

Insitu Intelligent Power Generation from Smart Roads

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Abstract:- In the present scenario power has become the major need for human life. Due to day-to-day increase in population and scarcity of the conventional sources, it becomes necessary that we must depend on non-conventional sources for power generation. This paper emphasizes on the idea that the kinetic energy getting wasted while vehicles move, can be utilized for power generation with a special arrangement of piezoelectric crystals. This electrical output can be improved by arranging these piezocrystals in series and parallel. This generated power can be amplified and stored in a battery. This generated power can be used for general purpose applications like streetlights, traffic signals etc. Thus we can satisfy the future demands to some extent. It is essential to utilize the generated power in a sustainable form, therefore here we introduce an intelligent street light system on roads. The lighting of street light is designed in such a way that it remains ON when required.

Keywords: Piezoelectric crystals, intelligent street light system, power generation.

I. INTRODUCTION

Electricity has become a lifeline of present day civilization and thus its demand is enormous and is growing steadily. India is a developing country and short fall in the power supply has direct impact on development of the country. This rising concern about the gap between demand and supply of electricity for masses has highlighted the exploration of alternate source of energy and its sustainable use. Energy demand and heavy traffic correlation motivate us to dream about a device in road that would harvest the energy from vehicle driving over it with low implementation cost and free from pollution. This paper intends to introduce an alternative source of energy by using piezoelectric material-a class of smart material. The piezoelectric roads will produce electricity from the stress experienced by the roads due to movement of automobiles. For this piezoelectric material embedded beneath the road, a piezo smart road can convert pressure exerted by moving vehicles into sustainable electric current. This proposed system is based on piezoelectricity, which uses pads of piezoelectric crystals buried over hundreds of meters of road to generate electricity when put

under the pressure of quickly moving traffic thereby lighting up the streetlight. [2]

II. PIEZOELECTRIC CRYSTALS

The search for a clean, reusable source of energy has caused a spike in interest in the exploration of piezoelectric crystal. Whenever piezoelectric crystals are mechanically deformed or subject to vibration they generate a small voltage, commonly known as piezoelectricity. The piezoelectric effect exhibits two properties: The first is the direct piezoelectric effect that describes the material's ability to transform mechanical strain into electrical charge. The second form is the converse effect, which is the ability to convert an applied electric potential into mechanical strain energy. These properties allows the material to function as a power harvesting medium. [3]

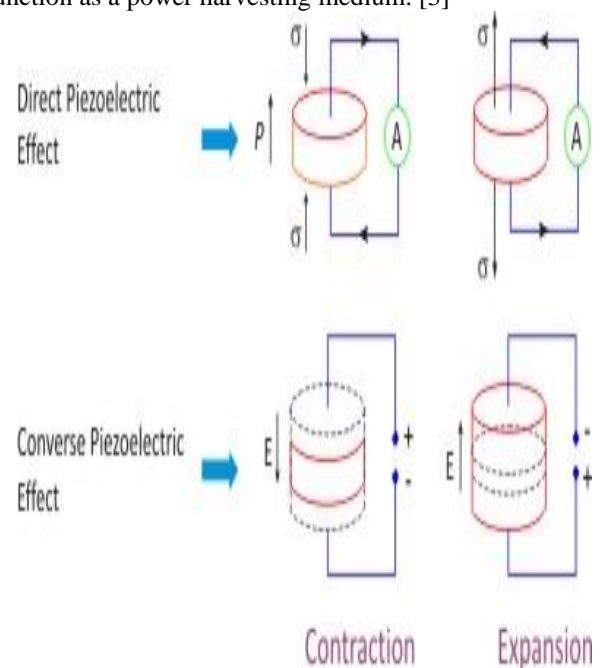


Figure 1 shows the different piezoelectric effect

III. BOOST CONVERTER

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple. The schematic for boost converter is shown in the figure 2

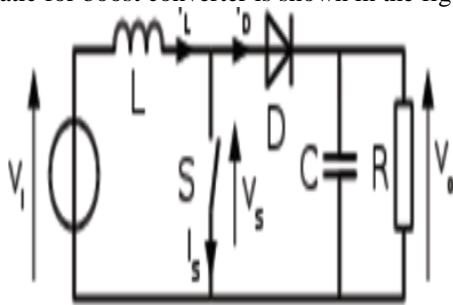


figure 2 shows the Boost converter

The basic principle of a Boost converter consists of two Modes of operations:

Continuous mode: In the On-state, the switch S (see fig.2) is closed, resulting in an increase in the inductor current. When a boost converter operates in continuous mode, the current through the inductor (IL) never falls to zero.

Dis-Continuous mode: In the Off-state, the switch is open and the only path offered to inductor current is through the flywheel diode D, the capacitor C and the load R. This results in transferring the energy accumulated during the On-state into the capacitor. In some cases, the amount of energy required by the load is small enough to be transferred in a time smaller than the whole commutation period. In this case, the current through the inductor falls to zero during part of the period.

IV. PROPOSED TECHNIQUE

The piezoelectric crystals play a vital role in power generation. Piezoelectricity is the electric charge that accumulates in certain solid materials in response to applied mechanical stress. When a mechanical stress is given to the piezoelectric crystals, it gets converted to an electrical signal. This electrical signals are of low signal strength. So it is essential to convert this low strength signal to high strength signal using boost convertor . The high strength signal thus produced are now stored in a battery, which is used to light the street lamps. A well-designed, energy-efficient street lighting system should permit users to travel at night with good visibility, in safety and comfort, while reducing energy use , costs and enhancing the appearance of the neighbourhood. In this work, we have perused through some of these efforts at achieving the above mentioned energy efficient automated

street lighting system with the help of piezoelectric materials and light dependent resistor(LDR). Intelligent street light system is a concept in which the street lamps turns ON and OFF only when required. It is completely different from the existing ordinary street lamps. The street light needs to be turn ON only under required situation i.e., when a person or vehicle passes. Only during the time of passage of any vehicle or person, the lamp turns ON otherwise it remains OFF thus saving power. In order to detect the presence of any vehicle or a person sensors are required. For vehicle to pass, it is essential to turn ON the lamp for a short time compared to pedestrian crossing. This time can be set in advance using the microcontroller from ARM 7 family. Incase, any fault occurs in this system, and charging of battery go below a threshold the street light can be turned ON by using normal power supply and an alert is made via SMS.

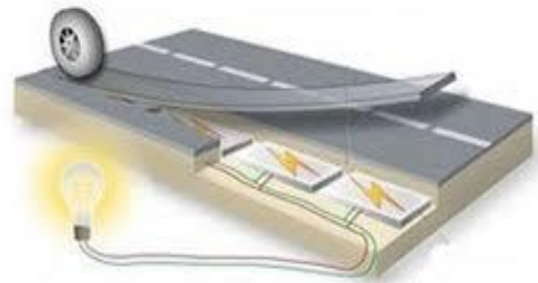


Figure 3 shows the animated implementation of Proposed Technique

V. BATTERY SEALED LEAD ACID BATTERY

A VRLA battery (valve-regulated lead-acid battery), more commonly known as a sealed battery (SLA) or maintenance free battery, is a type of lead-acid rechargeable battery. Due to their construction, the Gel and AGM types of VRLA can be mounted in any orientation, and do not require constant maintenance. The term "maintenance free" is a misnomer as VRLA batteries still require cleaning and regular functional testing. They are widely used in large portable electrical devices, off-grid power systems and similar roles, where large amounts of storage are needed at a lower cost than other low-maintenance technologies like lithium-ion.

VI. ACORN RISC MACHINE MICROCONTROLLER

The whole system is controlled by a Microcontroller from ARM 7 family. ARM is a family of instruction set architecture, for computer processors based on RISC architecture developed by British company ARM Holdings. A RISC-based computer design approach means ARM processors require significantly fewer transistors than typical processors in average computers. This approach reduces costs, heat and power use. These are desirable traits for light, portable, battery-powered devices—including smart phones, laptops, tablet and notepad computers and other embedded systems. A simpler design facilitates more efficient multi-core CPUs and higher core

counts at lower cost, providing higher processing power and improved energy efficiency for servers and supercomputers. The features are 8 to 40kB of on-chip static RAM and 32 to 512kB of on-chip flash program memory. 128 bit wide interface/accelerator enables high speed 60 MHz operation. In-System/In-Application Programming (ISP/IAP) via on-chip boot-loader. Software Single flash sector or full chip erase in 400 ms and programming of 256 bytes in 1ms. Embedded ICERT and Embedded Trace interfaces offer real-time debugging with the on-chip Real Monitor software and high speed tracing of instruction execution.

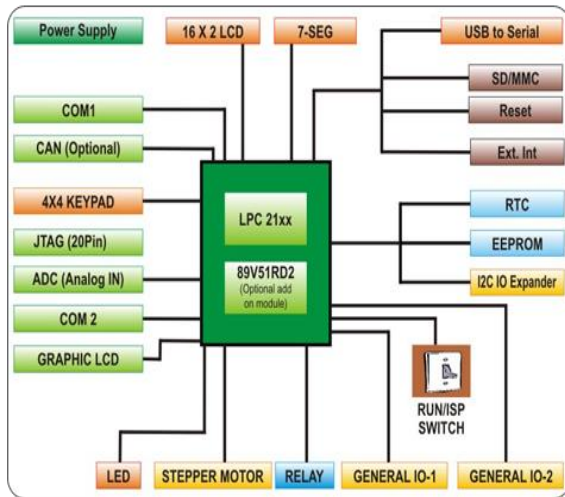


Figure 4 shows the Architecture of ARM Microcontroller

VII. INTELLIGENT STREET LIGHT SYSTEM

This project is designed with sensors which are capable of sensing the arrival of a vehicle and human beings. It drives the same information to the micro controller. The microcontroller is interfaced with the street lights and it is the responsibility of the controller to switch the status of the lights with respect to the acknowledgement received to it from the sensors. Along with it intensity of street light is also varied with motion of vehicles. Intelligent street lighting system is switched off during day time. The LDR is used to sense the variations of light during day and night. The circuit begins to function only during night.



Figure 5 shows the Intelligent Street Light System

VIII. HIGHLIGHTS OF PIEZO-SMART ROADS

A. ADVANTAGES

- Low cost.
- No fuel transportation required.
- This energy will not get exhausted.
- A green solution for power generation.
- No external source is needed for power generation.
- Even the most untouched and remote areas can be electrified.
- Simple construction, mature technology and easy maintenance.
- No consumption of any fossil fuel which is non-renewable source of energy.

B. DISADVANTAGES

- Implementing this concept is a little bit tedious.
- The present day roads need to be relayed again in order to implement this concept.
- This will result in traffic congestions all the city and needs a critical plan of over implementation and management.

IX.COMPARATIVE ANALYSIS

ENERGY	CONVERSION MECHANISM	PERFORMANCE ANALYSIS
LIGHT	Photovoltaic cell	Most solar panels have a 40% efficiency rate & 60% of the sunlight gets wasted
WIND	Wind turbine generator	Noise, wind cannot be predicted.
TIDAL	Ocean thermal energy conversion	Intensity of sea wave is unpredictable and there can be damage to power generation units.
MECHANICAL	Electromagnetic, electrostatic, piezoelectric transducers	The piezoelectric transducers are small in size and have rugged construction. It can detect the events of microseconds and also give the linear output. Insensitive to extreme climate condition

X. CONCLUSION

Thus it can be summarized that at the time when governments are finding it hard to make land available for new power plants, extracting energy while using the vast spread of highways all over the world seems no less lucrative proposition. As the conventional sources are depleting very fast, then it's time to think of alternatives. So this idea not only provides alternative but also adds to the economy of the country. This project deals with generating electrical energy from mechanical stress that are produced on the roads and using the energy produced to light the street lamps. Now the time has come to put forth these types of innovative ideas, and researches should be done to upgrade their implication. We conclude that it can be implemented in INDIA to accelerate the development.

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