An Adaptive Method for Monitoring the Quality of a Structure

D.Sivakumar, B.Balan, K.Fathima Naseem, Dhivya.T, R.Gayathri

Abstract: ***The process of monitoring the quality of a buildng structure is implemented to avoid unnecessary damages to the structures as well as human lives that are lost due to accident. Countries all over the world are involved in constructing large buildings and infrastructures. All structures including bridges and highways deteriorate with time due to various reasons including fatigue failure caused by heavy traffic loads and severe environmental conditions. This method is implemented for damge detection and hence it ensures safety of several lives. This monitoring technique is implemented for detecting the damages that occurs due to cracks and vibration. This damage grows periodically either due to mixture of composite materials in structures or due to any environmental disasters. After detection of cracks and vibration using these sensors, the data is stored and the information is immediately transmitted to the authorized person[1].Thus, it is fondly called as an adaptive method for monitoring the quality of a building structure.***

Index Terms: Structural health; Sensors; Structures and buildings

I. INTRODUCTION

The method of identifying damage is a strategy applied in civil, mechanical and even aerospace infrastructures termed as Structural Health Monitoring.All structures including many civil structures that posses a critical infrastructure such as bridges and highways, get damaged with time due to several reasons which may be due to a severe failure that has been caused due to heavy traffic loads, severe environmental issues and due to many natural disasters such as earthquakes etc.

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., So , for this purpose we do not require any routine or critical event –based monitoring(such as an earthquake), rather we can go for a simple continuous structural monitoring to assess the changes as a function of time and this can also be used as warning prior to an unsafe condition based upon this real-time data[3][4]. SHM method, such as Non-Destructive Evaluation (NDE), could be active or passive. It provides the possible scenario wherein both the experimenter and structure that has to be examined are involved. The structure is provided with sensors for damage detection. If the experimenter monitors for the damage using embedded sensors, then the process is termed as monitoring the system in passive manner. If the structures implement both sensors and actuators for monitoring the structure, this method is known as "active monitoring". Those days engineers used wired sensor networks for this purpose which were only feasible for long-term applications where the quality plays an important role. The abrupt reduction in the cost of using wireless sensors for SHM makes their use as importamt as that in both public and private structures thus increasing their applications termed as "short-term monitoring of the structures". Sensor nodes collect all raw data available from the sensor module and the data gets processed and transmitted to other sensor nodes. The datum is exchanged among the sensor nodes and the other nodes. Also a co-ordination is maintained among the nodes for a strong synchronization. The data is carried from the nodes to the base stations and all the data is stored for future analysis. But the limitations of wired sensors are, these networks drag the battery power and, as a result, the limiting factor is their entire lifetime will be its battery lifetime.There is a severe installation complexity and messy wires, which are its major drawbacks. This requires calibration and it is meant for only for monitoring. High installation costs. It takes very long time for deployment. To overcome these limitations we go for WSN(wireless sensor networks), where qquality of the building is measured using ADXL330 sensor and vibration sensors using ArduinoMEGA.Vibration in the structure is detected and monitored using vibration sensors and messages are transmitted to the authorized person as an immediate response. Data is stored in Excel sheets for future purpose and analysis using PLX software. Cracks can be detected using IR sensors and if any tilt is detected accelerometers monitors those tilts in the corresponding axes and thus the data is stored

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is stored in excel sheet with date and time for future analysis. In previous systems the sensors are fixed in various structures such as vechicles, buildings etc., to detect the damage caused due to corrosion, vibration or cracks. However the main challenge was, acquisition of data, data compression, detection of damages, and these systems involves application-specific dependability [2]. The system cannot change according to the application and hence here we have proposed a new system that employs three different sensors for three different applications.

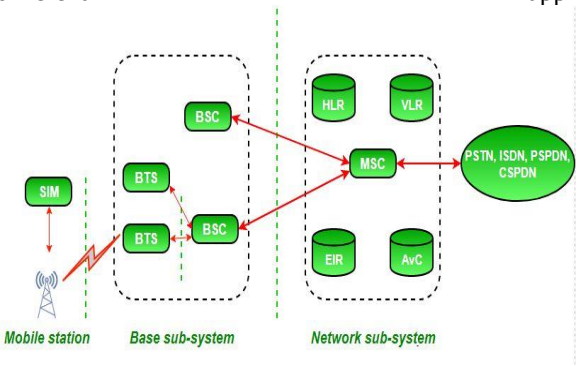

Fig. 1 GSM MODULE

II. WIRELESS STRUCTURAL QUALITY MONITORING SYSTEM:

Structural health Monitoring system has gained a highest priority, as structures constructed these days are of low quality and there occurs the mixing of composite materials that makes structural monitoring a mandatory one. Here we use structural monitoring using wireless sensors such as vibration sensors, accelerometers, IR sensor and a GSM module[5]. When a vibration or crack has been detected in the structure, vibration sensor starts inducing vibration and an immediate message is transmitted to the authorized person via GSM. Similarly, a crack when detected IR sensor takes the authority and sends an input to the GSM module and thus the message indicating 'crack detected' will be sent to authorized person. On the other hand, this system is also meant for storing the data of vibrations and cracks in an excel software (PLX software) for the future reference. Also accelerometer has been implemented in this work to determine if any tilt occurs in the building and finally output is sent and stored. Thus the proposed system is purposely implemented for better quality monitoring of a structure and thus it has been proved that a digitized world is emerging with new innovative ideas and this system proves to be one among them. This system can be implemented with certain hardware and software components as mentioned above and they are as follows:

- ARDUINO MEGA
- VIBRATION SENSOR (2)
- IR SENSOR
- LCD
- GSM
- ACCELEROMETER SENSOR
- 12V ADAPTER
- A2B CABLE

A.Arduino mega: This is a microcontroller which is subjected to ATmega2560. It contains everything expected to help the microcontroller; Arduino mega has 54 information pins out of which 15 is used for PWM yields, 16 is for direct data source, 4 for UARTs, an USB alliance, an oscillator, and a reset switch. It is interfaced to a Personal computer or laptop with a USB connection or it is given power with an AC-DC connector. It can also be powered using batteries to start. The arduino 2560 board is flawless.

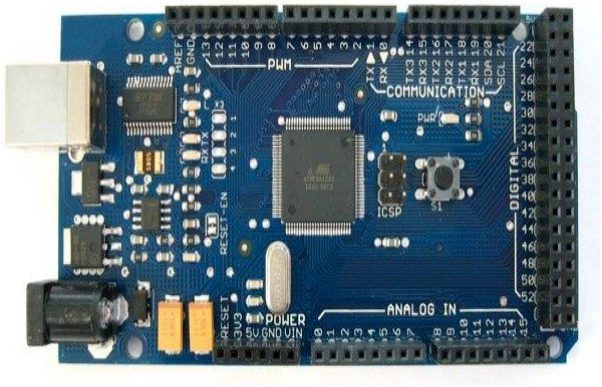

Fig. 2 ARDUINO MEGA

B. Vibration sensor: Vibration sensors are those that are used to measure vibrations in the form of displacement, velocity and acceleration. These sensors are implemente to analyse, meaure and display vibration that cannot be noticed by human sense. These sensors are in the form of accelerometers and their sensitivity ranges between 10-100 mV/g. Here we have implement pin and spring type vibration sensors.

C. IR sensor: IR sensor can be used to check the glow of an object and it can also recognize the development. These types of sensors gauges a simple infrared radiation, rather than releasing and hence it is termed as a standoffish Infrared sensor. Regularly under IR range, all of the articles transmit some kind of warm radiations. These sorts of radiations are impalpable to our eyes, which can be recognized by an infrared sensor. The maker is fundamentally an IR LED (Light Emitting Diode) and the locator is basically an IR photodiode which is delicate to IR light of vague wavelength from that released by the IR LED. Right when IR light falls on the photodiode, The insurances and these yield voltages, change in degree to the span of the IR light got[8].

D. LCD (Liquid Crystal Display): LCD is an electronic module which is implemented for displaying outputs in various appliactions. Here we use 16x2 LCD which can display 16 characters in one line and it has 2 such lines in it. Most of its applications include televisions, PC, devices such laptops and smartphones etc., The principle behind its working is that, LCD's blocks light rather than emitting it.An LCD consists of mirrors, a piece of glass along with a

polarizing film, a common a electrode plane made of indium-tin oxide. Above all is present a substance called liquid crystal substance.

D. Pin Diagram:

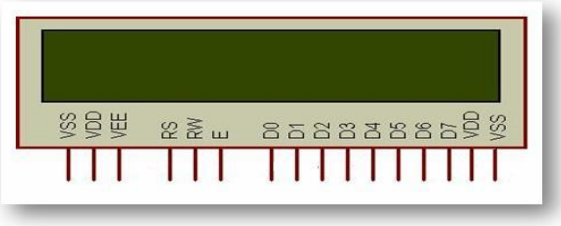

Fig. 3 LCD

E. GSM modem: This is a special type of modem that can accept a SIM card. It is operated by subscribing a mobile network as like in a mobile phone. GSM was one termed as groupe special mobile, but now it is abbreviated as Global system for Mobile communication. A SIM card which is mounted with GSM modem now receives a message known as SMS(short message service) from any mobile phone that has been connected with GSM. AT commands are abbreviated as Attention commands, which are implemented to control a modem. All the command line starts with AT or 'at' and hence modem commands are often termed as AT commands. GSM is a digital techniques that use narrowband TDMA. This technology is used for transmitting data signals and voice signals.

Fig. 4 GSM MODEM

F. System Architecture:

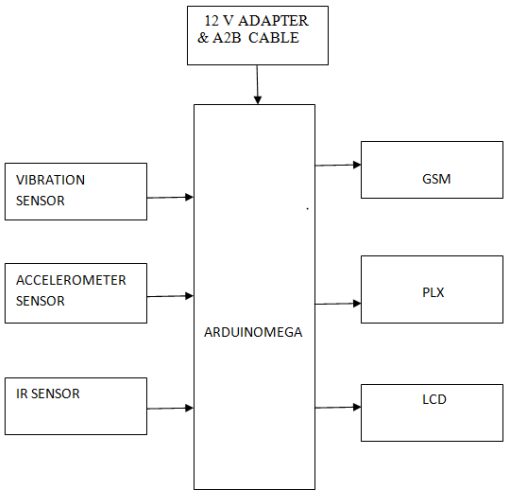

Fig. 5 SYSTEM ARCHITECTURE

III. RESULTS AND OUTPUTS

IR sensor detects the cracks occurring in the structure and displays 'CRACK DETECTED' in the LCD module.

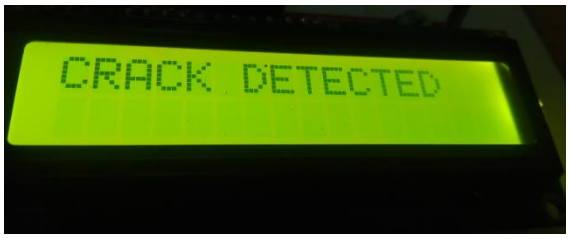

FIG. 6 LCD OUTPUT

If the structure undergoes any tilt, then accelerometer sensor comes into picture which implements three directions namely X,Y and Z where Z is the combination of X and Y. If the structure is getting tilted in any of these directions, then accelerometer sensor detects it immediately and displays it in theLCD module as 'TILTED IN XDIRECTION' or 'TILTED IN Y DIRECTION', accordingly.

FIG. 7 LCD OUTPUT

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FIG. 8 GSM OUTPUT

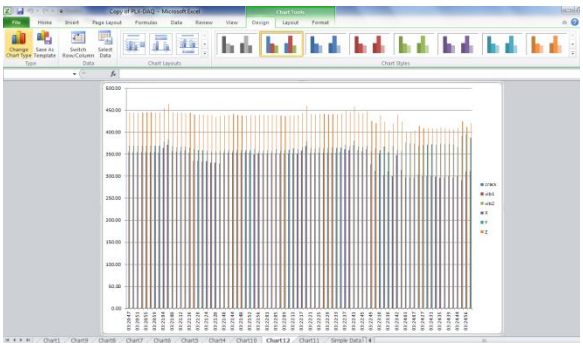
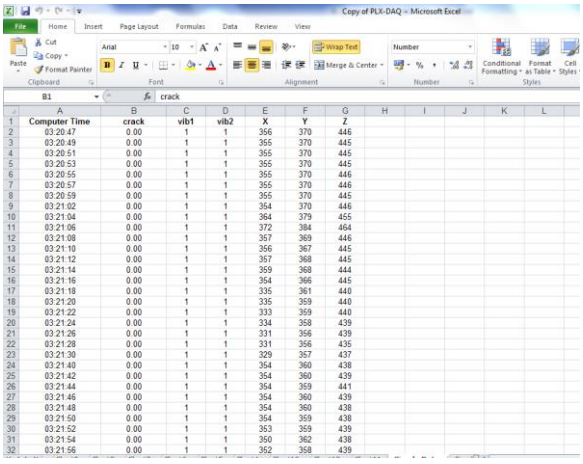


FIG. 9 PLX DATA PLOT



	A	B	C	D	E	F	G
1	Computer Time	crack	vib1	vib2	X	Y	Z
2	03:20:47	0.00	1	1	356	370	446
3	03:20:49	0.00	1	1	355	370	445
4	03:20:51	0.00	1	1	355	370	445
5	03:20:53	0.00	1	1	355	370	445
6	03:20:55	0.00	1	1	355	370	446
7	03:20:57	0.00	1	1	356	370	446
8	03:20:59	0.00	1	1	355	370	445
9	03:21:02	0.00	1	1	354	370	446
10	03:21:04	0.00	1	1	364	379	455
11	03:21:06	0.00	1	1	372	384	464
12	03:21:08	0.00	1	1	357	369	446
13	03:21:10	0.00	1	1	356	367	445
14	03:21:12	0.00	1	1	357	368	445
15	03:21:14	0.00	1	1	359	368	444
16	03:21:16	0.00	1	1	354	366	445
17	03:21:18	0.00	1	1	335	361	440
18	03:21:20	0.00	1	1	335	359	440
19	03:21:22	0.00	1	1	333	359	440
20	03:21:24	0.00	1	1	334	358	439
21	03:21:26	0.00	1	1	331	356	439
22	03:21:28	0.00	1	1	331	356	435
23	03:21:30	0.00	1	1	329	357	437
24	03:21:40	0.00	1	1	354	360	438
25	03:21:42	0.00	1	1	354	360	439
26	03:21:44	0.00	1	1	354	359	441
27	03:21:46	0.00	1	1	354	360	439
28	03:21:48	0.00	1	1	354	360	438
29	03:21:50	0.00	1	1	354	359	438
30	03:21:52	0.00	1	1	353	359	439
31	03:21:54	0.00	1	1	360	362	438
32	03:21:56	0.00	1	1	362	358	439

FIG. 10 PLX DATA SHEET

IV.CONCLUSION AND FUTURE WORK

This method provides a technique to detect the damages in building which leads to loss of lives and properties due to accidents that occur as buildings fall because of disaster or composite materials. As advanced data processing, evaluation concepts and new sensor technologies has developed this technique is simple to be adopted. Here we do structural monitoring using wireless sensors such as vibration sensors, accelerometers, IR sensor and a GSM module[6]. When a vibration or crack has been detected in the structure, vibration sensor starts inducing vibration and an immediate message is transmitted to the authorized person via GSM. Similarly, a crack when detected, IR sensor takes the authority and sends an input to the GSM module and thus the message indicating 'CRACK DETECTED'. In the present work, this module is meant for detecting damages in structures. A new system has to be proposed in future for both detection and correction of damages that has been detected prior. In future new systems should be proposed with more vibration sensors which can be used for detecting the safety level for constructing basement, thus avoiding unnecessary damages and loss of human lives.

V. AUTHOR DETAILS

I [1]Dr. D. Sivakumar**,** currently working as a Professor, Department of Electronics and Communication Engineering, SRM Easwari Enginering college,Chennai. I have a vast experience of over 23 years in the field of engineering, academics, administration and active research. I am an alumnus of Madras University, Annamalai University and Anna University, Chennai.

I have technical expertise spans in the area of MANET, wireless sensor networks, Wireless Mesh Networks, Mobile computing, Mobile Network Architecture Network Security and Intelligent Networks.

I have about 66 research publications to his credit in reputed international journals and about 75 conference proceedings. I have authored book pertaining to Information Technology. I have served as a doctoral level research supervisor in Anna University and Sathyabama University, Chennai. I have produced three Ph.D. holders so far. I am also a doctoral committee member in these universities[7].

I served as a reviewer for the reputed Elsevier International Journal of Mobile communication and china communication journal. I have filed two patents in the area of Antenna design and analysis. I have conducted many workshops, seminar and both international and national conference in his tenure. I have got best paper presenter award **at international conference** received from Computer society of India during CSI convention " Digital connectivity-social impact, **Outstanding faculty award** in the field of wireless mobile Adhoc Networks for my constant research contribution.Award has been given by Venus International Research Foundation during contemporary academic meet and Got award for getting maximum project funding from Central Government of India at Adhiparasakthi Engineering.

I am a recipient of the AICTE's research funding of INR 18 lakhs to do the active research in the area of wireless networks.

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[2]K.Fathima Naseem, [3]Dhivya.T, [4]R.Gayathri currently pursuing Bachelors in Electronics and Communication Engineering in Easwari Engineering College.

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