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Eco-Energy Sensor Networks

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ABSTRACT

This project perpetual environmentally powered sensor networks aims to develop a system for harvesting energy from the renewable environmental energy source using the embedded systems technology. Utilizing environmental energy sources holds great appeal as a power supply for low-power wireless sensor networks.This has become a major problem now a days as the proposed system involves human intervention. This project is aiming to pinpoint the best hardware selections that align with the requirements of a particular application. The primary goal is to optimize the hardware to precisely cater to the needs and demands of the given application. The primary design obstacle involves minimizing stress on storage components while maintaining a straightforward hardware and software structure. This design is a smart system that integrates streamlined, efficient hardware with robust software. This system will actively oversee the power subsystem to ensure continuous operation.

Key words : Harvesting energy, Embedded systems, Optimize Hardware, Renewable environmental energy.

1. INTRODUCTION

The sensor network vision relies on sustainable computing, enabling nodes to operate In outdoor environments, the most readily available energy source for continuous use is solar energy, harnessed from the surroundings. Designing a photovoltaic (PV)Establishing a system to sustain the perpetual operation of ultra-low power wireless sensor nodes presents distinctive hurdles, demanding simplicity, resilience, and the ability to function autonomously for numerous years without human intervention. Sensor networks have low duty cycles and varying power requirements, from microwatts in standby to milliwatts when active. Applications often operate at low duty cycles in unpredictable environments, necessitating adaptation to available energy reserves. The deterioration of energy storage devices, such as rechargeable batteries, limits the device's lifetime. This paper introduces Prometheus (figure 1), an extended-duration solar power subsystem for Telos, the latest wireless sensor network mote. The key challenge lies in reducing strain on storage elements while maintaining a straightforward hardware and software architecture. The design involves an intelligent system with lightweight hardware and efficient software actively managing the power subsystem for perpetual operation.

2. LITERATURE SURVEY

Researchers have been using Hardware components and the computers to help energy harvesting using solar energy for a while now. Here are a few important studies :

This introduces an innovative autonomous power source utilizing a novel system architecture. Unlike conventional approaches that typically rely on a single rechargeable energy buffer, our system incorporates energy scavenging to replenish two distinct rechargeable energy buffers. Moreover, it leverages sunlight energy efficiently and implements a sophisticated real-time management system to intelligently regulate both energy buffers[6].

A lightweight algorithm tailored for online load adaptation of energy-harvesting sensor nodes. This approach utilizes supercapacitors as energy buffers and is specifically engineered to effectively manage the nonlinear system model. Notably, the algorithm is designed to be lightweight, ensuring its suitability for execution on low-power sensor node hardware[7].

This introduces a Smart Power Unit (SPU), which encompasses a power supply architecture. This architecture adeptly handles energy harvesting and employs cutting-edge fuel cell technologies, ultimately enhancing power availability for embedded systems [8]. This presents an efficient energy harvesting system compatible with diverse environmental sources like light, heat, or wind energy[9].

3. METHODOLOGY

I. Our system's architecture, as depicted in Figure 1, closely mirrors the typical environmental power systems found in today's energy landscape. You can refer to [2] and [3] for more detailed information on these systems. Essentially, these systems comprise four primary The system comprises the following components: an energy source, a buffer, a charge controller, and a consumer.

The source of energy is responsible for providing a specific current output based on the prevailing environmental conditions, such as solar energy refer as [1]. On the other hand, the energy consumer, exemplified by devices like the Telos mote wireless sensor node, operates in various modes, each with significantly different levels of current consumption.

An energy buffer is used to store excess energy during periods of ample energy supply and subsequently release this stored energy when the primary source is insufficient. Typically, energy buffers consist of supercapacitors, or rechargeable batteries. Lastly, a controller circuitry is responsible for replenishing the energy buffers and ensuring that the required current or voltage is supplied to the consumer.

Several research endeavors have delved into harnessing environmental energy sources for energizing wireless sensor networks [4], [5]. Our inspiration was drawn from a UCLA-developed design detailed in [4]. This design effectively provided power to the preceding MICA mote , renowned for its high power demands, outperforming the Telos mote used in our system.

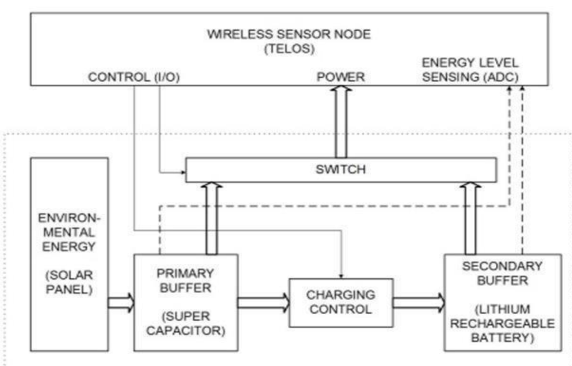

Figure 1: System Architecture and Prometheus Implementation

The UCLA design primarily relies on an additional buffer. comprised Using a NiMH rechargeable battery and straightforward hardware for energy transfer control. However, it has a limitation as solar energy refer as[1] directly charges the battery, subjecting it to daily recharge cycles, which ultimately stress the battery. This constraint restricts the system's operational lifetime to a maximum of two years, a duration not significantly longer than what can be achieved Using only batteries and still far from achieving continuous operation.

Pico Radio [5] explored the use of rechargeable batteries but abandoned the idea due to limitations in recharge cycles. Instead, the system exclusively utilizes capacitors. However, in the absence of Due to the energy source, the system encounters interruptions within a few hours.

II. MIT's Cricket incorporates a capacitor for buffering current surges but cannot Our system deals with the recharge cycle concern to enable operation without a continuous supply of solar energy, thanks to advanced charging control. Additionally, our wireless node is meticulously designed for energy-efficient operation, resulting in a significantly lower power load. This eliminates the need for energy-intensive refer as[1] and complex power control logic, as seen in Zebra Net

III. The electrical engineering community has explored hybrid Batt Cap designs that combine supercapacitors and batteries on a At the chemical level, yet in a cost-effective manner high-power systems, the conventional approach involves combining NiCad batteries with large capacitors, which is inadequate for space-constrained sensor networks.

4. RESULTS AND DISCUSSIONS

We have successfully implemented the perpetual System that works without the power . Super Capacitors are effortlessly charged by harnessing the power of solar panels, The charging module receives the input of the super capacitors charge (figure 3, figure 4), The polymer battery is connected to the charging module’s battery pins, and the charging module receives the output from it (figure 2).

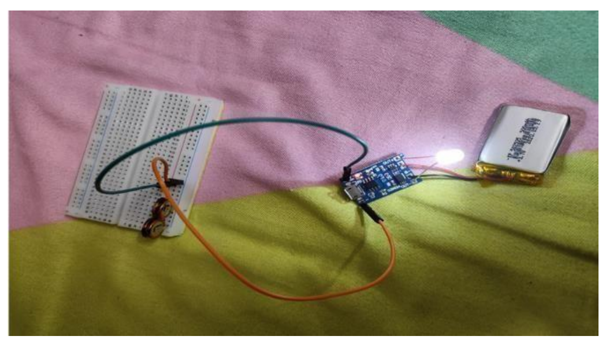

Figure 2: Output

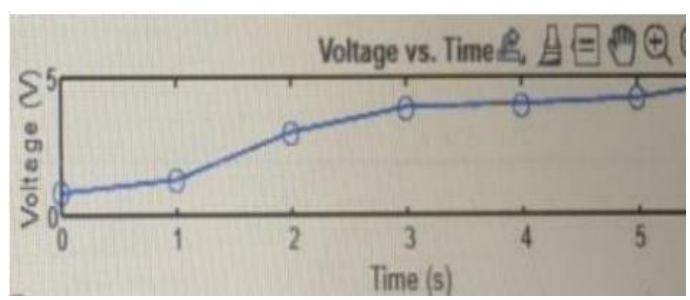

Figure 3: Voltage VS Time

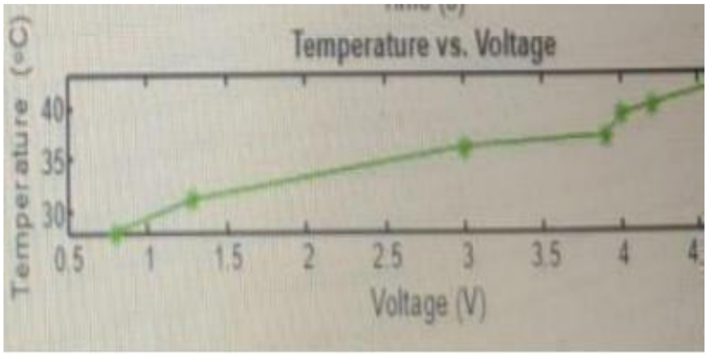

Figure 4: Temperature VS Voltage

5. CONCLUSION

In summary, our journey in developing Perpetual environmentally powered sensor network system has been about turning an idea into a practical solution. Our system effectively oversees a two-stage buffer to extend the longevity of the system's hardware, encompassing supercapacitors and lithium rechargeable batteries.

The data on energy levels collected by our sensor node can be utilized for developing Wireless networking protocols designed with power efficiency in mind. Through empirical demonstrations, we have validated that our system operates as anticipated based on our analysis, resulting in prolonged sensor network deployments with enhanced longevity.

But we're not stopping here. We're eager to make it even better by improving accuracy, adding more types of applications, and including many sensors in it. Our future plan is to use more applications and run on this system with more observations.

Ultimately, this research is a step toward using technology to explore and understand the natural world more safely. It shows how science and technology can work together to help us explore the world of Renewable sources.

REFERENCES

[1] J. Schaeffer and D. M. Pratt, The Real Goods Solar Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living, 11th ed. Gaiam Real Goods, Aug. 2001.

[2] xiaofan Jiang, Joseph Polastre, and David Culler, university California, Berkeley. Berkeley: Perpetual Environmentally Powered Sensor Networks.

[3]A. Kansal, D. Potter, and M. B. Srivastava, "Performance aware tasking for environmentally powered sensor networks," Sig metrics 2004, 2004.

[4].S. Roundy, D. Steingart, L. Frechette, P. K. Wright, and J. M. Rabaey,"Power sources for wireless sensor networks," in Proceedings of EWSN 2004, Berlin, GERMANY, Jan. 2004.

[5]S. Roundy, B. P. Otis, Y.-H. Chee, J. M. Rabaey, and P. Wright, "A 1.9ghz rf transmit beacon using environmentally scavenged energy," in IEEE Int.Symposium on Low Power Elec. and Devices, Feb. 2003.

[6] Alberola, J. (2008). "Innovative Autonomous Power Source with Dual Rechargeable Energy Buffers and Sunlight Energy Utilization.

[7] Renner, C. (2014). "A Lightweight Algorithm for Online Load Adaptation of Energy-Harvesting Sensor Nodes Using Supercapacitors."

[8] Porcarelli, [Author Initials]. (2012). "Smart Power Unit (SPU): A Novel Power Supply Architecture for Enhanced Energy Harvesting and Fuel Cell Integration."

[9] Le, T. N., & Pegatoquet, A. (2015). "Efficient Energy Harvesting System Compatible with Multiple Environmental Sources: Light, Heat, and Wind Energy Integration." .