IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 6, June 2021

DOI: 10.17148/IARJSET.2021.8669

Structural Health Monitoring of using Internet of things (IoT)

Md Omais Hussain[1], Dr .Neetu Urs[2]

PG Student, Civil Engineering, Dayananda Sagar College of Engineering, Banglore, India[1]

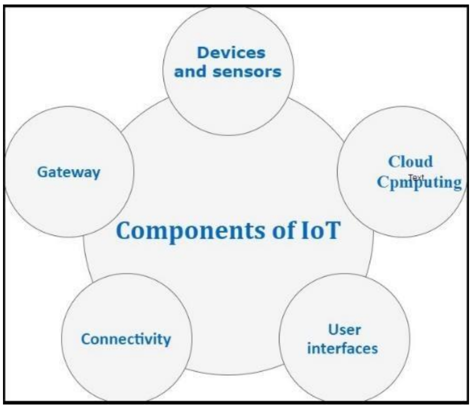
Associate Professor, Civil Engineering, Dayananda Sagar College of Engineering, Banglore, India[2]

Abstract: Maintenance should be of highest significance and emphasis in the infrastructure and construction industries. Technological advances is a practical instrument for comprehensive facilities management. The Network System built on Database can also be used, such as that of the Internet of Things(IoT) platform The structure is monitored everywhere. The new strategy for maintaining huge structures around the planet, in particular those that are characterized by extreme conditions is structural integrity tracking leveraging IoT system. The systems, sensors are deployed, which provide plenty of actual statistics based on real time data. This can be set to warn the consumer of any faults, variations of the vibrations and wind effects that affect the functionality of the structure. The procedure to correct the deterioration or to replace the damaged part should be indicated. In this respect even cloud computing technology is used. And provide us with real world data, Internet of things provides a communication link. It helps to communicate with building structures with basic compressive sensing. This surveillance would also include information on structural condition, statistics sufficient to evaluate health and productivity.

Keywords Structural Monitoring, Internet of Things, Sensors.

I. INTRODUCTION

SHM is a competitive sector of research-oriented tasks that necessitates a large rise in structure research and development, as well as their complexity. The demand for structural health monitoring has grown over time in order to meet public demands while also ensuring the safety of the structures and the people who work in them. Health monitoring is useful and efficient in detecting faults such as cracks and vibration characteristics, allowing for quick action before a more serious incident occurs.



Several theories have already been proposed and executed to suit the structural criteria of Retrofitting and Stabilization. By having few features to minimize network computational time and financial supports, theories have helped to overcome the efficiency and dynamic behavioral performance of monitoring systems. Accept and share data, as well as increase system variability. The Structural Health System makes use of networking in order to keep up with IoT developments.

Structural Monitoring, when combined with the Internet of Things [IoT], is a cutting-edge technology that allows users to connect with smart remote devices that run on the Internet of Things platform (IoT). The Internet of

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 6, June 2021
DOI: 10.17148/IARJSET.2021.8669

Things (IoT) is a cloud-based data sourcing, storage, and network access platform. With the new flexible approaches involved in IoT, the structural engineering community has been able to overcome a few current issues. The development of structural monitoring systems that are enhanced with IoT applications can provide precise and timely responses. Furthermore, the combination of structural monitoring, cloud computing, and IoT services has resulted in a cost- effective data sensing method. The cloud computing platform stores data, automatically imports data for smart monitoring, and provides remote access for smart devices. This strategy increases the capacity of a traditional monitoring system's old capacity.

Non Destructive Testing (NDT) is a procedure of conducting an experiment and analysing the results, which is particularly significant in the fields of construction, building erection, and structure operating life, i.e. to evaluate the combined qualities of any complex structure. This type of test is used to determine the size and location of surface flaws or cracks. NDT is unique in that it can monitor the accuracy of any building throughout its service life.

II. LITERATURE REVIEW

Through data tracking and a complete literature analysis, an embedded study compared and used a wired network to a portable information system, including its architectural tracking system, which employed a different processor with the same dynamic reaction as the created framework.

- Lost data recovery of fast-moving wireless sensing using compressed sensing for structural health monitoring.

Y. Bao, Y. Yu, and H. Li;In electromechanical admission-based dynamic health surveillance, a new compression-based sensing technique to information processing is presented. This is the case in this paper. This method entails projecting the initial conductor identification as statistical features on a perform work, sending the investigation waveform to the operating system with information leakage, and finally restoring the lost information using a density estimation procedure. [1]

- High-performance wireless piezoelectric sensor network for distributed structural health monitoring," International Journal of Distributed Sensor Networks; LS. Gao, X. Dai, Z. Liu, and G. Tian, 2016;The implementation of a specially introduced embedded piezoelectric (PZT) sensing technology through dispersed proposed construction monitoring systems is presented in this paper, that mostly provides membership function extraction with either a measurement frequency of roughly towards 12.5 Msps (samples per second) including integrated lamb-wave data processing. [2]

- A summary review of wireless sensors and sensor networks for structural health monitoring; J. P. Lynch and

K. J. Loh, 2006; Motion wireless detectors need new device configurations including threshold values from restrictions. The above report is intended as a descriptive analysis of accumulated expertise developed throughthe use of remote devices and smart platforms to manage construction integrity as well as performance in the structural design community. [3]

- The Internet of Things (IoT) is being used to monitor the structural health of buildings. Renato sante olivito, Domenico luca carnie, and Paolo Francesco sciammarella 2018; The conceptual framework is used throughout this journal to provide devices that can constantly track existing and new architectures while consuming less battery power. The methods are effective and require the installation of detectors at pre-determined thresholds. The data from the sensors is integrated with statistical models to determine structural protection. [4]

- IoT-based structural health monitoring M.P. Suresh Kumar and G Vennila. 2019; The Internet of Things (IoT) systemic surveillance framework has proven to be well suited to deployment scenarios such as smart buildings and green infrastructure, enhancing its effectiveness and product protection while improving the efficiency of precision control on only one end.. [5]
- Civil Infrastructure IoT 2016; A. Prabha; A. Prabha; A. Prabha; A. Pra The Internet of Things (IoT) for Civil Services and Infrastructure is discussed in this article. The suggestion The Piezomat Attachment Model, the innovative Detector Encoding Process, the FEM Evaluation, and the Internet of Things Integration are

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

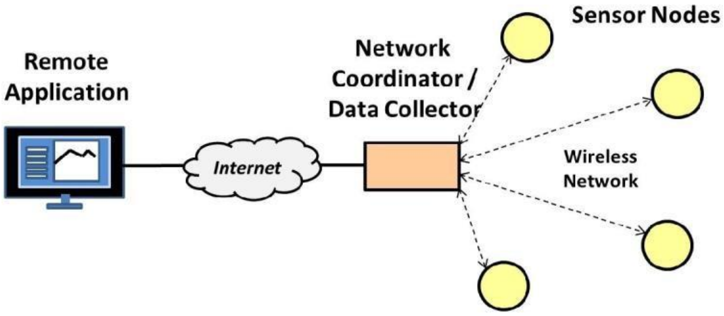
Vol. 8, Issue 6, June 2021

DOI: 10.17148/IARJSET.2021.8669

all considered cross-functional and cross-technique. The importance of research into alternative energy systems and then a highly efficient paradigm with realistic application would be enormous. [6]

- S. Park, S. R. Anton, J.-K. Kim, D. J. Inman, and D. S. Ha, 2010; Instantaneous baseline structural damage detection utilising a tiny piezoelectric guided waves system; Simultaneous, minimum, enhanced Piezo resistive direction flows are demonstrated in this article. Online longitudinal comprehensive needs monitoring is used by the monitoring gadget. Initially, three Piezo resistive Substrate (PZT) small, low-cost, and long- lasting intelligent pads are placed on a substrate and are expected to be equally binding in order for structural flaws in an aluminium plate to be discovered.[7]
- E. F. Crawley and J. De Luis, 1987, E. F. Crawley and J. De Luis, 1987, E. F. Crawley and J. De Luis, 1987,

E. F. Crawley and J. De Luis, 1987, E. F This work is primarily concerned with the observational astronomy of effective vibration modulation of a heat-actuating laser. The actuator is a very thin gyroscopic bar that is heat-inserted into the bridge on one side and tightly linked to it on the other. When subjected to heat, the device transforms into a piezoelectric detector that extends yet does not break any contracts. Even though no exult is transmitted towards the tube, it is assumed that the push is isolated, thus the energy would not change the temperature environment of either the structural part or the tube. In important to deter convection, we are



considering about two sensors one from the top and the other at the bottom of the beam, functioning together through a similar period of time location. [8]

Figure 2: Block diagram of Structural Monitoring Source:schematicscholar.org

III.EXPERIMENTAL INVESTIGATION

A cantilever beam with one side welded joint is first tested for free vibration in this study. The model beam was unbroken and in good condition, thus it was checked for free vibration using SW-420 sensors, which were positioned at both ends of the model beam. The beam is then damaged in the form of a notch at various spots on the beam, and varying changes in dynamic behaviour are recorded. Datasheets and bar graphs are used to document the outcomes. The IoT platform includes an Arduino Uno, a vibration recording sensor called the SW-420, and a Wi-Fi module for sending data to a distant device. The Arduino Uno is used to detect whether or not the structure is damaged, as well as the location of the damage if it is there, and to report the health status to an internet server. The data is saved in the cloud and may be accessed remotely from any computer or mobile device. The platform is used to inspect both damaged and undamaged steel beams before sending the information to an internet server. The health status is broadcast to the internet stored on Blynk software, which is an IoT-based foundation platform.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 6, June 2021

DOI: 10.17148/IARJSET.2021.8669

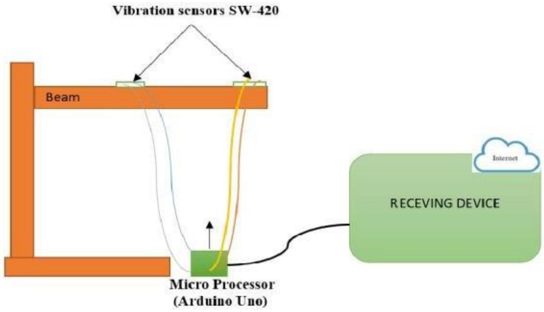


Figure 3: IoT setup for SHM

Arduino Uno, a microcontroller board based on the Microchip microcontroller manufactured by Arduino, is essential hardware. The board reads digital information and sends it to the MCU Wi-Fi module. The Wi-Fi module is a UNIX- based open-source firmware and development board. Vibration sensors and IoT applications are specifically focused (SW-420). The software needed to record the values is an IDE cross platform that includes a C++ library for running the codes and numerous common input and output operations.

As shown in Figure 3, a combination of two Sw-420 sensors is proposed in this research.. These sensors capture vibrations recorded when the cantilever beam is perturbed, and these readings are sent through an IoT process in which the software runs the values and, if the values exceed the threshold limit, an alert is sent to the end user or an SOS message is sent about the health condition, i.e. if the beam loads the values less than the safe limit, the beam is healthy. The method is detailed in the flow chart above.

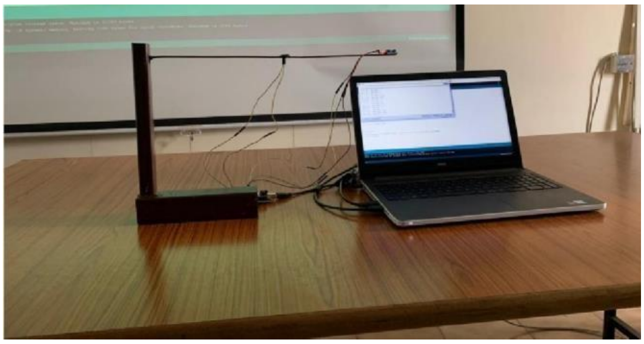


Figure 4: Onsite setup for monitoring readings

IV.RESULTS AND DISCUSSION

Sensors were attached in a combination, first at the fixed end and one-third span away from the free end, and then at the mid span and free end at the same time. The above readings represent the beam's free vibration condition, i.e. the cantilever prototype beam was perturbed by providing load at the free end. The Arduino programme was used to track the findings, which were then plotted on a serial plotter. The beam had recorded more vibrations than the safe limit of

0.015 Hz before any harm occurred, according to the above results (linear tread line in the graph shows the safe limit of the beam). The recordings from other locations were below the safe level. By providing a 2.5mm notch on both sides of the beam, the beam was damaged. Two places on the beam were inscribed, one at mid-span and the other at one- third span from the free end. After each section has been damaged, two separate readings are taken.

The graphs below illustrate the free vibration data of a beam under free load, with the amplitude measured in mm/sec2 on the X axis and time measured in seconds on the Y axis.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 6, June 2021

DOI: 10.17148/IARJSET.2021.8669

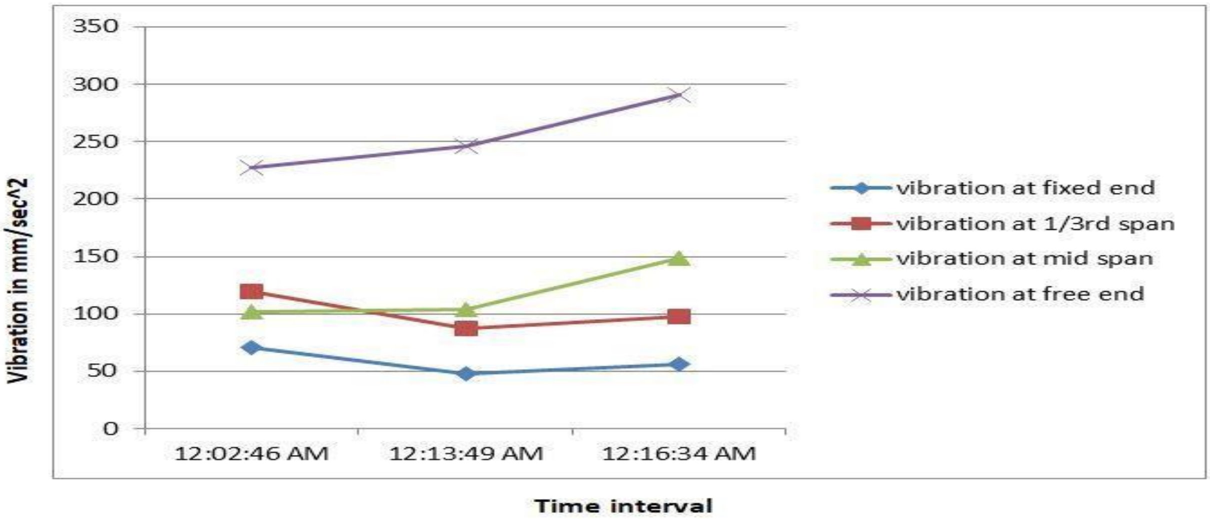


Figure 5: Free vibration data collected from sensor when mounted at different spans in undamaged condition

The above graph shows the combined results of the beam when sensor is placed at fixed end, one third end, mid span and free end . Red line indicates vibrations at one third end ,blue line indicates vibrations at fixed end, green line indicates vibrations at mid span, purple line indicates vibrations at free end.

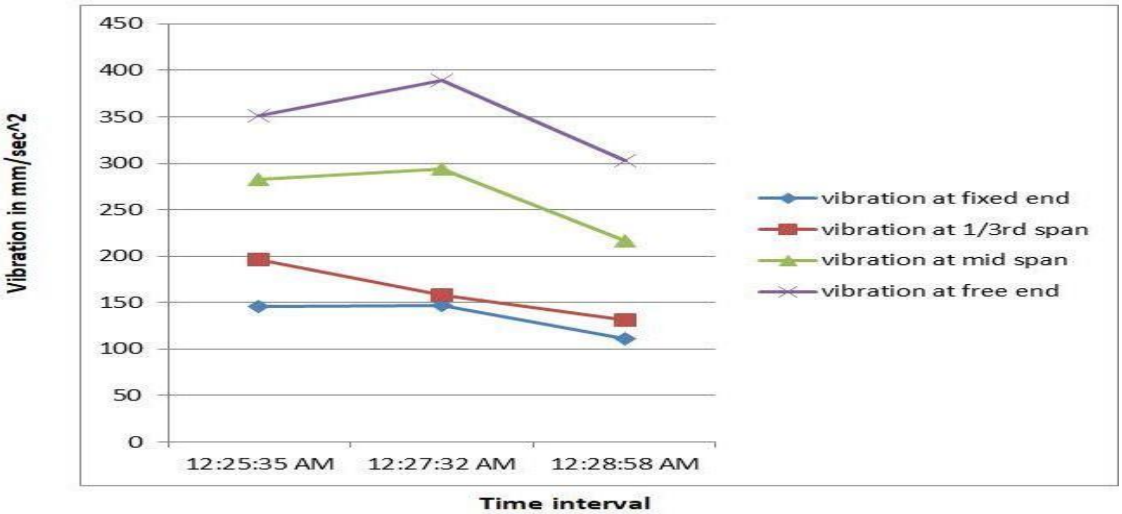


Figure 6: Graph representing the damaged results of beam at different spans

The beam was damaged by making an engraving of 2.5mm at the midpoint of the beam. This graph shows that the damage has surpassed the safe limit of 96mm/sec2 at both places, i.e. at mid span and one third distance. These values were recorded on a remote device, and when the beam crossed its threshold limit, a warning notice was generated. The graphs were recorded for a variety of other positions, and when the sensor was positioned one third of the way from the free end, the graphs showed values greater than the fixed end. The results reveal that when the sensor was placed at the midpoint of the beam, 1.5 times more r data was recorded, although the readings were still beyond the safe limit.

When compared to the sensor positioned at the fixed end, the values of the damaged section are twice as high as

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 6, June 2021

DOI: 10.17148/IARJSET.2021.8669

the undamaged ones. These findings give us a clear picture of the harm that the remote device is indicating. As the vibration is recorded, the numbers grow up to an average of 96mm/sec2. Despite the fact that the numbers were equal to 96mm/sec2, the message displayed a warning indicator to inform the user that the beam was in danger of failing. The damage recorded is over twice as high as the undamaged vibration readings, with the undamaged values averaging 69.24mm/sec2 compared to 318.19mm/sec2 for the damaged readings. Warning messages were issued to the remote device when the results exceeded the safe limit of 96mm. Because of the behaviour of cantilever beams, the damage recorded is almost 1.5 times more than the undamaged vibration readings, i.e. the undamaged readings recorded an average of 124mm/sec2, but the damaged readings recorded an average of 312.65mm/sec2. When the results were above the safe limit, a warning message was delivered to the remote device. The results showed that vibrations in a cantilever beam are always subjected to more vibrations than other sections of the beam when sensors mounted at the free end exceeded the average safe limit, proving that vibrations in a cantilever beam are always subjected to more vibrations than other sections of the beam. . The Blynk app is available for free download on the Google Play Store and the Apple App Store. This programme allows you to examine and download vibrational data, as well as send an alert to the control centre by email, mobile application notification, and an SOS message. It has a number of advantages, including the ability to build super charts with real-time clock recording.

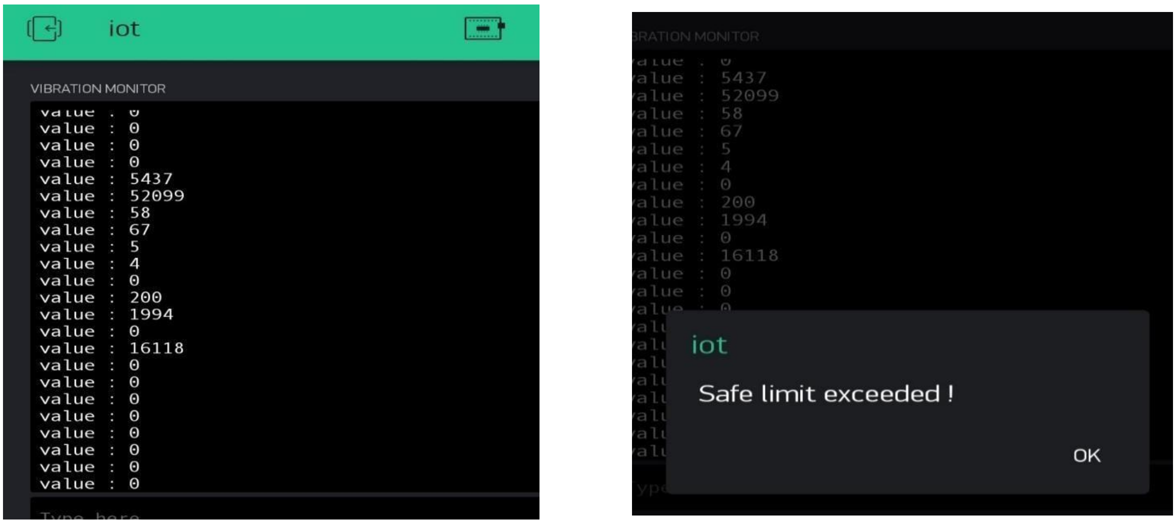


Figure 7: Vibration data recorded on the remote device and the warning signal being shown on the device for exceeding the safe limit of 96mm/sec^2

V.CONCLUSIONS

A full real-time IoT platform for SHM was set up in this research. The platform includes an Arduino Uno microcontroller, a SW420 vibration sensor, and a Wi-Fi module, which were all put on the beam prototype. When the sensors were mounted one third span distance from the fixed end, the vibrations of the damaged beam were almost 0.5 times higher than the vibrations of the undamaged steel beam, but the values remained within the threshold limit, whereas when the sensors were mounted one third span distance from the fixed end, the values were way within their limits, and in trial 3 of damage at mid span and one third span was at its peak safe limit and an alert was recorded. The vibration of the damaged steel beam was nearly 1.5 times larger than the vibration of the undamaged beam at mid- span. When the sensor was attached on the free end, however, data consistently above the threshold limit, even in an undamaged state, whereas damage results were three times the undamaged state readings.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 6, June 2021

DOI: 10.17148/IARJSET.2021.8669

REFERENCES:

[1]. Compressive sensing-based lost data recovery of fast-moving wireless sensing for structural health monitoring; Y. Bao, Y. Yu, H. Li

[2]. High-performance wireless piezoelectric sensor network for distributed structural health monitoring,” International Journal of Distributed Sensor Networks; LS. Gao, X. Dai, Z. Liu, and G. Tian, 2016

[3]. A summary review of wireless sensors and sensor networks for structural health monitoring; J. P. Lynch and K. J. Loh, 2006

[4]. IoTfor structural health monitoring Paolo Francesco sciammarella, Renato sante olivito and Domenico luca carnie 2018

[5]. Structural health monitoring using IOT M.P. Suresh Kumar, G Vennila. 2019 The IOT

[6]. Prabha. A, (2016), “IoT of Civil Infrastructures” International Journal of Research in Advanced Technology, 1(6), pp. 6-9.

[7]. Instantaneous baseline structural damage detection using a miniaturized piezoelectric guided waves system; S. Park, S. R. Anton, J.-K. Kim, D. J. Inman, and D. S. Ha, 2010.

[8]. Use of piezoelectric actuators as elements of intelligent structures; E. F. Crawley and J. De Luis, 1987.

[9]. Health Monitoring of Civil Infrastructures Using Wireless Sensor Networks; S. Kim, S. Pakzad, D. Culler, 2006

[10]. A summary review of wireless sensors and sensor networks for structural health monitoring; J. P. Lynch and K. J. Loh, 2006.

[11]. Deploying wireless sensor networks with fault-tolerance for structural health monitoring; M. Z. A. Bhuiyan, G. Wang, J. Cao, and J. Wu, 2015

[12]. Ahmed Abdelgawad, Kumar Yelmarthi (2016), “Structural Health Monitoring: Internet of Things Application” IEEE 59th International Midwest Symposium on Circuits and Systems (MWSCAS), 16 -19 October 2016, Abu Dhabi, UAE.

[13]. Structural Health Monitoring Framework Based on Internet of Things: A Survey C. Jr. Arcadias Tokognon, Bin Gao, Senior Member, IEEE, Gui Yun Tian, Senior Member, IEEE, and Yan Yan,2017

[14]. BrindaChanv, Sunil Bakhru, Vijay Mehta (2017), “Structural Health Monitoring System Using IOT and Wireless Technologies,” International Conference on Intelligent Communication and Computational Techniques (ICCT) Manipal University Jaipur, pp. 151- 157.

[15]. Carmelo Scuro et al (2018),” IoT for Structural Health Monitoring,” IEEE Instrumentation & Measurement Magazine, pp. 4-14.

[16]. J. S. Hall and J. E. Michaels, “Multipath ultrasonic guided wave imaging in complex structures,” Structural Health Monitoring, vol. 14, no. 4, pp. 345–358, 2015.

[17]. D. Dai and Q. He, “Structure damage localization with ultrasonic guided waves based on a time-frequency method,” Signal Processing, vol. 96, pp. 21–28, 2014.

[18]. R. C. Tennyson, A. A. Mufti, S. Rizkalla, G. Tadros, and B. Benmokrane, “Structural health monitoring of innovative bridges in Canada with fiber optic sensors,” Smart Materials and Structures, vol. 10, no. 3, pp. 560–573, 2001.

[19]. J. P. Amezquita-Sanchez and H. Adeli, “Signal processing techniques for vibration-based health monitoring of smart structures,” Archives of Computational Methods in Engineering, vol. 23, no. 1, pp. 1–15, 2016

[20]. H. Zhang, J. Guo, X. Xie, R. Bie, and Y. Sun, “Environmental effect removal based structural health monitoring in the internet of things,” in Proceedings of the 7th International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS ’13), pp. 512–517, July 2013.

[21]. L.-S. Huo, X. Li, Y.-B. Yang, and H.-N. Li, “Damage detection of structures for ambient loading based on cross correlation function amplitude and SVM,” Shock and Vibration, vol. 2016, Article ID 3989743, 12 pages, 2016

[22]. D. Samaratunga, R. Jha, and S. Gopalakrishnan, “Wave propagation analysis in laminated composite plates with transverse cracks using the wavelet spectral finite element method,” Finite Elements in Analysis and Design, vol. 89, pp. 19–32, 2014

[23]. A. Hera and Z. Hou, “Application of wavelet approach for ASCE structural health monitoring benchmark studies,” Journal of Engineering Mechanics, vol. 130, no. 1, pp. 96–104, 2004.

[24]. Chandanshive, Viren & Kazi, Arbaz. (2017). “Application of Internet of Things in Civil Engineering construction projects-A State of the Art”. IEEE Conference ID: 40353. 2017 4th international conference on “computing for sustainable global development “, 01st -03rd march 2017.