

Smart Street Light System using Hybrid Power Source

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Abstract—The Smart Lighting Systems go far project demonstrates an interoperable smart lighting solution that incorporates heterogeneous lighting technologies to allow intelligent functions. In developing nations, the amount of produced electrical power is insufficient to meet demand, and natural resources for generating electricity are scarce. In India, street lighting accounts for one-fifth of total energy consumption. The street lights are also built to meet old reliability requirements. As a result, a significant amount of energy is lost, putting a strain on the energy resources used to generate electricity. Alternative sources of energy are currently being investigated in order to plan for the future of conventional energy sources. A well-designed street lighting system should enable traffic and pedestrians to drive safely and comfortably at night, while decreasing energy usage and costs. Green energy conservation aims to supply electricity to grid-connected electric and electronic networks, while thermoelectric electricity generation is primarily dependent on the thermoelectric generator's activity (TEG). In this paper, electrical energy is generated by consuming non-biodegradable waste, as well as energy from piezoelectric sensors. The electricity is produced using waste products and a piezoelectric generator, and then stored in a battery to power the streetlight.

Index Terms— Thermoelectric generator, Non bio-degradable waste, Piezo electric sensor, Conventional energy source, grid, Green energy conservation.

I. INTRODUCTION

The most effective source of light in a city is street lighting, which absorbs the most electricity. Even if there is no need for street lighting during the day, it is often found that these lights are kept on, which violates the energy saving law and contributes to increased energy waste. As the energy tariff rises, this constant lighting would cause even more emissions and damage to the atmosphere. The most critical use of streetlight is for public transit in the dark or when the light is insufficient. As a result, ensuring the appearance and regulation of street lighting is a crucial aspect of our way of life's safety. The market for portable and light-weight electronic devices is increasing all the time. Simultaneously, efficient power generation systems are becoming more relevant. The existing power grid is under a lot of pressure due to appliances' dependency on batteries or power drawn from grid lines. The appliances' size, weight, safety, and lifetime constraints must also be considered. In recent years, replacing batteries and relying on power grids has become a top priority, and networks that depend exclusively on these invariant power sources are becoming increasingly difficult to control.

As a result, we must be prepared to harvest ambient energy using energy scavenging technologies in order to reduce the use of such harsh sources and allow battery-free operations. Street lights usually consume 35-400

watts, depending on the fabric used to make them. Low-pressure sodium bulbs, for example, need 35-55 watts to operate, which is a lot of energy for something so small and ineffective. As a result, we've devised a self-sufficient scheme in which the road lights don't need electricity from the local grid and instead rely on the wasted.

The system will be able to charge during the day when no street lights are needed, and will only be able to operate at night after being charged for at least 12 hours. We've given it a calendar of the coming year's sunrise and sunset times to ensure that the lights switch on and off on their own at the right times, making the system programmable and intelligent. The most commonly used energy harvesters convert solar, vibrational, and thermal energy into electricity.

The system in question makes use of vibrational harvesters, which can be electromagnetic (inductive), electrostatic (capacitive), or piezoelectric in nature. Piezoelectric (PE) harvesters are becoming more popular as a result of the materials' piezoelectricity, which can provide a large amount of accessible power. To maximise voltage output, the PEs are arranged in a nonparallel configuration.

II. LITERATURE SURVEY

The demand for electricity in cities is growing at a rapid rate. There is a growing need for energy management that is environmentally friendly and consumes no fuel or natural resources. A large number of studies have been lost in this field. Thanks to the proposed approach, several posts, research papers, and books have been described as being quite similar.

In the study [1] The performance power of fabricated piezoelectric structures has been estimated using a model, and theoretical estimates have been compared to experimental findings. The manufactured piezoelectric energy harvesters are distinguished by the use of a simple resistive load to live the system's output power and a sinusoidal oscillation as mechanical input. The energy usage of emerging microsystems devices must be reduced. The ultimate aim of the study is to power these devices using energy storage techniques such as vibration-to-electric conversion or wireless power transfer in study [2].

The techniques we used in an energy-harvesting scenario were used to build a microsensor node. For digital circuits, modelling and running at the lowest energy point within the subthreshold area. The approaches for improving the energy efficiency of analogue components, such as the transmitter, are now complete in studies [4]-[5].

In this study [6] electronic interface capable of efficiently harvesting the energy associated with a piezoelectric transducer's random voltage waveform. Its operating principle is based on an inductive step-up converter with a dynamic driving circuit to align the converter's phases. The energy is stored in a capacitor that is also used to control the active elements of the step-up converter, resulting in a fully self-contained energy scavenging device. Using piezoelectric generators to convert vibrational energy to current is an area that has received a lot of attention. It has been demonstrated that the extracted energy can be greatly improved by using an innovative non-linear treatment of the piezoelectric voltage, which involves intermittently switching the piezoelectric portion on a resonant electrical network for a very short time in several studies [7]-[8].

This paper proposed a vibration driven energy harvesting piezoelectric material. This paper proposed a vibration driven energy harvesting platform supported piezoelectric material is proposed in study [9]-[10].

In study [11]-[12] Waste-to-energy plants use municipal solid waste (MSW), also known as garbage or trash, to provide steam to a boiler that produces electricity. It entails mass burning of unprocessed MSW in a massive incinerator with a steam boiler and an energy generator.

III. METHODOLOGY

A. Block Diagram

Figure 1 shows the Block diagram

B. Working

In this proposed model of smart street light using hybrid energy power source, three sources are at hand to dispense power supply. The initiators are piezoelectric plate, non-bio degradable waste and grid supply. At the earlier stage, piezoelectric process dispenses power to battery, here the generated power is AC so rectifier is used to convert to DC and non-bio degradable waste act as source to produce power by the process of incineration. In this process waste are burned in the fire box, the heat produced in the method is converted into the power using thermo electric plate. In case the power generation from the above two process is not sufficient to operate

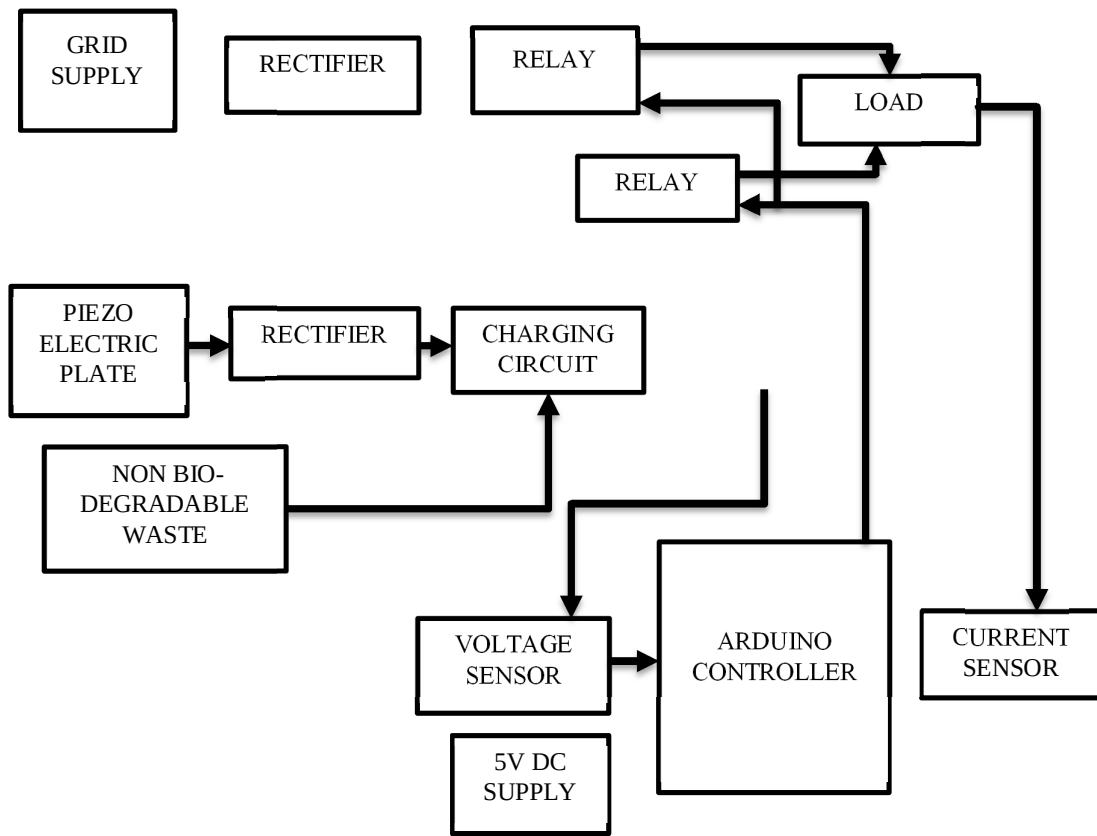


Figure 1. Block diagram

Incineration Process

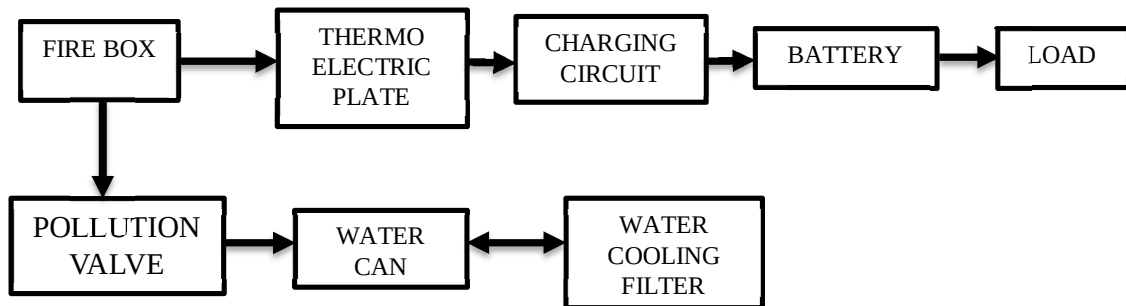


Figure 2. Incineration process

Piezoelectric Process

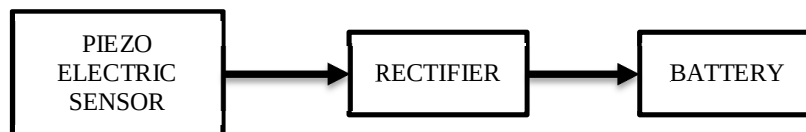


Figure 3. Piezoelectric process

the load then grid supply is involved to operate the load. The voltage sensor is interconnected with Arduino to sense the voltage level in the battery. The Arduino gets processed and change the power source accordingly with the help of relay. The load is monitored by current sensor whether it is working or not.

IV. LIST OF COMPONENTS

- A. Arduino Uno
- B. Voltage sensor
- C. Piezoelectric sensor
- D. Current sensor
- E. Thermoelectric plate
- F. Relay
- G. Rectifier
- H. Battery

A. Arduino Uno

It's a microcontroller module built on the ATmega328. On this board, there are 14 digital input/output pins, 6 analogue inputs, a USB port and power jack, as well as a reset button. It includes all you need to assist the microcontroller; all you have to do is connect it to a computer through USB or power. The required voltage range is 7 to 12 volts. The ATmega328 has 32 KB of flash memory. On board, there's also 2 KB of SRAM and 1 KB of EEPROM. It's powered by an ATmega8U2 that's been set up as a USB to serial converter.

B. Voltage sensor

A voltage sensor is a device that measures and calculates the amount of voltage present in a given component. Both AC and DC voltage levels can be determined using voltage sensors. This sensor's input is a voltage value, and its output is a switch and signal present, both audible and analogue. In this sensor module, a potential divider reduces the input voltage by either a factor of five. This system uses voltage ratio rules between the high and low voltage parts and contains zero ferromagnetic materials. It was effective to minimize the size to a fraction of the size of traditional models. It also has good insulation properties.

C. Piezoelectric sensor

A piezoelectric sensor is an electronic device that uses the piezoelectric effect to translate changes in friction, acceleration, temperature, strain, or force into an electric current. An electric charge is produced across the surfaces of a piezoelectric crystal whenever a force is applied to it. A voltage proportional to the pressure may be used to calculate this. Piezoelectric pressure sensors take advantage of this effect by measuring the voltage produced by the pressure applied across it in a piezoelectric element. It directly generates an output voltage from the applied pressure. The piezoelectric element's output is a charge proportional to pressure. To detect this, a charge amplifier is required to convert the signal to a voltage.

D. Current sensor

Current sensor is a device which is also known as current transformer. It measures the current flowing through using the magnetic field to detect the current and generate a proportional current. When the current flows through the conductor, the proportional magnetic field will be created around the conductor. Current transformer (CT) measures current flow using this magnetic field. If the CT is designed to calculate AC current, inductive technologies are used. Likewise, we use a Hall effect system to calculate DC current using a hall effect sensor. The value is determined in a Rogowski coil is an air cored encircling conductor toroidal winding. Winding selects the conductor surrounded by an alternating magnetic field, and the output is proportional to the amount of changing current.

E. Thermoelectric plate

Thermoelectric materials transform temperature changes into electric voltage to produce power directly from heat. A temperature difference and heat flow can be converted into electricity using thermoelectric technology. A thermoelectric module for power generation resembles a traditional thermocouple in several ways. Consider a single thermoelectric pair with a temperature difference applied. The Peltier effect is used in thermoelectric coolers. When a DC electric current flows through the system, heat is transferred from one side to the other, causing one side to become cooler while the other becomes hotter. The hot side is connected to a heat sink, allowing it to stay at room temperature while the cold side drops below it. Multitasking is effective in a number of cases. Multiple coolers can be cascaded together for lower temperatures in special applications, but overall performance suffers.

F. Relay

A relay act as switch that is powered by electricity. A set of input port for a single or multiple control signals, as well as a set of operating touch terminals, make up the unit. Any range of contacts in various contact modes, such as make contacts, split contacts, or combinations, can be found on the switch. In electronic devices, relays are the most popular switching system. The relay's trigger voltage is 5 volts. We used a +5V Dc power supply to one end of the coil and a switch to ground the other end because the relay has a 5V trigger voltage. This switch may be anything from a small transistor to a microcontroller or microprocessor that can switch things on and off.

G. Rectifier

A rectifier is an electrical system that converts AC (which reverses direction periodically) to DC (which only flows in one direction). The inverter performs the reversing process. The procedure is known as rectification because it "straightens" the current direction. Rectifiers come in a variety of specific shapes and sizes, including vacuum tube diodes and crystal oscillator receivers, as well as modern semiconductor design.

H. Battery

A battery can be described as a device that contains one or more electrochemical cells. Since the facility system's electricity supply and demand should be balanced, real-time energy output across the grid should meet the constantly changing loads. The widespread availability of cost-effective battery energy storage systems (BESS) may now play a significant role in the current balancing phase. Batteries are the most commonly used power source, from small handheld devices to large-scale industrial applications.

V. HARDWARE RESULT

The figure shows the hardware of proposed system in this we are used piezoelectric sensor, thermoelectric plate, voltage sensor, current sensor to generate electricity to run the load.

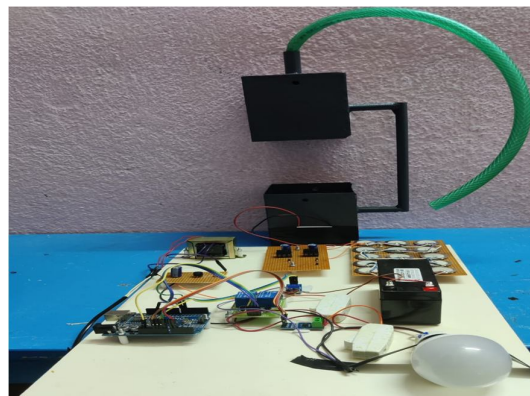


Figure 4. Hardware of proposed system

A. Software result

The figure 6 shows the output of the hybrid source i.e. piezoelectric source and non bio-degradable source

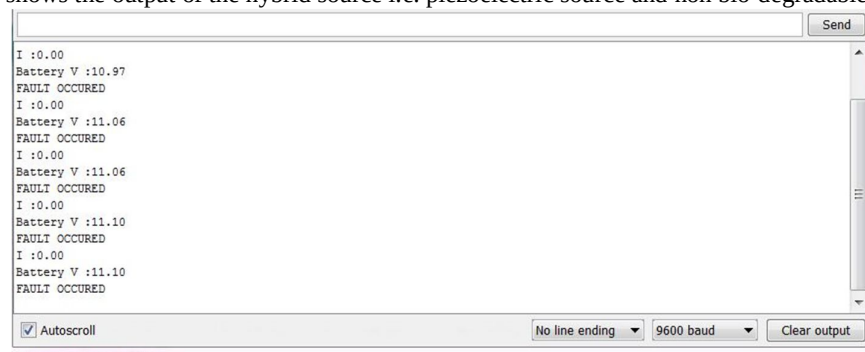


Figure 6. Hybrid source output

The figure 7 shows the output of the grid supply

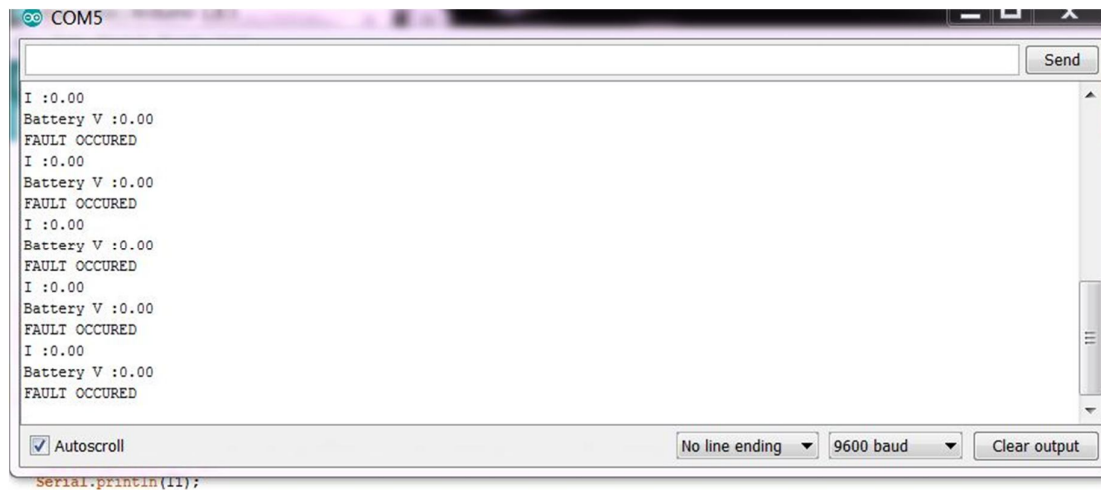


Figure 7. Grid supply output

VI. CONCLUSION

The concept of smart street light system using hybrid energy source have always been a great service to our society. By using the non bio-degradable waste in the environment reduces the spread of diseases and provides the clean environment. Piezoelectric method of generating electricity is very useful for energy management in society. This design is proposed for providing the uninterrupted power supply. This system does not require fuel input. Because, it is self-generating. The effort made in this paper are intended to improve the energy management which ultimately help environment by controlling and reduction of pollution.

REFERENCES

- [1] Renaud, Michael, Tom Sterken, A. Schmitz, P. Fiorini, C. Van Hoof, and R. Puers. "Piezoelectric harvesters and MEMS technology: fabrication, modeling and measurements." In TRANSDUCERS 2007-2007 International Solid-State Sensors, Actuators and Microsystems Conference, pp. 891-894. IEEE, 2007.
- [2] Chandrakasan, Anantha P., Denis C. Daly, Joyce Kwong, and Yogesh K. Ramadass. "Next generation micro-power systems." In 2008 IEEE Symposium on VLSI Circuits, pp. 2-5. IEEE, 2008.
- [3] Calhoun, Benton H., Denis C. Daly, Naveen Verma, Daniel F. Finchelstein, David D. Wentzloff, Alice Wang, Seong-Hwan Cho, and Anantha P. Chandrakasan. "Design considerations for ultra-low energy wireless microsensor nodes." IEEE Transactions on Computers 54, no. 6 (2005): 727-740.
- [4] Ramadass, Yogesh Kumar. "Energy processing circuits for low-power applications." PhD diss., Massachusetts Institute of Technology, 2009.
- [5] Dallago, E., D. Miatton, G. Venchi, V. Bottarel, G. Frattini, G. Ricotti, and M. Schipani. "Electronic interface for piezoelectric energy scavenging system." In ESSCIRC 2008-34th European Solid-State Circuits Conference, pp. 402-405. IEEE, 2008.
- [6] Ramadass, Yogesh K., and Anantha P. Chandrakasan. "Minimum energy tracking loop with embedded DC-DC converter enabling ultra-low-voltage operation down to 250 mV in 65 nm CMOS." IEEE Journal of Solid-state circuits 43, no. 1 (2008): 256-265.
- [7] Lallart, Mickaël, and Daniel Guyomar. "An optimized self-powered switching circuit for non-linear energy harvesting with low voltage output." Smart Materials and Structures 17, no. 3 (2008): 035030.
- [8] Seeman, Michael D., Seth R. Sanders, and Jan M. Rabaey. "An ultra-low-power power management IC for energy-scavenged wireless sensor nodes." In 2008 IEEE Power Electronics Specialists Conference, pp. 925-931. IEEE, 2008.
- [9] Chao, Lu, Chi-Ying Tsui, and Wing-Hung Ki. "A batteryless vibration-based energy harvesting system for ultra low power ubiquitous applications." In 2007 IEEE International Symposium on Circuits and Systems, pp. 1349-1352. IEEE, 2007.
- [10] Tun, Maw Maw, Dagmar Juchelková, Helena Raclavská, and Veronika Sassmanová. "Utilization of biodegradable wastes as a clean energy source in the developing countries: A case study in Myanmar." Energies 11, no. 11 (2018): 3183.

- [11] Clapp, Christa, Alexia Leseur, Oliver Sartor, Gregory Briner, and Jan Corfee-Morlot. "Cities and Carbon Market Finance: Taking Stock of Cities' Experience With Clean Development Mechanism (CDM) and Joint Implementation (JI)." (2010).
- [12] Alzate, Santiago, Bonie Restrepo-Cuestas, and Álvaro Jaramillo-Duque. "Municipal solid waste as a source of electric power generation in Colombia: A techno-economic evaluation under different scenarios." *Resources* 8, no. 1 (2019): 51.