

**DAMAGE DETECTION IN HERITAGE BUILDINGS USING WIRELESS
SENSOR NETWORK**Saloni Rathod¹ and Kalpesh Chaudhary²^{1,2}*Department of Electronics and Communication Engineering Gujarat Technological University Ahmedabad,
Gujarat, India.*

Abstract: Old monuments and heritage buildings are important assets of the country and need to be protected and conserved. Heritage structures are often characterized by their extraordinary architecture, design or material. The conservation of such structure is crucial activity. The paper deals with the monitoring and static risk assessment using the technique of dynamic parameter measurement in a broad WSN system. The historical building exposed to the traffic vibration, which can induce stresses inside the material, as well as small seismic actions are vulnerable. Monitoring and vibration risk assessment using WSN(wireless sensor network) system provides data gathering and decision making before, during and after crisis event. The work deals with deploying wireless sensor network (contains MEMS sensor) monitors damage in heritage building. The above shall be accomplished by hardware implementation (prototype). The monitoring will be done by RF technology. The complete study would be based on Sarkhej Roza, Ahmedabad.

Keywords: heritage building, WSN, MEMS sensor, RF technology

I. INTRODUCTION

Old monuments and heritage buildings are important assets of the country and need to be protected and conserved for their rich technical skills and building materials. Heritage buildings and old monuments are the pride of our nation as they depict the glorious past and social life of ancient days. And they are fundamental constituent of a country's historical memory. Their preservation is thus a major concern.

Maintenance of the national and worldwide architectural heritage buildings is one of the central issues. Historical buildings, mostly due to the age, are placed at significant risk, for the effects of thermal variations and, especially, to dynamic actions like those produced by earthquakes, traffic induced vibrations or wind.

Wireless sensor networks (WSNs) enable radically different solutions overcoming the above limitations. Small, self-powered nodes relying on radio communication reduce the invasiveness of the system, allow the deployment of more devices, and enable experimenting with different configurations of the sensing infrastructure. The usage of Wireless Sensor Networks allows for a pervasive observation over the sites of interest in order to minimize the potential damages that natural phenomena may cause to architectural or engineering works.

In my proposed work, WSN will develop. And the sensor nodes are deployed on heritage building to monitor damage detection due to heavy vibration of damage can be send to remote user.

Ahmadabad is one of oldest cities in India and known as world's heritage city. and as it contains so many heritage buildings it requires proper monitoring. I have selected sarkhej roza as my study area. this heritage is about 585 years old.



Figure 3.2 : Damages found in sarkhej Roja ^[12]

There are so many factors that affects the heritage buildings. And in that vibration is a most crucial parameters. Source of vibration are counting street and rail activity, sonic blast, development vibrations, impacting and seismic tremors, wind sea waves. Vibration due to rail activity is that structure of old monuments turns subject of concern in late decades

Anyway, vibration is the most urgent parameter that is in charge of harm in legacy. Undemeath are some conceivable hams in legacy constructing because of vibration. cracks in mortar, slackening of rooftop tiles, Cracks in dividers and lintels, falling roof mortar, Leading to potential pulverize.

Objective

- Prototype development
- Development of efficient node that senses and converts real world signals to digital signals that consists vibration MEMS sensors.
- Manipulation of the number of nodes required and node positioning.
- Development of two vibration sensor node and master node.
- Interconnection of nodes and determination of master and sensor nodes.
- Communication between the nodes using RF technology for damage detection and required action.
- Real data analysis at SARKHEJ ROZA.
- Data analysis done in MATLAB.
- Manipulation of the data and compatibility with study sites.
- GUI development .

II. IMPLEMENTATION

A. Layer wise architecture

Here different size of controller are chosen because sensor node would be small in size is necessary to put on pipe. PIC18LF1508 is come with small size and enough memory.

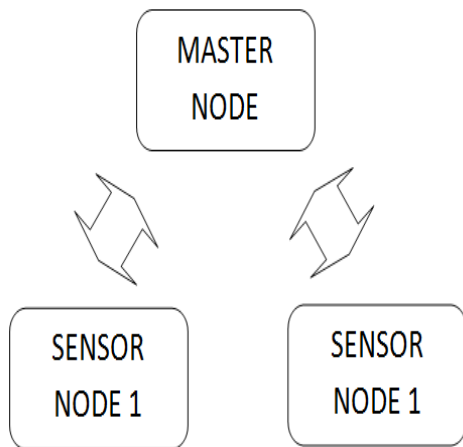


Figure 2.3 : Prototype Structure and sensor node

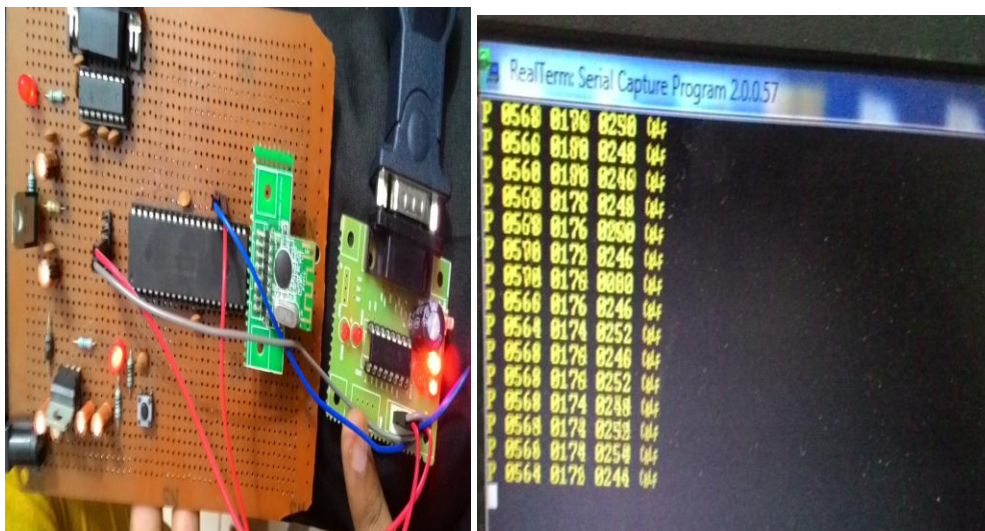
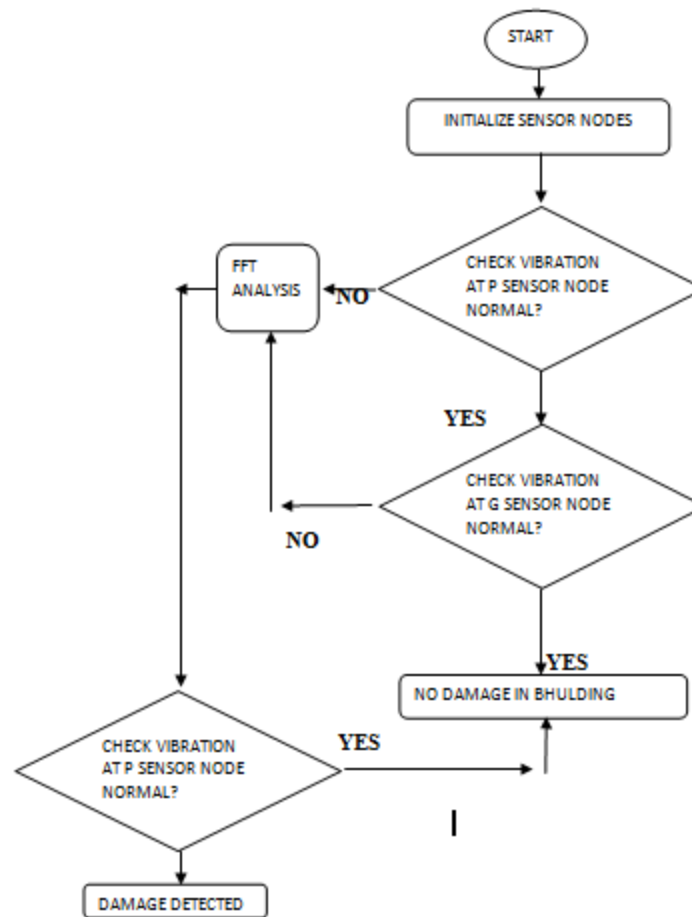


Figure 2.4 : Master node and data acquisition

III. DAMAGE DETECTION ALGORITHM

The algorithm shown below determines the situation around the sensor node. First of all, it checks the vibration at sensor node 1, if it is less than the predetermined lower threshold then it will check for the sensor node 2, if it is less than the predetermined lower threshold then it will display 'no damage in building' And if the vibration is higher than the predetermined upper threshold then it will given to FFT analysis to remove noise. After doing FFT analysis it will check the condition again of threshold value if it is less than the predetermined lower then it displays, 'NO DAMAGE DETECTED'. If the vibration is higher than the predetermined upper threshold then it displays DAMAGE DETECTED.



IV. RESULT

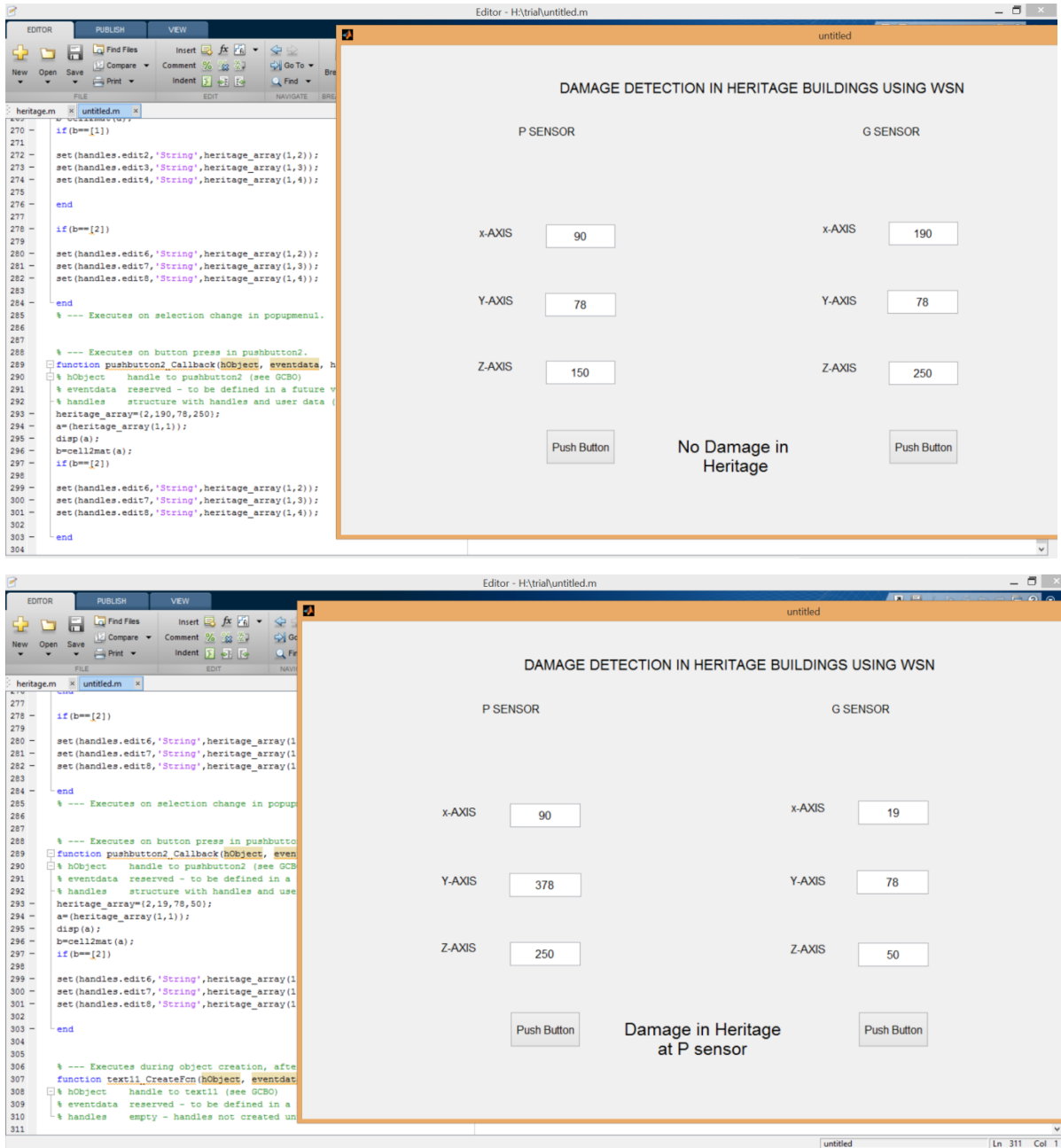


Figure 3.1: Results in GUI

Here for the purpose of self designed hardware the assembly designing was not done. So if the nodes are designed using assembly hardware in bulk the estimated cost of each sensor node turns out to be of onetime cost of deploying sensor nodes in 1 km stretch is approximately Rs. 40,000/- which is affordable compared to using cameras because if we use camera then one camera is of 35,000 .At some places wired sensor network .that makes system bulky so wireless sensor network deployment is more preferred than other system

V. CONCLUSION

An efficient damage detection system is an unavoidable infrastructure. In a developing country like India, where heritage construction more than other countries so, better scope of digitizing in the heritage buildings.

An appropriate technology that suites the Ahmadabad heritage a proposed model based on wireless sensor network using RF technology have been suggested for localized area, SARKHEJ AREA. A system can thus be established based on the proposed prototype using hybrid WSN. The system has the advantage of providing real time data of the damage in heritage buildings through vibration sensors. The system thus proves a decision support system for local government to tackle damages issues .

REFERENCES

- [1] Mr. Hoang Duc Chinh and Dr. Yen Kheng Tan, Smart Wireless Sensor Networks; InTech , Janeza Trdine 9, 51000 Rijeka, Croatia, 2010, pg. 29.
- [2] Waltenegus Dargie and Christian Poellabauer, Fundamentals of Wireless Sensor Networks, Wiley Series on Wireless Communications and Mobile Computing, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom, 2010, pg. 4-5.
- [3] Waltenegus Dargie and Christian Poellabauer, Fundamentals of Wireless Sensor Networks, Wiley Series on Wireless Communications and Mobile Computing, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom, 2010, pg. 47-48.
- [4] Domenico Balsamo, Giacomo Paci, Luca Benini and Davide Brunelli , 'Long Term, Low cost, Passive Environmental Monitoring of Heritage Buildings for energy Efficiency retrofitting' , Environmental Energy and Structural Monitoring Systems (EESMS), 2013 IEEE Workshop on, pages 1-6, 2013
- [5] Fabrizio D'Amato, Paolo Gamba, and Emanuele Goldoni, 'Monitoring heritage buildings and artworks with Wireless Sensor Networks', in Proc. of 2012 IEEE Environmental Energy and Structural Monitoring Systems, EESMS 2012, 28 September 2012, Perugia, Italy, pp. 1-6.
- [6] M. C. Rodríguez-Sánchez, S. Borromeo, J. A. HernándezTamames, 'wireless sensor networks for conservation and monitoring cultural asset , IEEE sensor journal 11(6), pp. 1382-1389(2011).
- [7] A. Abrardo, L. Balucanti, M. Belleschi, C. Carretti, and A. Mecocci, 'Health monitoring of architectural heritage: the case study of San Gimignano', IEEE Workshop on Environmental Energy and Structural Monitoring Systems (EESMS), 2010, September 2010, pp. 98-102.
- [8] Jingcheng Zhang, Allan Hyunh, Qinzhong Ye, Shaofang Gong, 'Cultural Bee - A Fully Wireless Monitoring and Control System for Protecting cultural Heritage', 2011 IEEE workshop , pp. 250-255.
- [9] Luca Bencini, Giovanni Collodi, Davide Di Palma, Gianfranco Manes, Antonio Manes , 'An Embedded wireless sensor network system for cultural heritage monitoring', 2010 Fourth International Conference on sensor technologies and application, pp. 185-190.S
- [10] D. Abruzzese , M. Angelaccio , B. Buttarazzi , R. Giuliano , L. Miccoli , A. Vari, 'Long life Monitoring of Historical Monuments via wireless sensor network', ISWCS 2009, pp. 570-574.
- [11] M. Ceriotti, L. Mottola, G. P. Picco, A. L. Murphy, S. Guna, M. Corra, M. Pozzi, D. Zonta, and P. Zanon, 'Monitoring heritage buildings with wireless sensor networks: The Torre Aquila deployment ', 2009 International Conference on Information Processing in Sensor Networks, IPSN '09, 2009, pp. 277-288.
- [12] Ahmadabad Municipal corporation , Archaeological department, sarkhej Roza, Ahmedabad.