Development of FFT Analyzer for measuring Vibration

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***Abstract*— The paper presents Automotive componants for measuring vibration by using Micro Electro Mechanical Systems (MEMS) Sensors And Arduino Megha2560. The ADXL345 with 3-DOF including 3-axis accelerometer uses data transmission through cheap microcontroller boards and send commands and receive data in real-time with different sampling rates. Vibration signals of MEMS are analyzed by fast fourier transform(FFT) algorithm under the frequency spectrum to predict fundamental frequency. Due to the complex properties of acoustic signals, effective features for fault detection cannot be easily extracted from the raw acoustic signals. To solve this problem, Fast Fourier Transform (FFT) is utilized.**

Keywords— **Arduino Megha 2560, ADXL345, FFT(Fast Fourier Transform), Vibration Measurement.**

I. INTRODUCTION

Fourier's theorem states that any waveform in the time domain can be represented by the weighted sum of sines and cosines. The FFT spectrum analyzer samples the input signal, computes the magnitude of its sine and cosine components, and displays the spectrum of these measured frequency components.

For one thing, some measurements which are very hard in the time domain are very easy in the frequency domain. Consider the measurement of harmonic distortion. It's hard to quantify the distortion of a sine wave by looking at the signal on an oscilloscope. When the same signal is displayed on a spectrum analyzer, the harmonic frequencies and amplitudes are displayed with amazing clarity. Another example is noise analysis. Looking at an amplifier's output noise on an oscilloscope basically measures just the total noise amplitude. On a spectrum analyzer, the noise as a function of frequency is displayed. It may be that the amplifier has a problem only over certain frequency range. In the time domain it would be very hard to tell [7].

Many of these measurements were once done using analog spectrum analyzers. In simple terms, an analog filter was used to isolate frequencies of interest. The signal power which passed through the filter was measured to determine the signal strength in certain frequency bands. By tuning the filters and repeating the measurements, a spectrum could be obtained [8].

The FFT spectrum analyzer is an invaluable tool for mechanical engineers in today's world of measurement and analysis of mechanical systems. FFT analyzers are an essential tool in such fields as vibration and shock data analysis, machinery monitoring and analysis of complex waveforms. Use of the FFT analyzer is required in many industries, including military, transportation, aerospace, manufacturing and consumer products. Many mechanical engineers today make careers in the fields of vibration and machinery analysis; the knowledge of principles and applications of the FFT analyzer is essential for these disciplines [8].

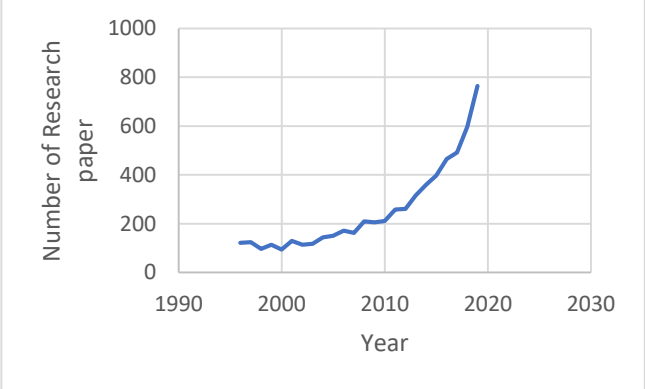

Fig. 1 Research on FFT analyzer in last 25 year

II. LITERATURE REVIEW

Mohan Kumar G R et.Al.[3] The scope of the project is to observation on the recent trends and latest growth in the ground of experimental modal analysis. First, to take out the FEM technique, the car door is created by using software called CATIA V5 R20 and analysis is carried out using software called Hyper works 12.0, FEM technique is done by free- free analysis method to acquire the different frequencies and mode shapes at different nodes.Second, modal analysis is done experimentally through FFT analyzer to attain the results of frequencies and mode shapes.Third, to reduce the vibration one of the technique used to altering frequency of the structure by adding stiffener to car door structure

Khadersab A et.Al.[4] In this paper the bearing faults induced in rotating machinery is investigated experimentally using various vibration analysis techniques that are time, frequency and timefrequency domains. The input signal obtained from the rotating machinery with rolling element bearings that is ball bearing with inner and outer race defects health bearings are analysed with respect to Fast Fourier FFT.

Hamid GHADERI et.Al.[5] Recently, research on effective Acoustic Emission (AE)-based methods for condition monitoring and fault detection has attracted many researchers. Due to the complex properties of acoustic signals, effective features for fault detection cannot be easily extracted from the raw acoustic signals. To solve this problem, Fast Fourier Transform (FFT) is utilized. This method depends on the variations in frequency to distinguish different operating conditions of a machine.

TusharChindha Jagtap et.Al.[6] Various types of failures and cracks are seen in mufflers due to vibration from engine and road excitations.FEA techniques are used in this work to avoid resonance. Physical experimentation is performed on using FFT analyzer. The aim of this project is to study the existing industrial Muffler. Modelling of existing muffler was created by using CREO Parametric 2.0 software.FEM is carried out for both existing and modified muffler by using ANSYS.

Siddha Uttam Y. et.Al.[7] Seat is one of the most suited components for the tactile response, as the passengers and driver is in contact directly with the seat. From NVH (Noise vibration Harshness) point of view in an automobile structure Seats are the most important part. The vibration sensation is a common man-made non-natural surrounding with which humans have a restricted acceptance to survive due to their body dynamics. The design achieved for the seating system to protect the human body in a vibration surroundings. Finite element analysis is being latest regularly to calculate vibration and response to understand the nature of ride vibration and its effect on perceived human comfort.

Mohansing R. Pardeshi et.Al.[8] The objective of this paper is to analyze the leaf spring for the constraints such as material composition, vibrations developed in the springs. And finally for both, the analytical results are compared with experimental results and verified. Vibration analysis is done and also how much damping will be required for the spring is determined. Mode frequency for the spring is also determined using ANSYS software and FFT analyzer.

III. METHODOLOGY

A. CONNECTION CIRCUIT OF FFT ANALYZER

The main objectives of the study has been done to investigate vibration will be measured by MEMS (ADXL345). In order to solving this problem, experimental determination of characteristic frequencies can use microcontroller boards (Arduino Megha 2560) to connect with ADXL345 via the SDA and SCL pins.

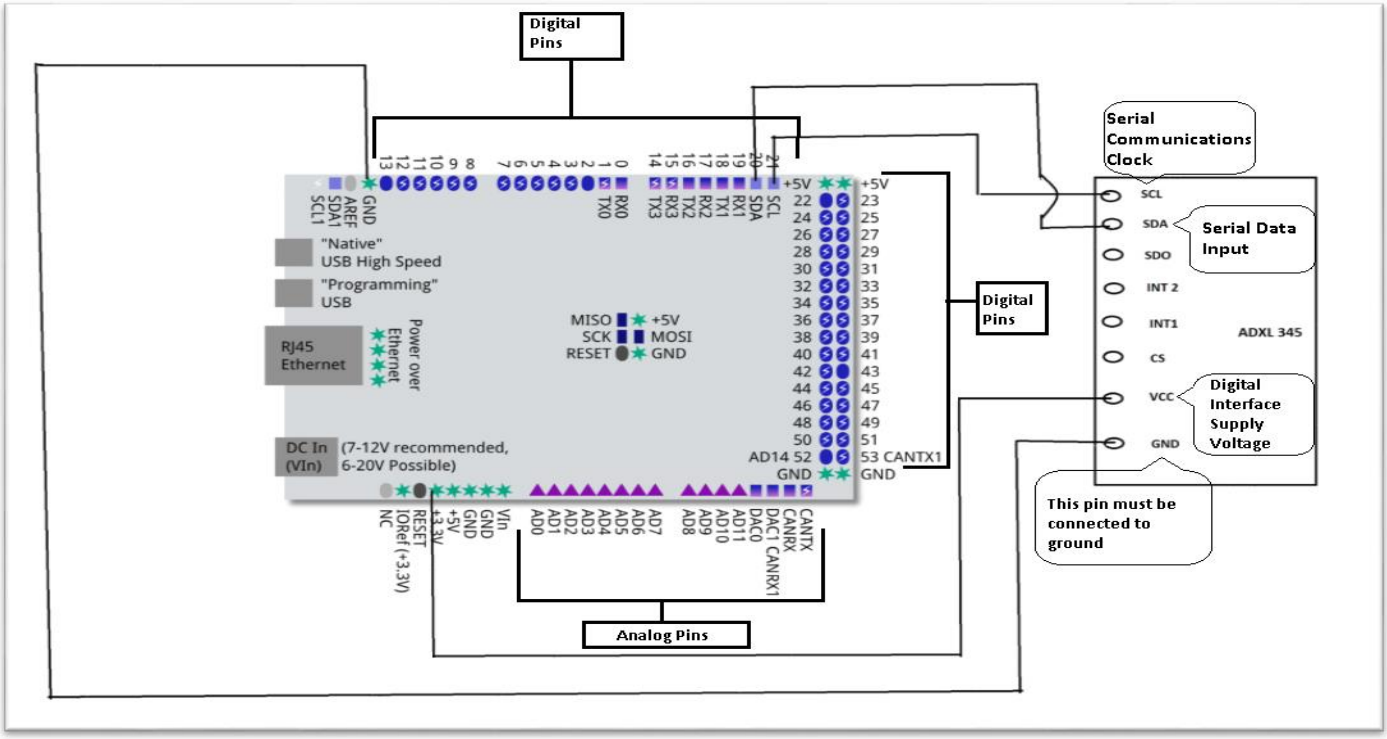

Fig. 2 Connection circuit of FFT analyzer[9]

Interfacing Arduino Megha 2560 and ADXL 345 can be programmed to run open-source code libraries supplied by Arduino Software, and receive acceleration signal through Matlab software using “serial” function.

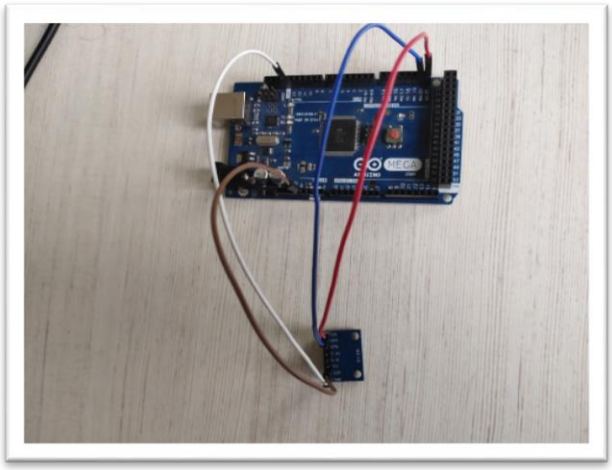

Fig. 3 Arduinomega2560 with ADXL34

B. EXPERIMENTATION

In our collage the dynamic lab in univershal vibration apratus which there is one experiment force vibration of spring mass system. At this system one end is connect with spring and another with bolted joint to give vertical displacement. The ADXL345 connected at the end of bar when also joint a spring. After this sensor give a reading of accerelation and this reading put in the matlab software. Tthis matlab software give a graph of accrelation, velocity and displacement vs time represented.

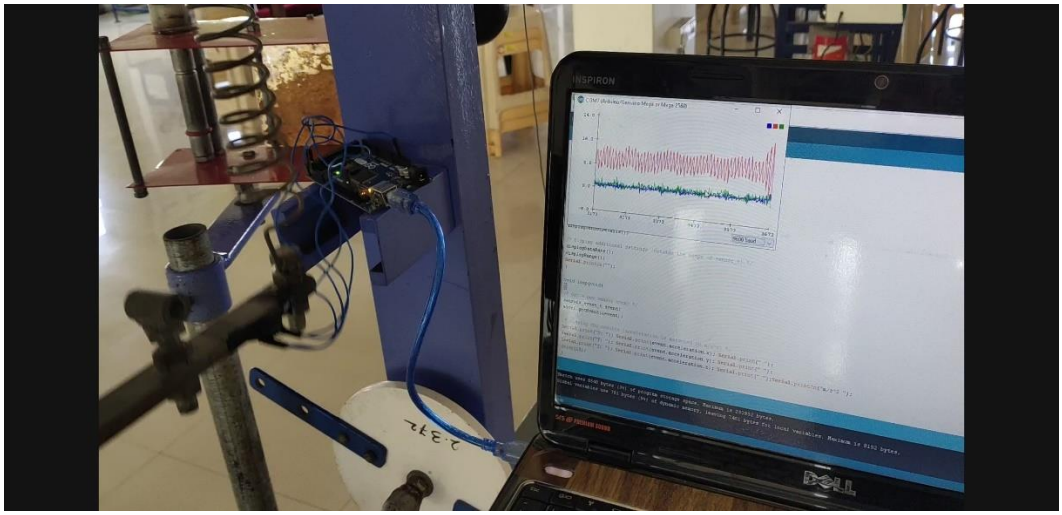

Fig. 4 Experimental setup

Also We done the varification of this FFT analyzer with analytical answer. The value of analytical calculation is 7.1613 mm and in Matlab software showing a graph at value is 6.90 mm. So this value is nearal to same. So using of this analyzer to getting a reading.

IV. RESULTS AND DISCUSION

The reding taking by use of Arduino Megha2560 and ADXL345 is import into MATLAB Software. This MATLAB software output get a graph like Acceleration, Velocity and Displacement.

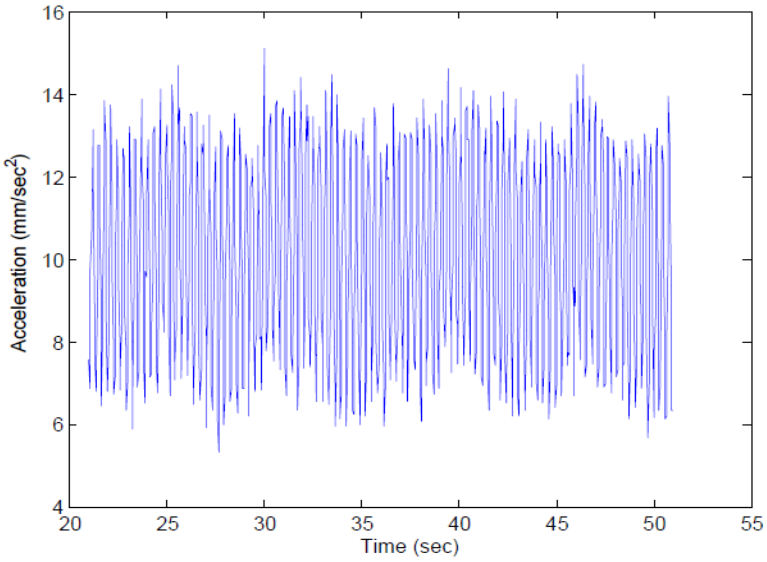

Fig. 5 Acceleration vs Time

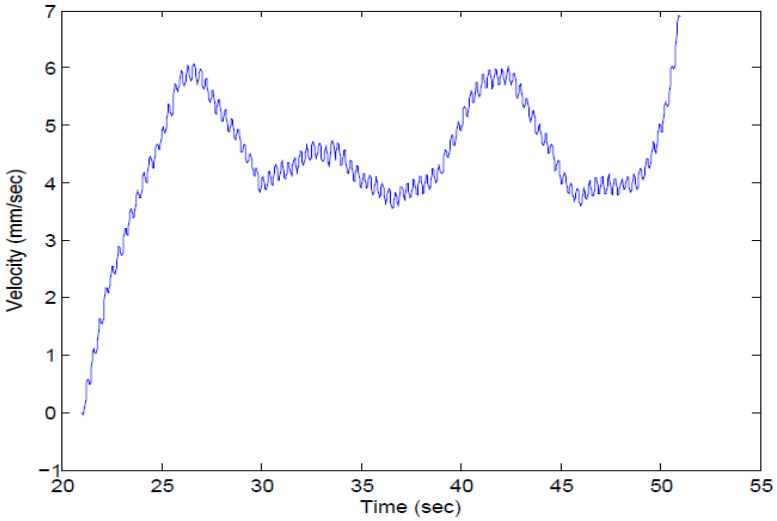

Fig. 6 Velocity vs Time

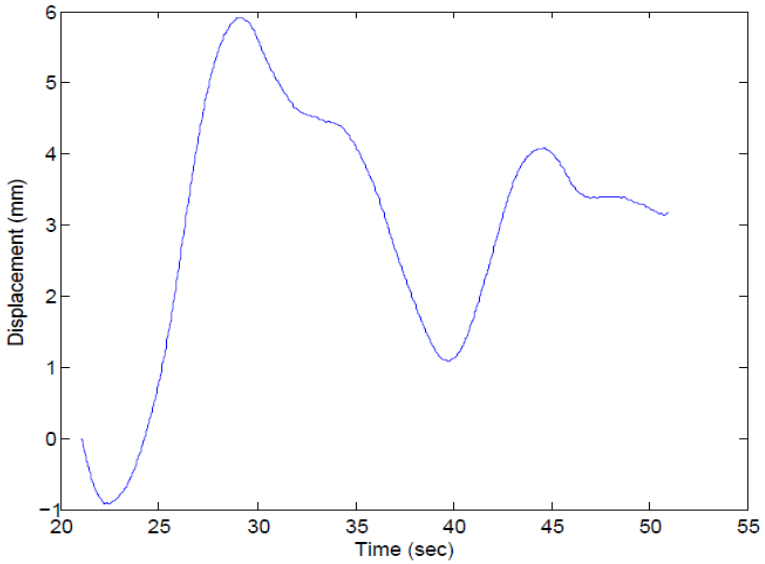

Fig. 7 Displacement vs Time

V. CONCLUSION

The purpose of the present work was the study vibration measurement for behaviour of helical coil spring based on Arduino Megha 2560 and MEMS (ADXL345). We taking the experimentally analyzed reading and calculate the deflection after comparisons with each other. The results are minor differences. So, this FFT Analyzer can use to measurement the vibration of any automobile component.

REFERENCES

1. R, M. K. G., 2017. "*Vibration Analysis of Car Door Using FE and Experimental Technique*", International Research Journal of Engineering and Technology(IRJET), 4(6), pp. 1115-1119.
2. Khadersab, A., 2018. "*Vibration Analysis Techniques for Rotating Machinery and its effect on Bearing Faults*", Procedia Manufacturing, Volume 20, pp. 247-252.
3. KABIRI, P., 2011. "*Automobile Independent Fault Detection based on Acoustic Emission Using Wavelet*", Ndt.Net, Issue November, pp. 3-4.
4. Khairnar, N., 2018. "*VIBRATION ANALYSIS OF MUFFLER*", Issue 02, pp. 2888-2894.
5. Siddha Uttam Y., 2013. "*Natural Frequency Analysis of Automotive Seating System by using FEM Software*", International Journal on Mechanical Engineering and Robotics (IJMER), Volume-1, Issue-2.
6. Pardeshi, M. R. S., 2014. "*VIBRATION ANALYSIS OF E-GLASS FIBRE RESIN MONO LEAF SPRING USED IN LMV*". Issue 02, pp. 305-311.
7. Note, A., n.d. About "*FFT Spectrum Analyzers*", Issue 408.
8. Physics Corporation, D., n.d. "*The FFT Analyzer in Mechanical Engineering Education*",Issue 1, pp. 1-3.
9. Kadiwala, J., 2019. "*Vibration analysis of exhaust system of automobile vehicle*", Bardoli: s.n.
10. Asabe, A. M., 2014. "*Performance Enhancement of Automotive Silencer Using Finite Element Analysis*", International Journal of Engineering Science Invention, 3(8), pp. 14-22.
11. Y, S. U., 2013. "*Natural Frequency Analysis of Automotive Seating System by using FEM Software*", International Journal on Mechanical Engineering and Robotics (IJMER), 1(2), pp. 93-98.
12. Cao Y, and Zhao D, "*Finite Element Modal Analysis Theory and Application*", J. Mech. Eng. Autom., 1, 2007, 73–75.
13. AGNES MUSZYNSKA. "*Vibrational Diagnostics of Rotating Machinery Malfunctions*", International Journal of Rotating Machinery 1995, Vol. 1, No. 3-4, pp. 237-266.
14. Rajkumar, Rajesh Kannan "*A Modelling and Analysis of Damping Effect in Exhaust System Using Ansys*" , IJAAME vol.3-No 5, Oct 2016, Pp.38-43