Fuzzy Based Control in Piezo Power-Driven Generation Using Boulevard Traffic

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Abstract: - This paper presents the basic idea of generating power using Piezo electric effect by road traffic. The concept of generating energy from road traffic is implemented by using piezoelectric materials. The system design structure was proposed considering the factors involved with material science for piezoelectric generator modelling and field of power electronics for additional components in producing a realistic outcome. It also ensures ease of vehicle performance, as this system utilizes energy source derived as the kinetic energy released from vehicles or the pressure developed by the vehicles into electrical power output, that is, obtained by harnessing kinetic energy due to the strain of vehicles over the road surface. The power generated using piezoelectric materials is interconnected with the power electronics system. The interconnected system power, output power is optimized and stabilized using a fuzzy based controller in the feedback. The MATLAB Simelectronics and fuzzy logic toolbox are used along with Simscape to develop this Piezo electric generation and fuzzy algorithm.

Index Terms — Piezo Electric, Power Electronics, Optimized Power flow, Fuzzy Control, Algorithm.

I. INTRODUCTION

Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. The word Piezoelectric is derived from the Greek piezein, which means to squeeze or press, and piezo, which is Greek for "push". Piezoelectric sensor is a device that implements the piezoelectric effect, to measure the change in pressure, acceleration, strain and force that are developed by the road vechile.

II. PROPOSED ENERGY HARVESTING CONCEPT

By pressing one Piezo electric crystal a certain amount of electricity is generated for an defined pressure. To generate significant amount of electricity the pressure applied to the crystal should be sufficient. After this the generated energy is boosted by means of boost converter. The output power of the converter is interfaced with power load. The load may either be a critical or non- critical load. To get an optimized stabilized output fuzzy controller is used in the feedback system. The MATLAB Simelectronics and fuzzy logic toolbox is used along with Simscape to develop this Piezo electric generation and fuzzy algorithm.
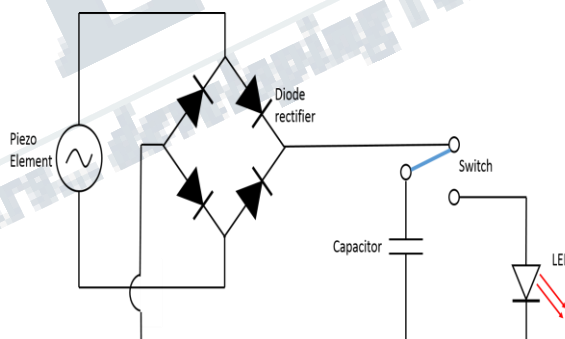

Fig.1. General Block diagram on Piezo Electric Effect
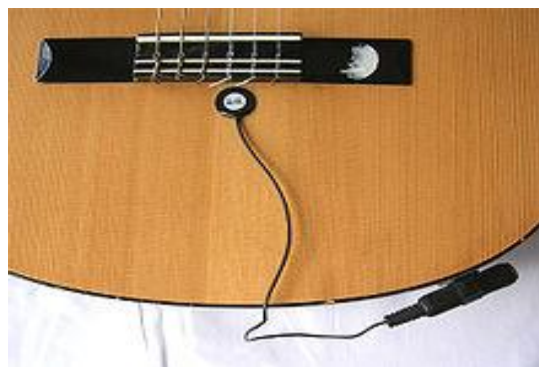
**SENSOR USED IN THE PROPOSED CONCEPT**

Fig.2. Proposed Piezo Sensor

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The principle of operation of a piezoelectric sensor is that a physical dimension, transformed into a force, acts on two opposing faces of the sensing element. Depending on the design of a sensor, different "modes" to load the piezoelectric element can be used. It may either longitudinal, transversal and shear. The variation in pressure that is obtained from road vehicle is detected in the form of sound. Then the detected pressure in the form of sound is given to the piezoelectric microphones where the sound waves bend the piezoelectric material, and create change in voltage. A piezo sensor attached to the body of an instrument is known as a contact microphone. In the proposed technique the sensor can act as both a sensor and an actuator which is often the term transducer. Transducer is preferred when the device acts in this dual capacity, but most Piezo devices have this property of reversibility whether it is used or not. Direct piezoelectricity of some substances, like quartz, can generate potential differences of thousands of volts. A piezoelectric transformer is a type of AC voltage multiplier. Unlike a conventional transformer, which uses magnetic coupling between input and output, the piezoelectric transformer uses acoustic coupling. An input voltage is applied across a short length of a bar of piezoceramic material such as PZT, creating an alternating stress in the bar by the inverse piezoelectric effect and causing the whole bar to vibrate. The vibration frequency is chosen to be the resonant frequency of the block, typically in the 100 kilohertz to 1 megahertz range. A higher output voltage is then generated across another section of the bar by the piezoelectric effect. Step-up ratios of more than 1,000:1 have been demonstrated.
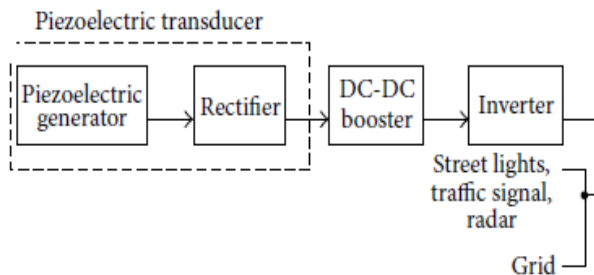

Fig.3. Proposed Piezo Electric generator interfaced with grid

SIMULATION TEST RESULT

The above figure shows the voltage and frequency signals during piezo electric power generation interfaced with power inverters and loads (Critical & Non- Critical Load). It shows that the disturbance in the frequency lasts less than 100 ms and then stabilizes to its nominal values at 60 Hz. However the voltage deviates from 1 pu but the deviation is very minimal and within the IEEE limits.
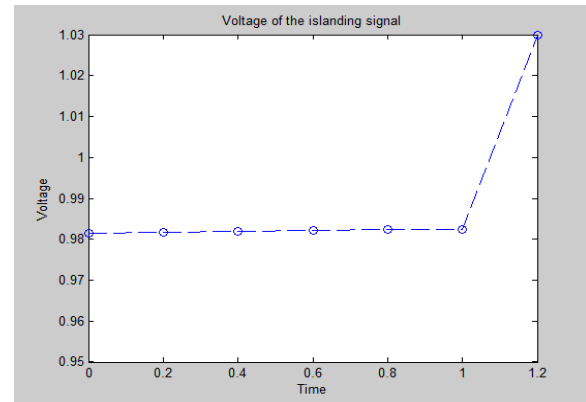
Fig.4. Voltage
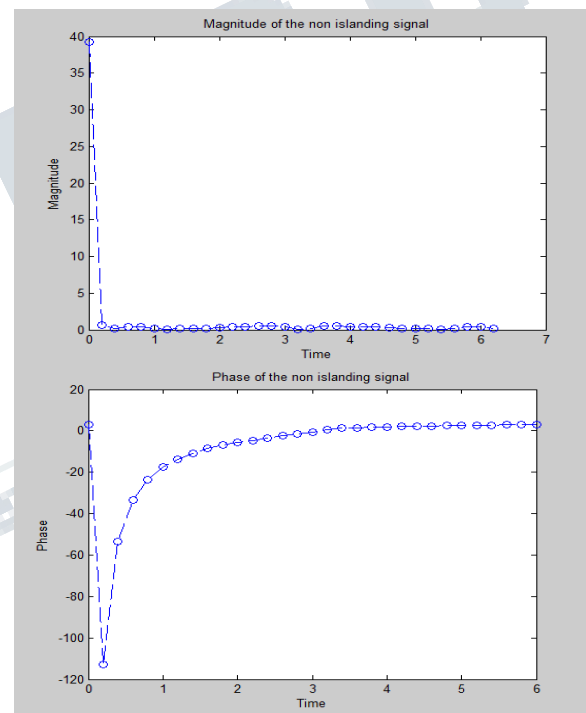
Fig. 4. Magnitude and phase (Hz) versus time (s) during Piezo Electric Power Generation

The phase sequence only deviates for less than 100 ms and goes back to normal. This response is very important to distinguish between islanding and non-islanding due to the difference in their waveforms pattern.

II. CONCLUSION

The Fuzzy based Controller designed for Power generation using piezo electric concept provides excellent output performance, optimized efficiency and high reliability. The Dynamic response of the system is found to be good under

transient condition. The DC bus utilization is increase by 15% along with less harmonic distortion when compared to the conventional PWM technique. This increases the entire power quality of the system.

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