

DYNAMIC PLANNING BASED SCHEDULING APPROACH FOR WIRELESS SENSOR NETWORKS

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ABSTRACT

Energy efficiency is an important issue in wireless sensor networks. A sensor node has a microprocessor and a small amount of memory for signal processing and task scheduling. Dynamic Planning is a method used in this approach it combines the flexibility of dynamic scheduling with the predictability offered by schedulability check. Whenever a node wants to transmit data packet to the other node, the cluster head attempts to guarantee data packets by constructing a plan for its transmission without violating the guarantees of the previously scheduled transmission. ParMyopic scheduling technique is used for transmission. The simulation results shows that the degree of parallelization increases the success ratio for the speedup function used. The resources or file sharing can be done effectively using this Parmyopic scheduling scheme in the wireless sensor network with the deployment of nodes. The query response time is reduced by allowing more than one applications to be executed simultaneously.

Keywords: Data Packets, Deadline, Earliest Deadline First, Myopic, Scheduling, Task

1. INTRODUCTION

Energy expenditure is an important issue in wireless sensor networks due to the short span battery life. Reliable content delivery over a wireless channel is a major source of energy expenditure. The increasing wireless transmission rate results in a rapid increase of the energy consumption of wireless devices. This approach follows the Myopic scheduling algorithm and in this nodes selectively transmit data streams of different data sizes at different transmission rates so that the system reward can be maximized under given time and energy constraints (Gong *et al.*, 2010). Scheduling strategy operates on an extremely fast time scale compared to the user dynamics, making it natural to analyze the user level performance in continuous rather than discrete time and assume that the users are served simultaneously rather than in a time-slotted fashion (Borst, 2005). In dynamic scheduling (Manimaran and Murthy, 1998; Ramamritham *et al.*, 1990), when new data packets arrive, the scheduler dynamically determines the feasibility of scheduling these new data

packets without jeopardizing the guarantees that have been provided for the previously scheduled data packets. When dealing with dynamic scheduling, it becomes necessary to be aware of several anomalies, called Richard's anomalies, so that they can be avoided. Changing the priority list, increasing the number of processors, reducing the computation times, or weakening the precedence constraints can increase the schedule length (Graham, 1976). Most existing work focuses on the minimization of the total energy consumption under the timing constraints and scheduling algorithms. To minimize the transmission energy, we vary packet transmission times and power levels to find the optimal schedule for transmitting the packets within the given amount of time.

2. LITERATURE REVIEW

Numerous solutions have been proposed for energy efficient problem in wireless sensor networks were largely targeted at communication channels over a single-transmitter-single receiver model; Zhang and

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chanson targeted both throughput and value (reward) maximization in an Additive White Gaussian Noise (AWGN) channel (Gong *et al.*, 2010). Many protocols have been developed for wireless sensor networks. S-MAC is one among the protocol used for energy efficiency. The main goal of the S-MAC protocol is to reduce energy waste caused by idle listening, collisions, overhearing and control overhead. The protocol includes four major components such as periodic listen and sleep, collision avoidance, overhearing avoidance and message passing. Periodic listen and sleep is designed to reduce energy consumption during the long idle time when no sensing events happen, by turning off the radio periodically (Bhapnagar and Robertzei, 1990). The Power Control Multiple Access allows different nodes to have different transmission power levels. PCMA uses two channels, one channel for “busy tones” and the other for all other packets. PCMA use busy tones, instead of RTS-CTS, to overcome the hidden terminal problem. The power level at which the busy tone is transmitted by a node is equal to the maximum additional noise the node can tolerate. Any node wishing to transmit a packet first waits for a fixed duration and senses the channel for busy tones from other nodes. The signal strength of busy tones received by a node is utilized to determine the highest power level at which this node may transmit without interfering with other on-going transmissions. Mean-while, more and more embedded systems are being built with renewable energy sources, such as solar power, wind power and mechanical power, from the environment (Li and Chou, 2005). The myopic scheduling (Ramamritham *et al.*, 1990) is a non-preemptive heuristic search algorithm for scheduling real-time data packets with resource constraints. A vertex in the search tree represents is strongly feasible. The schedule from a vertex is extended only if the vertex is strongly feasible. If the current vertex is strongly feasible, the algorithm computes a heuristic function for each data packet within the feasibility window and then extends the schedule by a data packet having the least heuristic value. The heuristic function for a task T_k is $H_k = d_k + W * EST(T_k)$, an integrated heuristic that captures the deadline and resource requirements of task T_k , where W is a constant which is an input parameter. If the current vertex is not strongly feasible, the algorithm backtracks to the previous search point and from there on extends the schedule using the task having the next minimum heuristic value. The larger the size of the feasibility checks window, the higher the scheduling cost

and more the look-ahead nature. The termination conditions are that (1) a complete feasible schedule has been found (2) the maximum number of backtracks or an H function evaluation has been reached, or (3) no more backtracking is possible. The time complexity of the myopic scheduling algorithm for scheduling n tasks is $O(Kn)$. The value of K is usually much smaller than n for practical purposes. Some techniques aim to reduce the static power consumption, as up to 70% of energy in a chip is wasted in standby (Janek *et al.*, 2007), so items such as clock gating and sleep modes are commonly used to reduce this value to a more manageable level (Yeap and Najm, 1996). The observation that leads to this approach is that transmission energy can be lowered by reducing transmission power and transmitting a packet over a longer period of time.

3. DATA MODEL

Many sensing tasks require a sensor network system to process data cooperatively and to combine information from multiple sources. In traditional centralized sensing and signal processing systems, raw data collected by sensors are relayed to the edges of a network where the data is processed. If every sensor has some data that it needs to send to another node in a network, then a well known wireless capacity per node throughput scales as $1/\sqrt{N}$, in other words, it goes to zero as the number of nodes N in a wireless sensor network increases. Sensor networks contain a large quantity of nodes that collect measurements before sending them to the applications. If all nodes forwarded their measurements, the volume of data received by the applications would increase exponentially, rendering data processing a tedious task. In this proposed data model, a single-transmitter-multiple-receiver model in which a wireless transmitter communicates with multiple receivers as shown in Fig. 1. In this model transmitter can only communicate with one receiver at a time and has an energy budget in each transmit cycle. Each receiver will receive data from the transmitter periodically. Every transmitter-receiver pair has a maximal amount of data to be transmitted in each time period. The receivers are located with different distances from the transmitter. The data to different receivers can be transmitted at different transmission rates.

3.1. ParMyopic Scheduling (K, Max-Split)

The ParMyopic scheduling algorithm is a non-preemptive heuristic search algorithm for scheduling real-time tasks with resource constraints.

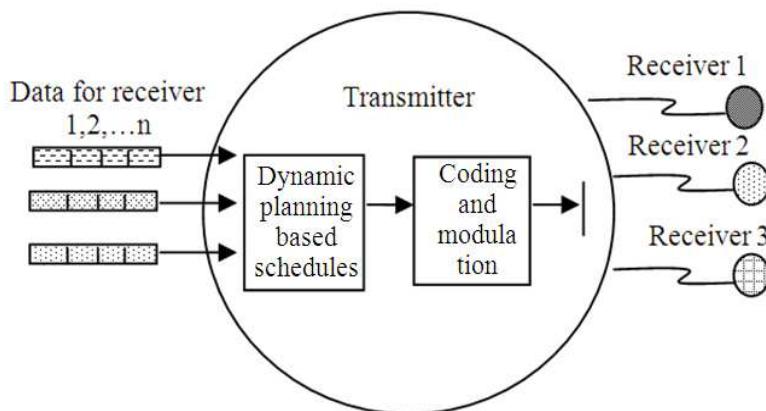


Fig. 1. Data model

A vertex in the search tree represents a partial schedule. The schedule from a vertex is extended only if the vertex is strongly feasible. If the current vertex is strongly feasible, the algorithm computes a heuristic function for each task within the feasibility window and then extends the schedule by a task having the least heuristic value. The heuristic function for a task T_k is $H_k = d_k + W * EST(T_k)$, an integrated heuristic that captures the deadline and resource requirements of task T_k , where W is a constant which is an input parameter. If the current vertex is not strongly feasible, the algorithm backtracks to the previous search point and from there on extends the schedule using the task having the next minimum heuristic value. The larger the size of the feasibility checks window, the higher the scheduling cost and more the look-ahead nature. The termination conditions are that (1) a complete feasible schedule has been found, (2) the maximum number of backtracks or H function evaluations has been reached, or (3) no more backtracking is possible. The time complexity of the ParMyopic scheduling algorithm for scheduling n tasks is $O(Kn)$. The value of K is usually much smaller than n for practical purposes:

Begin

1. Order the tasks (in the task queue) in non decreasing order of their deadlines and then start with an empty partial schedule.
2. Determine whether the current schedule vertex(schedule) is strongly feasible by performing feasibility check for K or less than K tasks in the feasibility check window as given below:

Let \bar{K} be the count of the number of tasks for which feasibility check has been done.

Let T_i be the $(\bar{K}+1)^{th}$ task in the current task queue.

Let num-split be the maximum degree of parallelism permitted for the current task T .

Let cost be the sum of degree of parallelism over all the \bar{K} tasks for which feasibility check has been done so far.

- (a) Num-split = max-split; $\bar{K}=0$; cost=0; feasible=TRUE.
- (b) While(feasible is TRUE)do
 - i. If (K -cost < num-split) num-split= K -cost.
 - ii. Compute EST (T_i) for task T_i .
 - iii. Find the smallest j such that $EST(T_i) + c_i^j \leq d_i, 1 \leq j \leq \text{num-split}$.
 - iv. If (such j exists) $\bar{K} = \bar{K} + 1$; cost=cost+j.
 - v. else if(num-split < max-split) break
 - vi. else feasible =FALSE.
3. If(feasible is TRUE)
 - (a) Compute the heuristic function (H) for the first K tasks, where $H_k=d_k + W * EST(T_k)$ for task T_k .
 - (b) Extend the schedule by the task having the best (smallest) H value.
- Else (C) Backtrack to the previous search level.
- (d) Extend the schedule by the task having the next-best H value.
4. Move the feasibility check window by one task.
5. Repeat steps (2-5) until termination condition is met.
6. end.

4. CONCLUSION

Figure 2 and 3 represent the success ratio by varying Laxity parameter and W respectively.

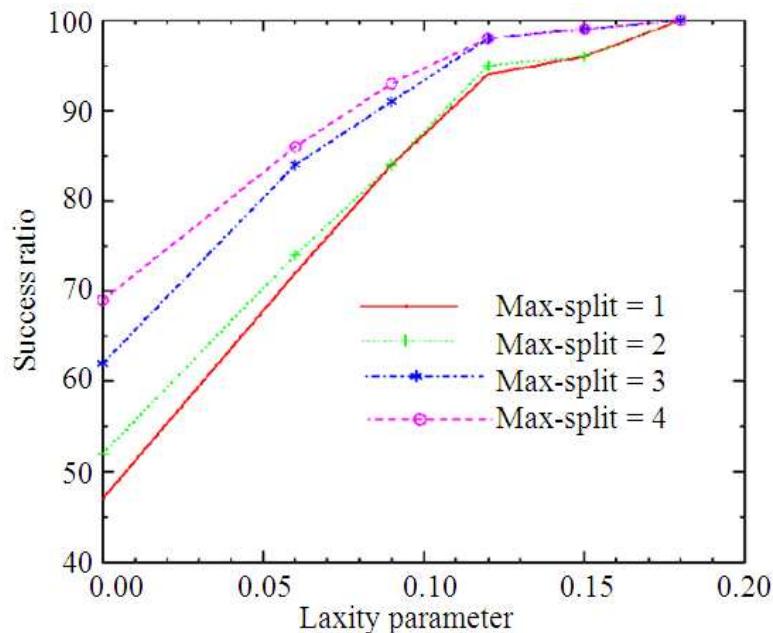


Fig. 2. Success ratio Vs. laxity

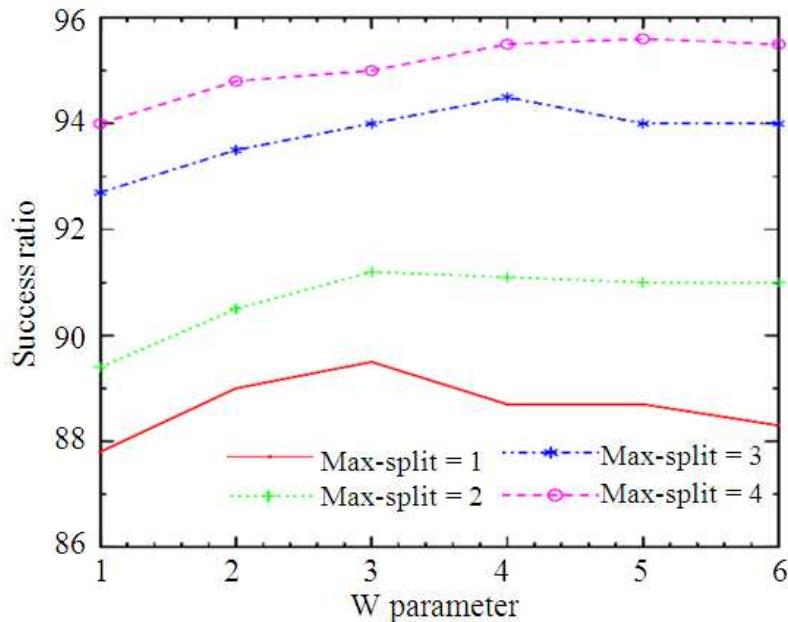


Fig. 3. Success ratio Vs. W parameter

When max-split is 1, the task is considered to be no parallelizable and the ParMyopic algorithm behaves like the myopic algorithm. When the value of max-split is more than 1, then the parallelism plays, so it needs

ParMyopic Scheduling algorithm. **Figure 2** shows the effect on success ratio of the laxity parameter (R), which helps in investigating the sensitivity of task parallelization to varying laxities. **Figure 3** shows the

effect of W for different values max-split offers a similar trend, as the success ratio increases initially with increasing W and saturates for larger values of W.

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