

Automatic Street Lights Lightened By Piezoelectric Roads

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ABSTRACT: This paper illustrates the streetlight glowing system on vehicle detecting movement and aims to assess the functionality of piezoelectricity in roads to utilize energy executed from the moving vehicles. The vitality of this technology arises as fossil fuels is being over consumed which makes it challenging to provide sufficient power in the next era as an effect of growing population. Piezoelectric road is a new energy evolution to provide a sustainable solution in terms of environment, economy, and social needs.

Controlling of street light is of utmost importance in developing country like India to reduce the power consumption. This paper presents a street light control system which combines various technologies: a timer, a statistics of traffic flow magnitude, photo diodes, Light Emitting Diodes (LED), power transistors. IR Sensors used on either sides of the road send logic commands for the LEDs at the output to get glowing for a patch ahead. Intensity control is also possible by pulse width modulation based on sensing the movement and density of vehicles. A programmable micro controller is engaged to provide different duty cycle for different intensities at different density conditions.

KEYWORDS: Street light, Sensor, Movement of Vehicle. Piezoelectric roads; Energy harvesting roads.

I. INTRODUCTION

Generally, street lights are switched on for whole night and during the day, they are switched off. But during the night time, street lights are not necessary if there is no traffic. Saving of this energy is very important factor these days as energy resources are getting reduced day by day.

Alternatives for natural resources are very less and our next generations may face lot of problems because of lack of these natural resources. This article describes about the circuit that switches the street lights on detecting vehicle movement and remains off after fixed time which implements power generation using piezoelectric roads.

Redirecting routes to integrate the principle of piezoelectric devices to urban roads is significant, at this stage. Focusing on the transition of energy to piezoelectric integrated roads, a renewable energy harvesting method, will lead the next power generation into a feasible and more reliable source of energy.

The term Energy Harvesting or Renewable Energy, such as solar panels or wind turbine, is a method of producing electrical energy by utilizing the energy surrounding the environment from the sun and wind, for example. However, energy formed from various vibration machines, objects in motion, or any other source of mechanical energy is not being captured. Therefore, this source of energy is dispersed and thus wasted. As an effective method to utilize this loss, piezoelectric material is used to absorb the wasted mechanical energy and convert it to electrical energy.

The principle of piezoelectricity lies behind the crystals. Electrical voltage is induced when crystalline materials are subjected to external force, pressure, or strain. There are several types of natural crystals, found at the surface or deep within the earth, which can be used today to apply piezoelectricity effect such as clear quartz and amazonite. A variety of artificial crystals are formed by chemical compounds, as well. These include Barium Titanate, Lead Titanate, and Lead Zirconate Titanate, etc.

The efficiency of piezoelectric devices is influenced by the type of crystals due to the variety of their properties. However, Lead Zirconate Titanate (PZT) crystals are being used widely to achieve a high piezoelectric

effect. The ease of fabrication to any complex shape, high material strength and long-life service, resistant to humidity and heat temperature over 100°C, are all distinctive factors of PZT [8]. In addition to crystalline material suggested, Table 1 shows other parameters that play a major role to determine the best outcomes of piezoelectricity [6].

II. RELATED WORK

Automation, Power consumption and Cost Effectiveness are the important considerations in the present field of electronics and electrical related technologies. Industry of street lighting systems are growing rapidly and going to complex with rapid growth of industry and cities. To control and maintain complex street lighting system more economically, various street light control systems are developed. These systems are developed to control and reduce energy consumption of a town's public lighting system using different technologies. The Proposed work is to control switching of street light automatically according to light intensity to develop flow based dynamic control statistics using infrared detection technology and maintain wireless communication among lamppost and control terminal using ZigBee Wireless protocol. This proposed system utilizes the latest technology for the sources of light as LED Lamps instead of generally used street lamps such as High Pressure Sodium Lamps, etc. The LED technology is preferred as it offers several advantages over other traditional technologies like energy saving due to high current luminous efficiency, low maintenance cost, high colour rendering index, rapid start up speed, long working life etc. This proposed system makes use of infrared photoelectric sensor (G12-3C3PA) for vehicle detection.

It is concluded that power asphalt is a very challenging technology as energy harvester. But the lack of implementing the technology of recent engineering innovation failed to maximize power density [12]. The output of power density is related to the frequency (Hz) and it has been verified that piezoelectric devices can operate in very high frequencies. Having high frequencies enable piezoelectric devices to isolate in a wider range generating more total power output. In other words, long-lasting frequency or decaying vibrations continues to generate power as a result of initial impact. Genziko applied the same principle of micro-cantilever array beams, as illustrated in Figures 5 and 6. Stacked arrays result in a higher power initially with single vibration, but are very low compared to decaying arrays.

III. PIEZOELECTRIC AUTOMATIC STREET LIGHT

Piezoelectric crystals can be embedded underneath the asphalt layer to utilize the energy generated due to the vehicle motion, as illustrated in Figures 3 and 4. As the vehicles move over the asphalt layer, the wheels exert a force or pressure into the crystals and thus deform. This deformation will absorb the force and undergo the process of power generation, as shown above, to be stored in batteries. The use of storage is essential at this stage, since street lights are operated for 12 h per day. Therefore, the energy can be dispersed when required.

Energy Generated: Power asphalt used to provide electrical power to street lights was tested in Hefer intersection, Israel. The set up involved piezoelectric devices lay beneath asphalt roads, at a total distance of 10 m only. The setup has generated electrical power of two Kilowatt-Hours (KWh) [11]. Another test has been conducted by POWERleap, a licensed technology manufacturer, has provided a data proving the reliability of power asphalt. The experiment involves 1 Km stretch power asphalt with vehicle passing rate of 200-400 in 16 h. Based on this experiment, the total electrical energy generated range between 400 KWh - 600 KWh. The revealed as a main source of energy as it saves cost and reduces fossil fuel consumptions.

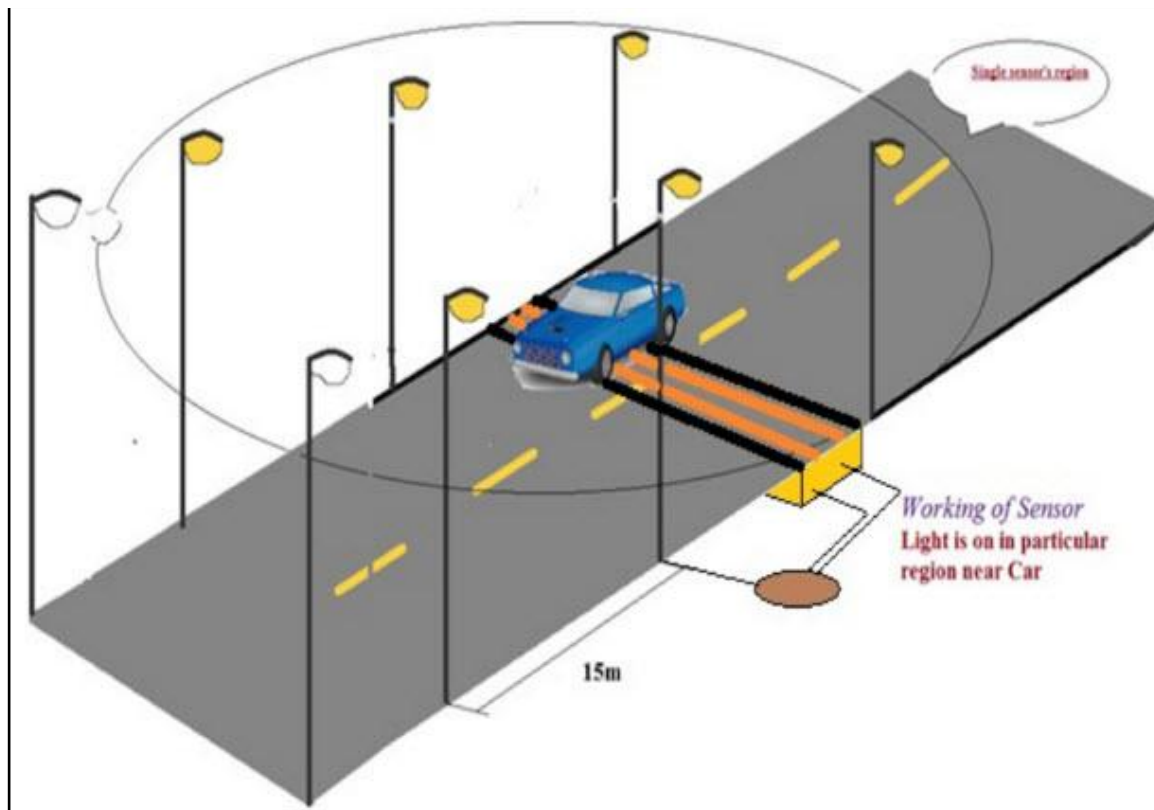
IV. EXPERIMENTAL RESULTS

The highway model consists of 14 led's as streetlights and 8 pairs of photodiodes-IR diodes used as sensors, variable resistors and a transistor which acts as switch as explained above. The IR diodes are placed on one side of the road and photodiodes are placed on the other side of the road, directly facing the IR diodes. Consider the case when there is no vehicle on the highway. In this case, the IR radiation emitted from the IR diode directly falls on the photodiode which is exactly opposite to it. This causes the photodiode to fall in conduction state. This implies that photodiode conducts and current passes through it. The current passes through the photodiode and goes through the variable resistor and the base-emitter region of the transistor. This in turn connects the collector of the transistor to the

emitter. From the circuit diagram we can see that emitter is connected to ground which implies that the collector also goes to the ground. The collector region of the transistor is connected to the port 1 (input port) which in turn goes to ground i.e., logic ZERO. So, to summarize we can say that, when there is no vehicle on the highway, then all the inputs to the microcontroller port 1 is ZERO. Consider the case when a vehicle obstructs the IR radiation path. In this case, IR radiation is blocked and hence it does not fall on the photodiode. This in turn implies that photodiode doesn't conduct. Hence there is no current flowing through this first transistor. So, the collector is at HIGH state. Let us assume that the first Photodiode-IR diode pair IR path is obstructed.

This leads to a transition from ZERO to HIGH at P1.0 pin.

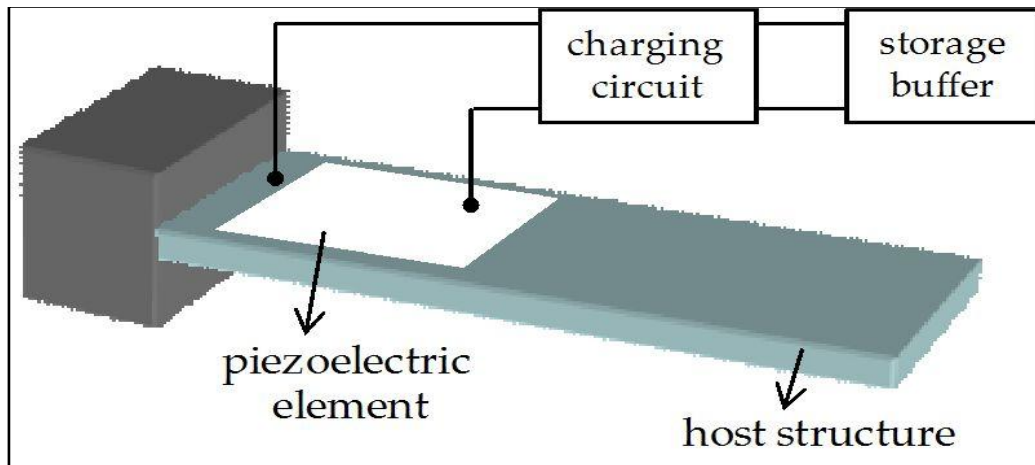
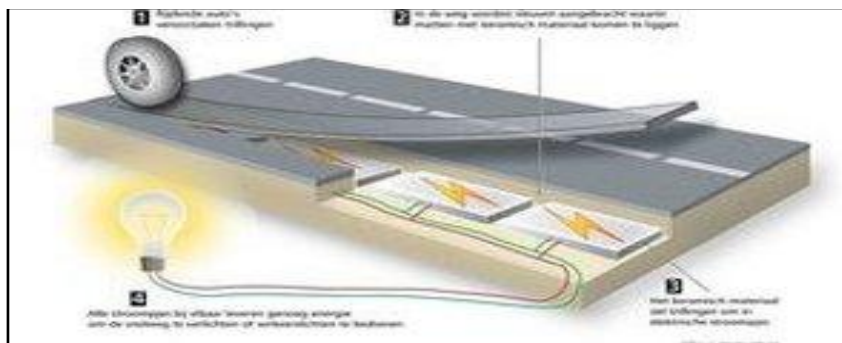
The below figure demonstrates the automatic sensing of vehicles during night time. This explains the exact expectation to be met through the this paper.



However with the analysis observed, results are not taken for granted to comply with the original hypothesis. Respondents engaged in this study employed an error variable which might fail the hypothesis. Having 34% of the respondents unaware of piezoelectricity to support research hypothesis develop misleading information. In addition to 48% respondents which generates a higher deviation away from the proven hypothesis. The data is granted for only 3% to have power asphalts in terms of street lights application.

To further ensure bias answers provided by the respondents, a chi-test is used to have a precise measure of the percentage error by respondents. This analysis determines the significance of respondents answered by chance based on

their piezoelectric awareness and power asphalt principle variable. For a valid data, the significance level must fall under 0.005% or 5% probability for this research. However, the chi-test table provided according to table count shows insignificant results and thus fails to support the proven hypothesis of power asphalt reliability. In other words, the likelihood to have answered the power asphalt reliability is 56% by chance, as shown in two sided Pearson chi-square. This percentage deviates critically from the significant level of 0.05 which concludes unreliable results given by respondents and thus failure to support hypothesis.



V. CONCLUSION

Street-lights are a large consumer of energy for cities using up to 50 percent of a city's energy budget. If every city installs the proposed system then a lot of power can be saved. Proposed system is power saving mechanism for street lights by using LED lamps as replacement of normal lamps and using special power savings mechanism for microcontroller and ZigBee modules. It turns out most reliable and time efficient way to switch ON/OFF streetlights. It provides an effective measure to save energy by preventing unnecessary wastage of electricity, caused due to manual switching or lighting of street-lights when it is not required. It adopts a dynamic control methodology for traffic flow. The proposed system is especially appropriate for street lighting in remote urban and rural areas where the traffic is low at times. The system is versatile, extendable and totally adjustable to user needs.

Having met the power metrics will make such invention a starting point to self-sustaining environment by being dependent on vehicle elements to curb down input energy and cost. This will be a revolution in the production of energy by meeting innovations and technologies to shape future energy. However, further concentration is required to quantify and result in a greater power outcome to become a reliable source of electricity.

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