SENSOR TASK REASSIGNMENT IN WIRELESS SENSOR NETWORKS USING BIO-INSPIRED ALGORITHM

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ABSTRACT

The task in Wireless Sensor Network is a piece of work that could be handled and processed by efficient sensor. The task assignment is the process of allocating efficient sensors to the tasks that are arrived. The reallocation process in Wireless Sensor Network is an important part in the task management phase. The reallocation process is invoked during the failure of sensors or completion of the assigned task by the sensor. The existing system assigns the sensors to the task mainly based on its residual energy performance parameter. Moreover, the sensors are not shared between the multiple tasks. The proposed system balances all the performance parameters required by the mission and identifies the suitable sensor that can be shared between multiple tasks. Initially the sensors are assigned to the task using Bio mimetic Optimization framework. Once if a sensor completes its non-tedious task, then that particular sensor is reallocated to the time consuming or a tedious task using the Bio-Inspired Algorithm. This work ensures the improvements in reliability, energy optimization, throughput of the task completion.


1. INTRODUCTION

WSNs consist of a large number of sensor nodes, which usually collect important information in target environment. WSNs have been envisioned for a wide range of applications, such as battlefield intelligence, environmental tracking, and emergency response. In WSNs, one of the most important constraints on sensor nodes is low power consumption requirement. Sensor nodes have limited, generally irreplaceable, power sources. Parallel processing among sensors is a promising solution to provide demanded computation capacity in WSNs.

Most of nodes in WSN are battery powered and have limited energy storage. Tasks should be allocated to sensor nodes with the consideration of energy conservation and balanced energy consumption to prolong the network lifetime. Meanwhile, many applications require that the tasks be finished in a short time. So, the task execution time should also be considered as an optimization metric. However, balancing energy consumption and minimizing task execution time are usually in conflict and may influence the network performance in a complex way. Early work for task allocation in parallel and distributed systems cannot be directly adopted for WSN due to the strictly limited energy, resource as well as the unstable wireless communication link in WSN. There is also some research that focuses on task allocation problem in WSN with the purpose of conserving energy or reducing task execution time.
When using traditional heuristic approaches, the computational complexities would grow exponentially with the problem size and may easily get stuck in local optimum. On the contrary, stochastic meta-heuristic algorithm adopting bionic intelligence can get the global optimum with high efficiency.

Task allocation and scheduling plays an essential role in parallel processing. How to assign a task to the most appropriate sensor node and simultaneously balance the network load in context of the uncertain and dynamic network environments are important and urgent issues in WSNs. As a typical problem of the area of high performance computing, task allocation and scheduling have been addressed in a variety of applications, such as multiprocessor system, grid computing, social networks, multi-hop wireless networks. Although task allocation problem has been studied deeply in distributed systems, the problem for WSNs is different from traditional distributed systems. In WSNs, the challenge of task allocation is distributing sensing tasks rationally among sensor nodes to reduce overall power consumption while guaranteeing these tasks being finished before deadlines and prolonging network lifetime.

Load balancing is a key point for prolonging the network lifetime. An inferior task allocation scheme will lead to overload of nodes and is harmful to the networks. Meanwhile, without proper task allocation strategy, each sensor node will just work individually, and all sensor nodes cannot work together in an energy efficient way. Due to challenging features and constraints of WSNs, such as environmental constraints, the dynamic topology, and the instability of wireless link, there exist more vulnerabilities and uncertainties for real-time applications in WSNs. Moreover, some sensor nodes may fail or be blocked. The failure of some sensor nodes should not affect the overall task of a sensor network.

2. TASK ALLOCATION

When a task source cluster senses a complex task, it first checks the number of sensor nodes in the first ranking domain. If the number of sensor nodes in the first ranking domain is greater than or equal to the number of subtasks, all the subtasks are allocated to the sensor nodes in the first ranking domain. Otherwise, the source cluster will ask neighbor clusters for collaboration based on their service abilities. If the collaborative clusters are selected, the task allocation can be completed according to two steps: (1) inter-cluster allocation and (2) intra-cluster allocation. Once the task leader has collected bidding answers from nearby nodes, it performs the selection of nodes to assign to the task. Nodes are ranked based on the utility they offer. The task leader greedily assigns them to the task, based on their ranking, until the task is fully satisfied or there are no more sensors bidding for it. Once the minimum satisfaction threshold is reached, the leader may decide to stop short of full coverage if the next node to add would go way past the necessary utility, as there is no additional profit earned by the network if the required demand is exceeded.

The sensor networks with allocated tasks are shown in Fig.1. The goal of task allocation can be simply described as follows. Generally, let m tasks be allocated reasonably to n sensors in order to minimize task execution time, save the energy consumption of nodes, balance the network load, prolong the network lifetime, ensure that the task would not fail by sudden failure of nodes and improve the reliability of task management.
3. RELATED WORK

Task allocation is a critical issue for proper engineering of cooperative applications in WSNs with latency and energy constraints. Recently, there are several algorithms to solve task allocation problem of WSNs with the purpose of reducing task completion time and energy consumption.

A distributed task allocation strategy for collaborative applications in Cluster-Based Wireless Sensor Networks is proposed in [1]. It is generally known that multiple sensor nodes collaborating with each other to perform tasks are an important means of energy balancing. In addition, a reasonable task allocation strategy is also an efficient method for task performing and energy savings. Furthermore, in order to save energy consumption, many WSNs are organized into clusters. In DTAC, the service abilities of sensor nodes are first evaluated and then the sensor nodes are classified into different ranking domains. DTAC is much more efficient for complex task processing in terms of reducing energy consumption, shortening execution time, and balancing network loads.

Modified Binary Particle Swarm Optimization (MBPSO) is proposed for task allocation in Wireless Sensor Network in [2]. A MBPSO, which adopts a different transfer function and a new position updating procedure with mutation, is proposed for the task allocation problem to obtain the best solution. Each particle in MBPSO is encoded to represent a complete potential solution for task allocation. The task workload and connectivity are ensured by taking them as constraints for the problem. The MBPSO-based approach also outperforms the approaches based on genetic algorithm and BPSO in the comparative analysis.

In [3], the Node Task Allocation based on PSO in WSN Multi-Target Tracking is proposed. Aiming at the task allocation in multi-target tracking of wireless sensor networks, the discrete particle swarm optimization based on nearest-neighbor is presented to reduce the communication energy consumption between nodes. First, task allocation is initialized with nearest neighbor algorithm. Then the fitness function is compared through change task allocation matrix to achieve task allocation.

In [5], the task allocation is done by using the PSO algorithm. The PSO pseudo code for task scheduling:

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a) Initial random swarm of particle (tasks)
b) Calculate fitness value for each tasks or particle
c) If (current fitness< pBest) then
    pBest ← current fitness
    Else, keep LAST PBEST
d) pBest ← Best pBest
e) Calculate velocity of each task
f) UPDATE tasks X or priority index according to velocity
g) Go to step 2 until finish irritation number.

4. PROPOSED FRAMEWORK

4.1 ARCHITECTURE

In the Sensor Task Management architecture, it shows how the sensor is allocated and reallocated to a task. The TM request the SM for sensors to the subtasks involved in the task. Then the SM using optimization framework selects an appropriate sensor for the task and allocates it to the subtasks for processing. The TM supervises the process of the tasks that are running and identifies the failed sensors or tasks. Then it request SM for reallocating sensor for the failed sensor or task. The SM then reallocates the sensor to tasks by using Optimization algorithm.

Fig.2: System Architecture
4.2 DATA FLOW

The proposed framework involves four different stages that include Sensor Manager Initialization, Task Manager-Initialization, sensor task allocation and sensor task reallocation.

4.2.1 SENSOR MANGER-INITIALIZATION

Sensor Manager-Initialization is the initial process of the proposed system. The SM requests the ‘n’ number of sensors to send their performance parameters. Then the ‘n’ number of sensors will reply to the SM with the performance parameters which may be different for each sensor. The SM then collects and stores all the performance parameters in the Sensor Database.

4.2.2 TASK MANAGER-INITIALIZATION

In the Task Manager-Initialization, the TM identifies the performance parameters that are needed for the subtasks involved in the task and assigns priority for the tasks. Priority is assigned based on the importance and emergency of the task. After assigning priorities to the tasks, they are stored in the Task Database.
4.2.3 SENSOR TASK ALLOCATION

In the sensor task allocation process, the TM sends sensor request for the tasks that are stored in the Task Database to the SM. In response to the request, the SM considers the sensors list and their performance parameters for allocating sensors to tasks. Considering the task requirements, sensor list and their parameters, the SM performs optimization process and allocates the appropriate sensor to the task. The Optimization algorithm is used for allocating sensor to task in WSN.
4.2.4 SENSOR TASK REALLOCATION

The TM supervises the ongoing task process. It collects the sensors list which completes its tasks and sends the sensor list as sensor status notification to the SM. Also it collects the failed task list whose process is stopped and sends sensor request to the SM. The SM with the task requirements and sensor list and parameters, reallocates the appropriate sensor to the task using Optimization algorithm.

Fig.6: Sensor task reallocation

5. PROPOSED FRAMEWORK STRUCTURE

In the proposed framework, the steps that are involved in producing the near optimal solution are given as follows:

- Consider a set of sensors and set of parameters with specific threshold range for the
parameters.
- Identify the parameters that are available in each sensor.
- Group the sensors that are having the identical parameters.
- Construct a matrix by considering two parameters and the sensors having those parameters.
- The matrix should be filled and the values are traced back.
- By tracing back, the near optimal solution will be obtained.

6. EXPERIMENTAL RESULT

This graph shows the comparison between PSO algorithm and Bio-Inspired algorithm. The more number of tasks are completed by using Bio-Inspired algorithm compared to PSO algorithm in same number of iterations. This provides the optimal solution with enhancement in energy optimization, reliability and throughput.

![Graph showing comparison between PSO and Bio-Inspired algorithm](image)

7. CONCLUSION

The local optimization algorithm implemented in WSN for task allocation results in generation of optimal solution which involves with huge iterations and large assumptions may reduce the accuracy in the near optimal solution. The proposed framework yields the near optimal solution with minimal iteration. Randomness is reduced in assumptions in the proposed framework, so it results in better optimal solution which enhances reliability, throughput and energy optimization of the entire mission in task assignment of WSN.

8. REFERENCES


