A Review of Energy Harvesting Real-Time System

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Abstract. Today the world is getting more complicated with the use of embedded system. Real-time based embedded systems are widely used everywhere. But the problem in today's real-time embedded system is limited power supply due to the compactness of the system . Many technologies are invented to cope-up energy need of mobile devices system .Energy harvesting easy is free energy solutions for such systm.Still there is wide area of research in this field. Up till no optimum solution has focused to satisfy the energy requirement of the real-time system using energy harvesting. This paper discusses the various energy harvesting issues related to the real time embdedded system.

1 Introduction

Real-time embedded system is the demanding field in the computer industry. Daily new products are coming to the industry. This includes battery powered mobile devices starting from laptop to mobile phones. The devices may used for various multimedia data processing such as audio, video, images and other types of data. Like traditional desktop system, requires continuous power supply for their functioning. Normally desktop system is provided power supply on the wall. There are some situations providing the power supply from the wall is not possible to mobile devices. Portable electronic devices, in which power is given by batteries, rely on energy efficient power management scheduling algorithm to increase the battery lifetime; while non-portable system need energy efficient schedule to reduce the energy cost. Several strategies are used such as changing the battery and providing continuous power supply from the wall. But for remote devices cost of battery replacement is high and regular power is not also possible. The possible way to save the energy using dynamic voltage scaling (DVS) [1], which operates the processor in several range of voltage and frequencies. Meikang Qiu *et al*. [2] design a novel loop scheduling algorithm for real–time applications that produce schedule consuming minimal energy. Energy harvesting provides solution to this type of system. Energy is power required by the system for their functioning. This can be found everywhere in the environment, movement of doors and windows or machine components, the vibration of motors, changes in temperature. These energy sources, which are neglected and normally not usually remain unused, can be tap into by means of energy harvesting to power electronic devices and broadcast wireless signals.

Fig. 1. Process of energy harvesting system.

In addition to that energy from various sources is found in adequate quantity for the efficient working of the system, which is not possible in the regular way up till now. The flow of energy source to its utilization is shown in figure 1. The energy source can be sufficient to provide the power to working of the system .Energy Harvesting is the simple process of transforming energy from the environment to the system storage, so that it can use for the various functions in the system. The various microprocessor based technologies have increased power efficiency, effectively reducing power consumption requirements.

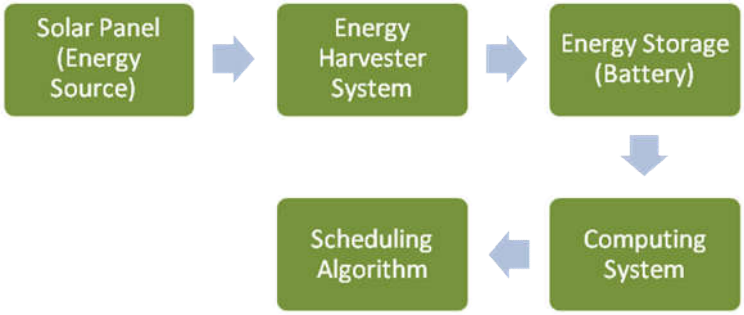

Fig.2. Energy harvesting system.

Nowadays small solar panels suffice to ensure continued operations, and several photovoltaic (PV) harvesting circuits have been recently proposed for this purpose. The advantage of the solar energy over other forms of environmental energy [3] is that the available solar energy can be predicted at least to some extent. This allows one to implement power management techniques and to plan optimized the future system activity in order to achieve more suitable operations. Another aspect [4] of harvesting system design is to use harvesting energy using appropriate power management approaches. The figure 2 shows the architecture of energy from solar panel to scheduling of several tasks with required energy. The energy is stored in the battery and according to the scheduling strategy used for process. This paper deals with the various types of energy harvesting methods used for real-time embedded systems, and also different approaches used to optimization of the energy in the system.

2 Related study

Energy can be harvested from different sources and may be used by several types of system. Power management is need of computer system design not only hardware structure but also to software side. In [5] Andre Allanena a*t al* considers the task on

single processor with variable voltage and frequency.Within a framework problem is solve the task execution using valid schedule within the task deadline **,** with the same battery level at the beginning and end. This uses the idle time using algorithms to recharge the battery at minimum level to execute the task. However this solution deals with the frame based system in a restrictive structure. All tasks have common deadline and also the problem of preemption is not solved. The possibility to harvest energy from environment and sustain everlasting operation has earned much interest recently. In [6] address sensor nodes which are situated in an outdoor environment in the sunlight. This algorithm work to maximize the overall reward. The frame based structure is considered and prediction is determined for the future frames for energy estimation. In [7], G. Sudha *et. al.* addressed the problem of scheduling complex periodic tasks in a single-hop wireless networked embedded system, where each node supports both DVS and DMS power management techniques. But the problem addressed in this paper can be extended to provide an optimal solution through analytical approaches like integer linear programming formulation. The lazy scheduling algorithm (LSA) proposed in [8] as clairvoyant algorithm, assume the knowledge of future availability of environmental power. The algorithm work on offline task schedule. To achieve the efficient energy management new lazy scheduling algorithm (LSA), the solution is provided for energy-aware lazy scheduling algorithm (EA-LSA) proposed in [9]. But the computational complexity is not reduce up to the extend and scope is remain for the improvement.

3 Scheduling in Energy Harvesting System

The aim is to used harvested energy within a system this section provides an assessment of available energy harvesting method acting suitable for real-time embedded system.

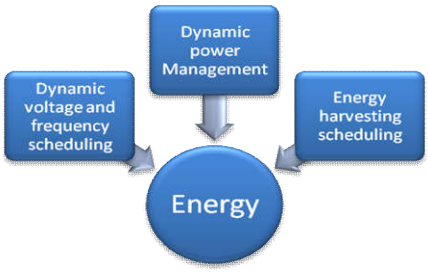

Fig.3. Different techniques used for energy supplier in the system.

The Table 1 gives the introductory survey on energy harvesting as applied to relevant themes in mobile devices.

Table 1. Overview of various approaches and scheduling techniques for energy utilization.

Sr. No.	Year	Different approach for energy utilization	Scheduling Techniques	Remark
1	2001	Rechargeable Batteries	Fix speed processor variable speed processor	To be able to reduce the cycle time of the system
2	2007	Energy-Aware Scheduling	Dynamic voltage scheduling and Dynamic Management Scheduling-Dynamic modulation scheduling	Energy minimization not only of processor but entire system
3	2008	Reward Maximization	Polynomial –time algorithm	Minimize battery capacity, to minimize round-trip losses
4	2010	Dynamic and Leakage Energy Minimization	Loop-Scheduling algorithm	To produce scheduling consuming minimal energy, minimize leakage power consumption
5	2011	Approximation algorithm for variable voltage processor	Dynamic Voltage Scheduling	Energy minimization max throughput
6	2012	Energy efficient dynamic voltage and frequency	Weighted First Come First Serve scheduling	Using resource constraints, work on energy saving
7	2013	Energy-aware LSA	Clairvoyant Algorithm	Reduce the LSA computational complexity, test is performed on varying energy capacity
8	2014	Semi-online Earliest deadline first based	Optimal Scheduling	Provide feasibility test, uses slack energy

Embedded systems are design to performance in high and accurate scale when needed, but most of the time energy shortage limits the performance. Figure 3 shows the effect of several techniques on the energy. Dynamic voltage and frequency scheduling (DVFS) lower down the execution whenever required. The Dynamic power management (DPM) decreases the energy consumption by idolizing the components. The techniques in [10] have limitations in energy harvesting system because they minimized CPU power.

4 Summary

Energy is the major concern of real-time embedded system; various approaches are used to improve the performance of the power management. This paper discusses some of them to put the focus on the problems related with efficient power utilization technique. It is observed that no optimum solution has been found with the effective use of energy in to the system. The research area is open for the development of power management and efficient uses of energy. Also the parameters related with energy harvesting and its utilization to keep it up to the mark. Another aspect of harvesting system design is to take advantage of energy available in the environment which is always neglected. The conventional device with traditional power supply wont aware so much about energy management policies, it never compromise on power supply. But the problem arises where giving continuous power supply is not possible. Today is the need of new power management strategies considering mobility of the system and energy need to improve the system overall performance.

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