Detection of Inclined Cracks in Concrete Structures Using an Acceleration Pickup. IEEJ Transactions on Electronics, Information and Systems, 129(6), 1087-1093.

[7] Giri, P., &Kharkovsky, S. (2016). Detection of surface crack in concrete using measurement technique with laser displacement sensor. IEEE Transactions on Instrumentation and Measurement, 65(8), 1951-1953.

[8] Prasanna, P., Dana, K. J., Gucunski, N., Basily, B. B., La, H. M., Lim, R. S., &Parvardeh, H. (2014). Automated crack detection on concrete bridges. IEEE Transactions on automation science and engineering, 13(2), 591-599.

[9] Guo, L., Li, R., Shen, X., & Jiang, B. (2016, June). Crack and noncrack damage automatic classification from concrete surface images using broad network architecture. In 2016 Chinese Control And Decision Conference (CCDC) (pp. 1966-1971). IEEE.

[10] Zhang, H., Yu, H., Zhang, H., & Yang, W. (2017, July). Accurate extraction of cracks on the underside of concrete bridges. In 2017 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) (pp. 2341-2344). IEEE.

[11] L. Zhang, F. Yang, Y. D. Zhang and Y. J. Zhu, "Road crack detection using deep convolutional neural network", Image Processing (ICIP) 2016 IEEE International Conference, pp. 3708-3712, 2016.

[12] Lee, S. H., & Hong, I. P. (2017, July). Design of Frequency Selective Paper for Crack Detection of Concrete Building Structure. In 2017 IEEE International Symposium on Antennas and Propagation & USNC/URSI National Radio Science Meeting (pp. 2016-2027). IEEE.

[13] Li, J.; Deng, J.; Xie, W. Damage detection with streamlined structural health monitoring data. Sensors 2015, 15, 8832–8851.

[14] Hyeong Gyeong Moon and Jung-Hoon kim, (2011). Intelligent Crack Detecting Algorithm On the Concrete Crack Image Using Neural Network Department of Civil and Environmental Engineering, Yonsei University, Soeul, Korea, ISARC.

[15] Cai, Y., Fu, X., Shang, Y., & Shi, J. (2017, June). Methods for long-distance crack location and detection of concrete bridge structures. In 2017 IEEE 3rd International Conference on Image, Vision and Computing (ICIVC) (pp. 576-580). IEEE.

[16] Yokoyama, S., & Matsumoto, T. (2017). Development of an automatic detector of cracks in concrete using machine learning. Procedia engineering, 171, 1250-1255.

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