International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-6, Issue-2)

Research Article **February 2017**

Special Issue on International Conference on Emerging Trends in Engineering (ICETE) -2017
Conference Held at Hotel Magaji Orchid, Sheshadripuram, Bengaluru, India.

Effective Multisource Energy Harvesting System for WSN

Sridhar N. H.
Assistant Professor
Dept of E & E Engineering,
A.I.T, Chikkamagaluru, India

Dr. G. S. Anitha
Associate Professor
Dept of E & E Engineering,
RVCE, Bangalore, India

Sumathi M S
Assistant Professor
Dept of TC Engineering,
BMSIT, Bangalore, India

Abstract:

Now a day's attention on energy harvesting for autonomous sensing, which can work on decades. The goal is to power scavenging for the system is exposed to reasonable environment energy conditions. We are looking for multiple energy sources such as solar, thermal and vibration. The amount of available energy has a direct effect on the performance, functionality and lifetime of WSN. Sensor node is usually equipped with limited amount of energy and therefore requires storage devices. The objective of this paper to discuss potential renewable energy resources, maximum power point method to extract the energy, power management module ,storage devices. The proposed system can successfully switch the power supply path according to the ambient energy sources and load power automatically.

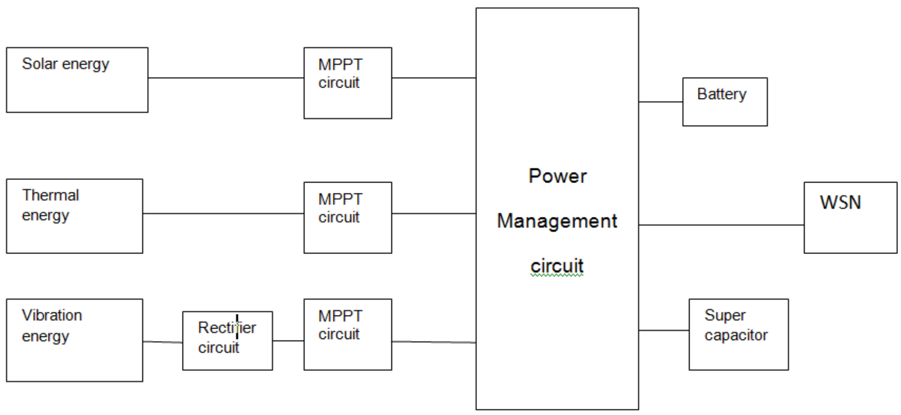
Keywords: MPPT, PZT

I. INTORDUCTION

Wireless sensor network widely used for industrial productions, military defense & disaster monitoring. Now a day's Wireless sensor network have played a major role in the research field [1]. Research within this field has covered a wide spectrum of topics such as leading to advance in node hardware, protocol stack design, localization and tracking techniques and energy management. Power supply from single energy source is unpredictable and irregular so that energy scavenging from multiple sources. Energy harvesting system has been studied extensively by using PV modules, it provide large power density [1-2]. Along with discussed on vibration based energy sources & temperature difference based energy sources. The energy system consists of multiple harvesters that convert the available energy from the atmosphere to electrical energy. The energy obtained by the harvesters can be stored in battery and super capacitor [3].An energy harvester can be considered as multiple renewable energy sources and also multiple energy consumers or loads. The real challenge in the design of energy harvesting systems is to provide a continuous and stable power supply to the load, at the same time the harvester size and cost as low as possible[1,2,3].

The key design goals which should be considered to implement an effective energy harvester are

- The energy harvesting from the multiple source transfer to the load with maximum efficiency, while transfer losing some amount of energy This requirement poses the following issues:
  (a) Each source extract the energy from the environment in a certain kind, that energy can be converted into electrical energy should be always kept operating at its maximum conversion efficiency, with the aid of an expressly designed maximum-power-point tracking (MPPT) circuit,
  (b) The circuits which converts harvested energy from one from to another form (e.g. DC/DC converters or AC/DC converter) should lose the least possible amount of energy during the transfer, and
  (c) The power consumption of the harvester control circuitry should be negligible when compared to the power delivered to the load;
- It should add buffer between the variable power consumption of the final system and the wide dynamic range of the variable ambient sources. This requires the harvester to store the collected energy in devices working as energy reservoirs,



Architecture of the multisource energy harvesting system.

The two alternatives commonly used for energy storage are secondary rechargeable batteries and super capacitors (also known as ultra capacitors). Super capacitors are similar to regular capacitors, but they offer very high capacitance in a small size. They offer several advantages with respect to rechargeable batteries. First of all, super capacitors can be recharged and discharged virtually an unlimited number of times, while typical life-times of an electrochemical battery is less than 1000 cycles. Second, they can be charged quickly using simple charging circuits, thus reducing system complexity, and do not need full-charge or deep-discharge protection circuits. They also have higher charging and discharging efficiency than electrochemical batteries. Another additional benefit is the reduction of environmental issues related to battery disposal.

II. LITERATURE REVIEW

Solar power is the most common and matured among the different forms of energy harvesting. However, it has the disadvantage of being able to generate energy only when there is sufficient sunlight or artificial light. Furthermore, existing systems were not designed for use with low power WSNs, prompting new research efforts. With the envisioned indoor WSN applications, a system has been developed to address the needs of WSNs deployed in indoor environments, where lights are operational at close to 100%duty cycle . To ensure that energy is not unnecessarily lost during the transfer from the harvester to the wireless sensor, a low-power maximum power point tracker (MPPT) circuit [2] has been proposed to efficiently transfer the harvested solar energy to rechargeable batteries even in non-optimal weather conditions. The Heliometer [3] project focused on developing a plug-and-play solar energy harvesting module for use with Cross bow/Berkeley motes. Another effort conducted empirical and mathematical analysis of two micro-solar power systems and used the results to propose design guidelines for micro solar power systems for WSNs [4].

Vibrational, kinetic and mechanical energy generated by movements of objects can also be harvested. Vibrations are present all around us and especially in bridges, roads and rail tracks. One method of harvesting vibrational energy is through the use of a piezoelectric capacitor while kinetic energy can be harvested using a spring-loaded mechanism. In [5], a vibration-based harvesting micro power generator is used to scavenge environmental vibrations for use in a sensor node. Traffic sensors can also be solely powered by the short duration vibrations when a vehicle passes over the sensor [6]. Experimental results have shown that when a piezoelectric pushbutton is depressed, sufficient energy is harvested to transmit two complete 12-bit digital word information wirelessly [7]. Similarly, a system that harvests energy from the forces exerted on a shoe during walking has been demonstrated [8] and indoor locations, like staircases, are potential locations to harvest vibrational energy for powering wireless environmental sensors, as shown in [9].

Current is generated when there is a temperature difference between two junctions of a conducting material. Thermal energy harvesting uses temperature differences or gradients to generate electricity, harvest the energy radiated from the human body by means of thermo generators (TEGs) [10]. To address the needs of telecommunications and other embedded applications, design of micro structured thermoelectric devices has been proposed in [11]. Due to the lack of moving parts in thermal energy harvesting devices, they tend to last longer than vibration-based devices.

III. TECHNIQUES OF ENERGY HARVESTING

Solar Energy Harvester. Solar power is the conversion of energy from sunlight into electricity, solar energy reservoir is considerably larger than all other energy, and it provides a large power density, making it a suitable choice to power WSNs. As the output characteristics of a solar panel changes nonlinearly with the change in temperature, maximizing the efficiency becomes critically important, and the MPPT circuit should be included in the solar energy harvester to find the operating point of voltage and current at which the solar panel should deliver the highest possible power [17,18,19]., the analog driving MPPT circuit contains a pilot cell, a capacitor, a hysteresis comparator, and a step up DC-DC converter.

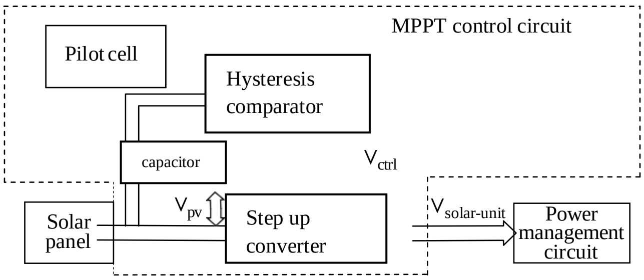


Fig 1.Schematic diagram of Solar Energy Harvester

Vibration Energy Harvester. We have used low cost lead zirconate titanate (PZT) material. This piezoelectric sensor uses the piezoelectric effect to measure mechanical input (acceleration, pressure, strain or force) by converting them to an electrical signal. Piezoelectric sensors are used for various process it provides mature technology with an outstanding inherent reliability. A vibrating piezoelectric element electrically behaves as a capacitive AC source It should be rectified at a desired DC voltage level for the power supply to an electronic device[7,9,11],. Energy harvesting circuit contains the full bridge diode rectifier with electronic control circuits. The voltage double (VD) rectifier and the MPPT circuit are used for the vibration energy harvester in this system

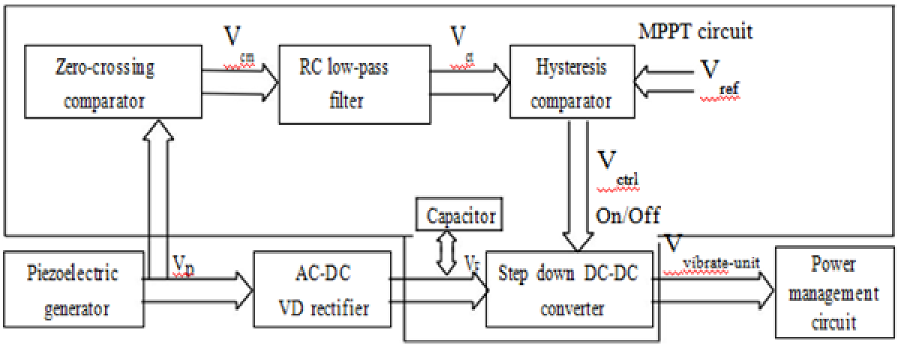


Fig 2 Schematic diagram of the vibration energy harvester.

Thermal Energy Harvester A simple TE generator is made by heating one face of TE module, and cooling the other face causing an electrical current to be generated by connected a load to the end points of the TE module. This behavior is described as the Seebeck effect, and was discovered by Tomas Seebeck in 1821. A TE generator has demonstrated attractive characteristics such as a long life cycle, no moving parts, simple and high reliability. However, its low efficiency is a big drawback that has continually prevented the widespread commercial application of this technology. Current TE materials can only convert a maximum of 5-6% of the useful heat into electricity. However, some significant researches is being carried out to develop new materials and module constructions, which promise harvesting efficiency of more than 10%.

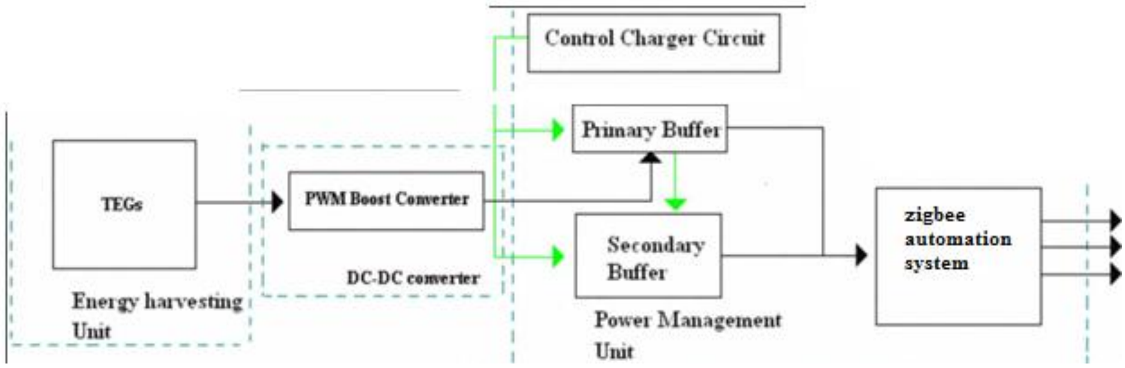


Fig 3.architecture of the thermal energy harvesting system

Figure 3 depicts the general architecture of the thermal energy harvesting system, which is composed of three subsystems: the thermal energy harvesting subsystem, the DC-DC converter subsystem and the power management subsystem. In the proposed system architecture, three primarily steps are achieved to harvest thermal energy for the target system. The thermal energy harvesting subsystem harvests thermal energy and converts it into electrical energy. Then the output of the TE generators is connected to the DC-DC converter subsystem to increase the available output voltage in order to supply the ZigBee chips and to charge some energy storage elements. Synchronously, the harvested energy is efficient distributed by the power management subsystem.

IV. CONCLUSION

In this paper we have presented an effective multi-source, Multi-storage energy harvesting architecture. It's straightforward, fully analogue design based on ultra-low-power components makes it a very efficient and cost effective solution to enable the autonomous operation of WSNs. autonomously and simultaneously while performing MPPT on each power source. The design of energy reservoirs using lithium polymer battery ensures a continuous power supply to the load system even during long periods of ambient energy shortage. The connected super-capacitor provides WSNs with a large instantaneous output power and protects the battery from charging and discharging frequently. We can achieve a practical WSNs platform shows that efficiency of the energy harvesting system can reach about 75–85%.

REFERENCES

[1] Hao Li, Gaofei Zhang, RuiMa, and Zheng You," Design and Experimental Evaluation on an Advanced Multisource Energy Harvesting System for Wireless Sensor Nodes," the Scientific World Journal, Article ID 671280, 13 pages, Volume 2014

[2] Berk Gurakan, Omur Ozel, Jing Yang, and Sennur Ulukus "Energy Cooperation in Energy HarvestingTwo-Way Communications" IEEE ICC2013 Communications Theory,PP 3126 -3130.

[3] Berk Gurakan, Omur Ozel, Jing Yang, and Sennur Ulukus, Member, IEEE "Energy Cooperation in Energy Harvesting Communications" IEEE Transactions On Communications, Vol. 61, No. 12, December 2013, Pp 4884-4897.

[4] Vassili Savinov, Vassili A. Fedotov, Peter A. J. de Groot, Nikolay I. Zheludev, "Radiation-Harvesting Resonant Superconducting sub-THz Metamaterial Bolometer"IEEE 2013.

[5] Yannick Verbelen and Abdellah Touhafi "Resource Considerations for Durable Large Scale Renewable Energy Harvesting Applications" International Conference on Renewable Energy Research and Applications Madrid, Spain, 20-23 October 2013, PP 401-406

[6] Kazuyasu Kawashima and Fumiaki Sato "A Routing Protocol Based on the Power Generation Pattern of Sensor Nodes in Energy Harvesting Wireless Sensor Networks" 2013 16th International Conference on Network-Based Information Systems,PP 471-475.

[7] Hongseok Yoo, Moonjoo Shim, and Dongkyun Kim "Dynamic Duty-Cycle Scheduling Schemes for Energy-Harvesting Wireless Sensor Networks"IEEE COMMUNICATIONS LETTERS, VOL. 16, NO. 2, FEBRUARY 2012.

[8] Fatemeh Jalalia, Safieh Khodadoustana, Alireza Ejlalib "Error Control Schemes in Solar Energy Harvesting Wireless Sensor Networks"ICSIT 2012,PP 979-984.

[9] J. Yick, B. Mukherjee, andD.Ghosal, "Wireless sensor network survey," ComputerNetworks, vol. 52,no. 12,pp. 2292–2330, 2008.

[10] X. Lu and S.-H. Yang, "Solar energy harvesting for zigbee electronics," in Proceedings of the 1st International Conference on Sustainability in Energy and Buildings, pp. 19–27, Springer, May2009.

[11] Sridhar N. H and Dr. G.S.Anitha ."A Piezo Electric Tile For Harvesting Energy :A Tool For Power Generation Laboratory" presented a paper in 18th ISTE Karnataka state level annual Faculty Convention held during 6th - 7th November, 2015.

[12] D. Dondi, A. Bertacchini, D. Brunelli, L. Larcher, and L. Benini, "Modeling and optimization of a solar energy harvester system for self-powered wireless sensor networks," IEEE Transactions on

[13] N. Wojtas, E. Schwyter, W. Glatz, S. K¨uhne, W. Escher, and C. Hierold, "Power enhancement of micro thermoelectric generators by microfluidic heat transfer packaging," Sensors and Actuators A, vol. 188, pp. 389–395, 2012.

[14] S. Roundy, B. P.Otis, Y.-H. Chee, J. M. Rabaey, and P. A.Wright, "1.9 GHz RF transmit beacon using environmentally scavenged energy," Optimization, vol. 4, no. 2, p. 4, 2003.

[15] R. Morais, S. G. Matos, M. A. Fernandes et al., "Sun, wind and water flow as energy supply for small stationary data acquisition platforms," Computers and Electronics in Agriculture, vol. 64,no. 2, pp. 120–132, 2008.

[16] C. Park and P. H. Chou, "AmbiMax: autonomous energy harvesting platform for multi-supply wireless sensor nodes," in Proceedings of the 3rd Annual IEEE Communications Society on Sensor and Ad hoc Communications and Networks (Secon '06), pp. 168–177, September 2006.

[17] Z. Abdin, M. A. Alim, R. Saidur et al., "Solar energy harvesting with the application of nanotechnology," Renewable and Sustainable Energy Reviews, vol. 26, pp. 837–852, 2013.

[18] D. Brunelli, D. Dondi, A. Bertacchini, L. Larcher, P. Pavan, and L. Benini, "Photovoltaic scavenging systems: modeling and optimization," Microelectronics Journal, vol. 40, no. 9, pp. 1337–1344, 2009.

[19] G. F. Zhang, R. Ma, Z. You, and Z. C. Zhang, "A low-power photovoltaic maximumpower point tracking circuit forWSNs," Key Engineering Materials, vol. 562, pp. 1045–1051, 2013.

[20] A. Tabesh and L. G. Fr´echette, "An improved small-deflection electromechanical model for piezoelectric bending beam actuators and energy harvesters," Journal of Micromechanics and Microengineering, vol. 18, no. 10,Article ID 104009, 2008.

[21] G.K.Ottman, H. F. Hofmann,A.C. Bhatt, and G. A. Lesieutre, "Adaptive piezoelectric energy harvesting circuit for wireless remote power supply," IEEE Transactions on Power Electronics, vol. 17, no. 5, pp. 669–676, 2002.

