STRUCTURAL HEALTH MONITORING FOR AIRCRAFT STRUCTURES

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ABSTRACT

The process of implementing a damage identification strategy for aerospace, civil and mechanical engineering infrastructure is referred to as structural health monitoring (SHM). Here, damage is defined as changes to the material and/or geometric properties of these systems, including changes to the boundary conditions and system connectivity, which adversely affect the system's performance. Sensors are used to identify and even localize damage within the structure. Microcontroller is used to read the data which is obtained from the sensors. This data is transmitted wirelessly through antenna to the receiver where again the data is read from the micro controller. Then the damages found are displayed on the LCD

.INTRODUCTION

The process of implementing a damage identification strategy for aerospace, civil and mechanical engineering infrastructure is referred to as Structural Health Monitoring (SHM). Here, damage is defined as changes to the material and/or geometric properties of these systems, including changes to the boundary conditions and system connectivity, which adversely affect the system's performance. In the most general terms, damage can be defined as changes introduced into a system that adversely affects its current or future performance. Implicit in this definition is the concept that damage is not meaningful without a comparison between two different states of the system, one of which is assumed to represent the initial, and often undamaged, state. This theme issue is focused on the study of damage identification in structural and mechanical systems. Therefore, the definition of damage will be limited to changes to the material and/or geometric properties of these systems, including changes to the boundary conditions and system connectivity, which adversely affect the current or future performance of these systems. In this paper the sensor used here is PZT sensor. The piezoelectric material i.e. PZT was chosen, because it is a well-known and well characterized material with a high piezoelectric coefficient. Due to their inherent ability to detect vibrations, piezoelectric materials have become a viable energy scavenging source. Currently a wide variety of piezoelectric materials are available and the appropriate choice for sensing, actuating, or harvesting energy depends on their characteristics.

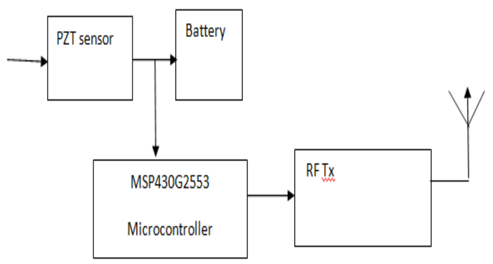
LITERATURE SURVEY

The detection and identification of damage/delamination in aerospace, civil and mechanical engineering infrastructure is called as Structural Health Monitoring (SHM). Due to the damage there will be changes in the structure or composite material hence this has to be detected at an early stage. Damage can be identified by comparing between two different states of the structure. By integrating the SHM in the structure, the accidents can be avoided.

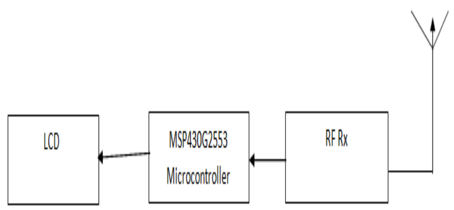
The two methods called Electro Mechanical Impedance (EMI) and guided wave are used to identify and detect the damage found in the structure. The combination of these two methods has more advantages in detecting the damage then compared to other methods

[1]. The Acoustic Emission (AE) method has been used widely in SHM systems which can be distinguished by changes in the structural properties. Poling process is one of the AE method which is easier to detect the damage then compared to other method [2]. The material called Carbon Fibre Reinforced Plastics (CFRP) is used because of their good stiffness and is placed in aeroplanes. Indicators are used for the detection of the damage. The piezo-sensor package is used for the testing of the SHM systems [3]. The technology called ceramic multilayer is used forming a package of PZT in LTCC sheet which helps in producing ultrasonic transducers and also helps to fight against the environmental issues [4]. By analysing the Compact Tension (CT) and Middle Tension (MT) the crack in the aluminium alloy can be identified by using the NDE techniques and mechanical loads [5].

IMPLEMENTATION



BLOCK DIAGRAM OF TRANSMITTER



BLOCK DIAGRAM OF RECEIVER

Battery used here is self powered battery, one option for powering a system is to harvest energy from sources such as vibration. This source is obtained from typical aircraft vibrations. These vibrations are sensed from sensors. Battery is self powered by these vibrations.

Sensors are used to identify and even localize damage within the structure. Microcontroller is used to read the data which is obtained from the sensors. This data is transmitted wirelessly through antenna to the receiver where again the data is read from the micro controller. Then the damages found are displayed on the LCD.

MODES OF VIBRATIONS

A complex body can vibrate in many different ways, each having its own frequency. The frequency can be determined by the moving mass in that mode and the restoring force which tries to return the specific distortion of the body back to its equilibrium position. When any complex body vibrates there is no one “simple harmonic oscillator”, as a reason many modes are excited and vibrate together. The shape of vibration is very complicated and changes from one instant to another and also, it is difficult to determine the shape of the modes. However, by using resonance both the frequency and the shape of the mode can be obtained. If vibration is given to a body to the nearest resonance frequency of the mode then that mode responds. If a beam with tension is vibrated, the beam has the variety of modes of vibration with different frequencies. For the energy harvesting system using sensors, three modes of vibrations are used as discussed below.

Mode 1

In this mode, low frequency is used. The lowest frequency is a mode where the whole beam just oscillates back and forth as one- with the greatest motion in the center of the beam. In mode 1 , the shape of the mode is at its maximum vibration in one direction and is shown in Fig. (a).

Mode 2

In this mode, the frequency of the vibration is increased to twice the mode 1 frequency. As the frequency is increased, it is seen that the beam again vibrates back and forth but in a different shape than the previous one. Here, the two halves of the beam vibrates in opposite direction to each other. One half vibrates down and the other moves up and vice versa and is shown in Fig. (b).

Mode 3

In mode 3, the frequency is increased to thrice the mode 1 frequency and it is seen that the vibrations are large, that is vibrating at the resonant frequency of third mode. In this mode the hump is divided equally where each vibrating length is opposite to the adjacent piece as shown in Fig. (c).

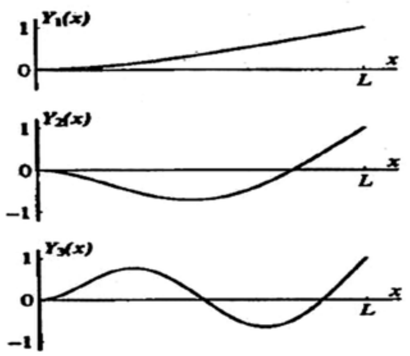
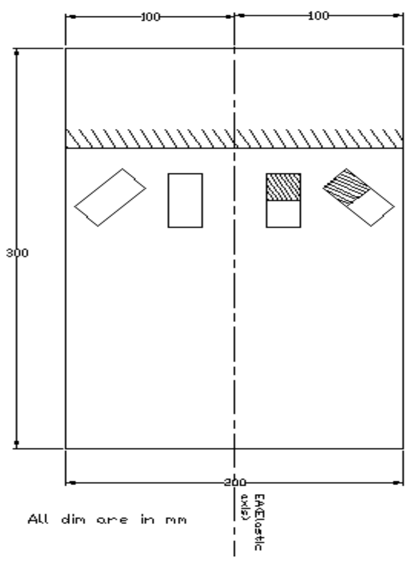


Fig: **Modes of Vibration (a) Mode 1, (b) Mode 2, (c) Mode3**

SPECIMEN

The figure shows the specimen (structure) in which the electrical isolation of the specimen taken care by adding the teflon tapes in between the fixture to ensure the isolation. The PZT 5H sensors fixed on the structure were also isolated electrically for the fixture and the specimen. The capacitance of the sensors is measured by using LCR meter key sight U1733C. The resistance is measured by using FLUKE 87 V true RMS multimeter in resistance mode found open circuit resistance for the structure and the fixture root.



RESULTS

The capacitance of the sensor measured at different frequencies is shown in below table

	100Hz	1KHz	10KHz	100KHz
H(0)	38.47nF	38nF	33.76nF	36.05nF
H(45)	39.09nF	38.58nF	34.97nF	33.92nF
D(0)	45.03nF	44.27nF	43.98nF	24.94nF
D(45)	44.45nF	44.05nF	43.45nF	26.74nF

Mode 1

Frequency= 30.100Hz Force= 352 mV

H(0)= 6.2V

H(45)= 3.9V

D(0)= 1.8V

D(45)= 2.6V

Mode 2

Frequency= 65.50 Force= 224mV

H(0)= 534 mV

H(45)= 146 mV

D(0)= 495 mV

D(45)= 51.3 mV

Mode 3

Frequency= 184.38 Force= 50 mV

H(0)= 342.9 mV

H(45)= 160.5 mV

D(0)= 245.5 mV

D(45)= 22.6 mV

Mode 4

Frequency= 207.20 Hz Force= 44mV

H(0)= 225.5 mV

H(45)= 123.8 mV

D(0)= 206.9 mV

D(45)= 22.1 mV

CONCLUSION

In this paper we have discussed about SHM and how to detect the damage found in structure. The initial test are done to find the capacitance of sensors.

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