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3 RD INTERNATIONAL CONFERENCE ON APPLIED ENGINEERING AND NATURAL SCIENCES

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20-23 Temmuz 2022 tarihlerinde MEET üzerinden çevrimiçi olarak gerçekleştirilen 3 rd International Conference on Applied Engineering and Natural Sciences akademik teşvik kriterlerini sağlamaktadır. Toplam 736 adet bildirinin yer aldığı kongre dört gün boyunca çevrimiçi olarak gerçekleştirilmiştir.

Türkiye dışından toplam 20 farklı ülkeden katılım sağlanmış olup, 736 adet bildirinin 371 tanesi yabancı katılımcı tarafından sunulmuştur.

Kongremize ilginiz için teşekkür ederiz.

Saygılarımızla,

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Development of Hybrid Energy Harvesting System for Low Power Devices in I.O.T Application

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***Abstract*— In combining multiple energy harvesters from different sources, there is a problem caused due to varying direct current (d.c) output which reduces coupling efficiency and total working of the system. Thus in this research, a hybridizing system is designed in which the blocking oscillator is used as an energy combiner to improve on the coupling efficiency and enhance the system's working operation. The hybrid harvester comprises of a blocking oscillator, radio-frequency (R.F) harvester, solar harvester and piezoelectric harvester. The blocking oscillator made of four inductors all wounded on a single toroid with three transistors as switches for the input. Rf harvester was designed using copper coil as antenna to receive the necessary power needed. Piezo-electric harvester is designed using piezo-elements arranged parallel to each other on a board. Solar panel with dimension 238 by 140 by17mm was used for solar energy harvester. The result of the system was able to power a sensor of 3V and charge a 10V super-capacitor even at low level of 0.3V. It attained 90% efficiency. In conclusion a hybrid energy harvester with an improved combining system was successfully developed which achieved better performance at maximum working condition and was still able to give manageable performance at low working condition.**

Keywords: energy harvester, blocking oscillator, piezoelectric, radio frequency, solar.

I. INTRODUCTION

Internet of things (IoT) has brought numerous devices together [1]. Devices connected to internet is increasing as population increases [2]. Energy harvesting helps in situations where the use of wires and batteries are impractical [3]. Also, battery capacity and lifespan commonly used to power wireless devices is limited [4]. Combining multiple energy sources of the same or different types increases reliability of the system [5]. Various improvements on the efficiency of hybrid energy harvesting system such as [6], combined the system using power oring method. [9] combined with single inductor method. The major problem with these hybrid systems is low efficiency due to poor coupling choice and performance degrades due to deviation in synchronized part. This research, improves on hybrid system's coupling efficiency and enhance its working operation.

II. MATERIALS AND METHODS

The piezo-elements are arranged in an order where the entire crystals are to be connected in parallel to each other as adopted from [7] because of the low current of the piezo which is to be stepped up for practical use while the support system of the harvester is designed from [12]. Radio frequency energy emitted by sources that generate high electromagnetic fields such as transmitters from radio networks, through power generating devices are captured and converted into usable dc voltage [13]. In this work, the transmitter is a low power device designed using a multi-vibrator which

operates at a frequency of 100kHz. The rectenna design was in accordance to [8] whereas antenna used is a copper coil, to produce the necessary power needed. Harvesting solar energy is done with the use of solar panel as designed adopted from [11]. Arranging the solar cells is adopted from the method in [10]. Placing the panel under sunlight enables it to harvest energy from the sun and convert it to useful power. The single diode in the panel converts power to d.c and so this is fed through the blocking oscillator to a super-capacitor for storage. The blocking oscillator circuit is used for voltage multiplication and combiner. It consists majorly of transformer, transistor, resistor and capacitor. This method combines the three harvesters to increase current. This connection is relevant because the boost converter would use the added current for more efficient charging.

III. RESULT

The summary of test result of the hybrid energy harvester is shown in table 1 using a 3farad capacitor. Fig (1) shows the hybrid system's efficiency tested at different load resistance at 300lux, 20kg, and 860Hz. Fig (2) shows charge performance between combining with blocking oscillator against power-oring.

IV. DISCUSSION

The overall performance of the three energy harvesters is shown and although the harvesters have different d.c output, which reduces working performance of hybrid systems, in figure (2) the rate of charge of the proposed system shows a better performance. This reduced the effect of varying d.c output enabling the system to work better than the state-of–the art (power oring) combining method. The blocking oscillator has a self-start feature at low voltage. As the voltage of the hybrid system was varied, it is observed in table (1) that even as low as 0.3V, the device was still able to power the load. While the power-oring combining method could not charge the storage and power the load. The efficiency was achieved when placed on various loads with different resistance. It attained 90% efficiency.

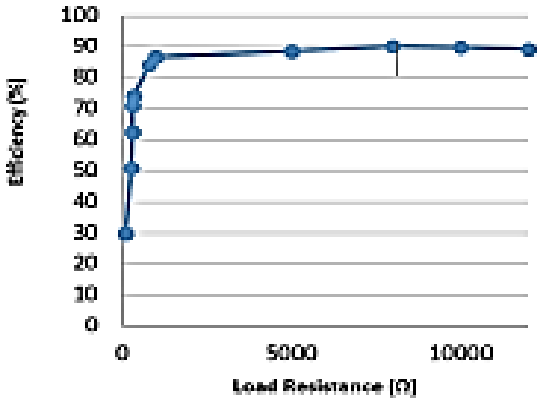

Fig 1: Efficiency against load resistance

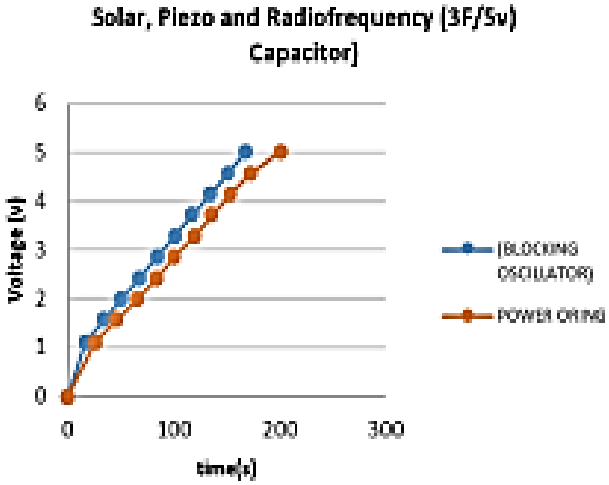

Fig 2: Charge performance between combining with blocking oscillator against power-oring

Table 1. Test result of hybrid harvester

Input	Device with power-oring	Device with blocking oscillator
7V	5sec charge, sensor ON	5sec charge, sensor ON
5V	5sec charge, sensor ON	5sec charge, sensor ON
2V	9sec charge, sensor ON	7sec charge, sensor ON
0.7V	20sec charge, sensor ON	12sec charge, sensor ON
0.3V	No charge, sensor OFF	Trickle charge, sensor ON

V. CONCLUSION

One of the most common threat associated with power insufficiency is the fact that the storage device will not store charges properly as it is supposed to and also the device would fail to stay powered on. However, in this research, using blocking oscillator to hybridize energy harvester is achieved enabling a hybrid energy harvester to be successfully developed which achieved better performance at maximum working condition and was still able to give manageable performance at low working condition.

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