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TWO STAGE DECISION MAKING APPROACH FOR SENSOR MISSION ASSIGNMENT PROBLEM

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Abstract. Sensor Mission Assignment (SMA) is the process of assigning sensors to missions in the best way, which may depend on the cost of using individual sensors and the requirements of individual missions. SMA is Np-complete and is a special case of Generalized Assignment Problem. The significant bottlenecks in SMA are energy conservation and uncertainty in the demand of the missions. In order to conserve energy, some sensors are considered to be in sleeping state while others remain active for sensing. In this paper, Sensor Mission Assignment problem is studied in the context of Generalized Assignment Problem combined with decision making approach. Two stage decision making approach is formulated to determine the minimum number of sleeping sensors to be activated so as to assign exactly one sensor to each mission optimally subject to some of the energy resource constraints and environmental constraints imposed on it. The method draws upon the existing generalized assignment problem and the decision making approaches by analyzing trade-offs among desirable value of objective function and the constraints that include all the parameters. The proposed method is applied to the simulation on a small sized wireless sensor network and it is shown that the method is energy efficient. The proposed method provides more holistic point of view on the factors impacting sensor mission assignment.

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1. Introduction

The generalized assignment problem, unlike assignment problem, does not have one-to-one correspondence between the jobs and workers. The jobs are assigned to workers in such a way that each job is assigned to exactly one worker, but a worker may be assigned more than one job, subject to the availability of time at his/her disposal. In existing literature, several researchers have developed different methodologies for solving generalized assignment problems. Among these, one may refer to the works of Ross and Soland [22], Cattrysse and Wassenhove [8], Amini and Racer [3], Lorena and Narciso [15], Chu and Beasley [9], Diaz and Fernandez [11] and Haddadi and Ouzia [13]. Airline crew-scheduling, nurse-scheduling, project assignment problems etc. are solved as special cases of generalized assignment problem by several researchers like Aickelin and Dowsland [1] and Harper *et al.* [14].

Keywords. Sensor Mission Assignment, Generalized Assignment Problem, decision making.

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Sensor networks [20] consist of a large number of small sensor devices that have the capability to take various measurements of their environment. These measurements can include seismic, acoustic, magnetic, IR and video information. Each of these devices is equipped with a small processor and wireless communication antenna and is powered by a battery making it vary resource constrains. To be used, sensors are scattered around a sensing field to collect information about their surroundings. For example, sensors can be used in a battlefield to gather information about enemy troops, detect events such as explosions, and track and localize targets. Upon deployment in a field, they form an ad hoc network and communicate with each other and with data processing centers.

Sensor networks are usually intended to last for long periods of time, such as months or even years. However, due to the limited energy available on board, if a sensor remains active continuously, its energy will be depleted quickly leading to its death. Much energy is wasted in wireless sensor networks due to idle listening, relaying data and redundant data gathering by active sensors in the network. Sleeping is a key technique used to reduce this energy waste [21]. So to prolong the network lifetime, sensors alternate between being active and sleeping. Traditional sleep-wake scheduling mechanisms of medium access control protocols either require periodic synchronization beacons or bring high end-to-end delivery latency due to the lack of synchronization [17]. Lulu Liang *et al.* [17] proposed a low latency protocol by adjusting the sleep window considering traffic patterns. Bartolini *et al.* [4] proposed a selection algorithm called Sensor Activation and Sensing Radius Adaption (SARA) to prolong the lifetime of a heterogeneous wireless sensor network.

There are several sensor selection algorithms to achieve the maximum network lifetime while still achieving the goal of deployment. The decision as to which sensor should be activated takes into account a variety of factors depending on the algorithm such as residual energy, required coverage or the type of information required. Sensors are selected to do one or multiple missions. These missions can be general and related to the function of the network, such as monitoring the whole field by ensuring complete coverage, or more specific and application-oriented, such as tracking a targets movement. At a given time, the system might be required to do multiple missions such as monitoring an event and, at the same time, track a single or multiple moving objects.

Recently, sensor nodes are being developed that, along with traditional batteries, mount energy-harvesting devices that opportunistically draw new energy from the environment [5]. Unlike traditional motes, nodes with energy harvesting capabilities alternate between periods in which energy must be sparely used, and situations in which there may be an excess of energy available, which would be wasted unless used in the short term [6]. Energy usage in the sensor network should be carefully planned to minimize energy waste [25].

Assignment and selection problems have received sizable attention, in both experimental and theoretical communities. A survey of the different sensor selection and assignment schemes can be found in [23]. SMA is Np-complete and is a special case of Generalized Assignment Problem(GAP). GAP [10] is also a generalization of the Multiple Knapsack Problem, in which the weight and value of an item may vary depending on the bin in which it is placed. Sensor Mission Assignment problem relates to GAP as well as other optimization problems, such as the Bin Covering problem, in which the goal is to use a set of items to fill completely as many bins as possible. An analogy can be seen between Sensor-Mission Assignment and the Bin Covering and the Multiple Knapsack and the Generalized Assignment [12] problems.

The authors of [2, 16, 19, 24] for example, solve the coverage problem, which is related to the assignment problem. They try to use the smallest number of sensors in order to conserve energy. Byers and Nasser [7] define a framework for modeling the assignment problem by using the notions of utility and cost. The goal is to find a solution that maximizes the utility while staying under a predefined budget. The utility specifies the sensing resources provided by the sensor for accomplishing the mission. The demand specifies the amount of sensing resources needed by the mission.

In this paper, a sensor mission assignment problem is examined which is motivated by the conservation of energy of the sensors in order to prolong the network lifetime. Assume that the missions are of different type and arrive over time with different demands. Assume that the system must react to new missions given the current operating environment, that is, the condition of the sensors will change over time. Also a framework of sensor mission assignment problem is given and an attempt is made to develop a two stage decision making approach

Table 1. Competence matrix for sensor mission pair.

$$C = \begin{array}{c|cccc|} & \text{Type 1} & \text{Type 2} & \dots & \text{Type J} \\ \text{Sensor } S_1 & e_{11} & e_{12} & \dots & e_{1J} \\ \text{Sensor } S_2 & e_{21} & e_{22} & \dots & e_{2J} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ \text{Sensor } S_I & e_{I1} & e_{I2} & \dots & e_{\mathrm{IJ}} \end{array}$$

to determine the minimum number of sleeping sensors to be activated so as to assign each mission to exactly one sensor but a sensor can handle more than one mission simultaneously with an objective of minimizing the total energy of the sensors needed for the execution of all the missions. Total energy includes energy needed for measurement and transmission. The proposed formulation of sensor mission assignment is applied to the simulation on a small sized wireless sensor network and it is shown that the proposed approach is energy efficient.

2. Model formulation

2.1. Framework of the problem

There are a number of attributes that characterize the nature and difficulty of the problem. In this section, a particular sensor assignment problem and its settings are briefly enumerated.

In the proposed sensor network model, assume a set of sensors $S_1, S_2, S_3, \dots, S_I$ are predeployed in a field in a random manner. The sensor network life time is known and is needed for a finite duration. Sensing resources may be limited and expensive, both in terms of equipment and operational cost. Assume that replacing the batteries may be difficult, expensive, or dangerous [18]. In order to reduce the energy wastage due to self-discharge, idle listening and to prolong the network life time for the predefined duration efficiently, some sensors in the net work are considered to be in sleeping state while others remain active for sensing. Each sensor has limited energy capacity.

Assume that the missions of different types arrive over time and have different demand. By a mission, we mean a primitive sensing task that requires information of a certain type, which may be contributed by exactly one sensor. The demand is known only at the beginning of the period of dissemination. The utility of the mission types may vary and it depends on the sensor that will be used to execute the mission according to a predefined competence matrix $C = [e_{\mathrm{ij}}]$ given in Table 1, where e_{ij} denotes the utility that the sensor S_i can contribute to the mission type j. The sleeping sensors are activated only when the use of all active sensors are incapable to execute all missions. The objective is to utilize the energy capacity of active sensors to the possible extend and if necessary, minimum number of sleeping sensors can be activated such that each mission is assigned to exactly one sensor subject to some of the constraints imposed on it.

2.2. Problem set up

Consider the following setting: Given a set of sensors $S_1, S_2, S_3, \dots, S_I$ of which some are in sleeping state while others are in active state and a set of K missions of J types $M_1, M_2, M_3, \dots, M_K$. Each mission is associated with a demand denoting the amount of sensing resources needed. Each sensor-mission pair is associated with the predefined competence matrix $C = [e_{\mathrm{ij}}]$ where e_{ij} denotes the utility that the sensor S_i can contribute to the mission of type j. This can be a measure of the quality of information that a sensor can provide to a particular mission. To simplify the problem, assume that the utility values e_{ij} received by a mission are additive. In some settings for example, in a localization application, the utility provided by sensors is not additive as it depends on the relative angles by which they view the target.

A two stage decision making approach is formulated. The two stages have different objective functions and different formulation. In the first stage, the formulated LPP searches to minimize the number of sleeping sensors to be activated in order to assign all the missions whereas in the second stage, the formulated GAP minimizes the total energy needed to execute all the missions.

2.3. Formulation for stage 1

The first stage formulation is used to know whether the number of available active sensors are capable to handle daily received missions, and if not, the formulation will determine the exact number of sleeping sensors to be activated to handle all received missions. In the second stage, sensor mission assignment can be optimized based on different criteria, where a set of objective functions to assign missions is proposed to the decision maker. The new objective function can be chosen by the decision maker based on the number of sleeping sensors to be activated. Thus the decision makers have the possibility to see and evaluate the direct effect of their choices concerning sensor mission assignment.

At the end of the first stage, a complete scenario has been detected that is, whether it is overloaded or under loaded. Overloaded (resp. under loaded) means the demand of all the missions are greater (resp. lesser) than the available sensing resources of the sensors. If it is overloaded, the exact number EN of sleeping sensors to be activated in order to handle all mission will be given to decision maker. A decision can be made whether to activate all the required number of sleeping sensors or a certain number of sleeping sensors based on the budget or necessity.

Based on the decision in the first stage, the objective function for stage 2 can be defined. One objective can be to give high priority to the missions that cannot be delayed or to the missions considered as more profitable. Another objective could be to assign mission types uniquely by the previous experience. From economic point of view the objective of maximizing the rate of profitability can be interesting but this objective is achievable only by limiting the number of sleeping sensors to be activated. For simplicity, consider the objective as to minimize the total energy usage of the sensors.

To optimize the energy resources, the proposed method calculates for each sensor, the real demand for each mission it has handled. When the accumulation of energy reached a predefined threshold, an alert is triggered and the process again starts with the new parameter.

2.3.1. Notations and parameters

The notations used to formulate the first stage are given in Table 2.

The mathematical formulation to minimize the number of sleeping sensors to be activated is given below as

Formulation 1

$$EN = \text{Min} \sum_{i=1}^{I} S_i(t) \tag{2.1}$$

subject to

$$\left[\sum_{k=1}^{k} c_{ik} \left(a_{ik} Eold_{ik} + \sum_{l=1, l\neq i}^{I} a_{lk} Enew_{lk}\right)\right] + \left[\sum_{j=1}^{J} X_{\text{ij}} E_{\text{ij}}\right] \leq Ecap_i(t) S_i(t) \forall i = 1, 2, 3, \ldots, I \tag{2.2}$$

$$\sum_{i=1}^{I} X_{\text{ij}} = D_j(t), \forall j = 1, 2, 3, \ldots, J \tag{2.3}$$

$$\sum_{k=1}^{K} c_{ik} = K, \forall i = 1, 2, 3, \ldots, I \tag{2.4}$$

TABLE 2. Glossary of notation.

Symbol	Description
N	Number of active sensors
M	Number of sleeping sensors
$I = N + M$	Total number of sensors
K	Number of missions disseminated ready for the assignment
J	Number of mission types
T	Time interval
$S_i(t)$	Represents active/activated sensor i at time t. That is, $S_i(t)$ represents active sensor i if $i = 1, 2, 3, N$ and activated sensor i if $i = N+1, N+2, \ldots, I$.
$Act(t)$	Set contains sensors active at time t
$Slp(t)$	Set contains sleeping sensors at time t
$D_j(t)$	Demand of mission type j at time t
$Escap_i(t)$	Available maximum energy capacity of the Sensor i at time t
E_{ij}	Needed energy to handle mission of type j by the sensor i
$Eold_{ik}$	Needed energy to transmit the measurement of type k if it is assigned to the same sensor i that is already handling the same type for other missions.
$Enew_{ik}$	Needed energy to transmit the measurement of type k if it is assigned to a new sensor i which is not handling the same type for any of the missions.
W_{ilj}	$W_{ilj} = \begin{cases} 1 \text{ if mission } l \text{ of type j assigned to sensor } i \\ 0 \text{ otherwise} \end{cases}$
$A_{IK} = [a_{ik}]$	Two dimensional matrix representing the history of the assignment of mission types to each sensor, where $a_{ik} = \begin{cases} 1 \text{ if mission type k handled by sensor } i \\ 0 \text{ otherwise} \end{cases}$
c_{ik}	$c_{ik} = \begin{cases} 1 \text{ if mission k is assigned to sensor } i \\ 0 \text{ otherwise} \end{cases}$
X_{ij}	Number of missions of same type j assigned to sensor i

$$\sum_{i=1}^{N} S_i(t) = |Act(t)|, \tag{2.5}$$

$$S_i(t) = 0, \forall S_i(t) \in Slp(t) \tag{2.6}$$

$$S_i \in \{0, 1\}, \forall i \in I \tag{2.7}$$

$$X_{\mathrm{ij}} \in Z^{+}, \forall i \in \{1,2,\ldots,I\}, \forall j \in \{1,2,\ldots,J\} \tag{2.8}$$

The first stage is computed at time $t = 0$ that is, it may be the morning of each day before deploying any mission. Constraint (2.2) ensures that the energy capacity of the sensors is not violated. Constraints (2.3) and (2.4) ensures that all missions are assigned and each mission is assigned to only one sensor. The constraints (2.5) and (2.6) are included to ensure the use of all active sensors. These constraints forces to search solution where $S_i(t) = 1\ \forall i \in Act(t)$. $Act(t)$ is the set which contains only active sensors that are available at time t and $|Act(t)|$ denotes the number of elements in the set.

The exact number (EN) of sleeping sensors to be activated can be found in the first stage and now the decision makers can decide the number of sleeping sensors to be activated which is denoted by L where $L \leq EN$.

2.4. Formulation for stage 2

The stage 2 is formulated as GAP. As already mentioned, many objective functions can be used in the second stage, but for simplicity choose here only one objective which minimizes the total usage of energy of all sensors.

Formulation 2

$$\text{Min} \sum_{i=1}^{N+L} \sum_{j=1}^{J} X_{\mathrm{ij}} E_{\mathrm{ij}} + \sum_{i=1}^{N+L} \sum_{k=1}^{K} c_{ik} \left(a_{ik} Eold_{ik} + \sum_{l=1, l\neq i}^{N+L} a_{lk} Enew_{lk} \right) \tag{2.9}$$

$$\left[\sum_{k=1}^{K} c_{ik} \left(a_{ik} Eold_{ik} + \sum_{l=1, l\neq i}^{I} a_{lk} Enew_{lk} \right) \right] + \left[\sum_{j=1}^{J} X_{\mathrm{ij}} E_{\mathrm{ij}} \right] \leq S_i(t) Ecap_i(t), \forall i \in \{1,2,\ldots,I\} \tag{2.10}$$

$$\sum_{i=1}^{N+L} X_{\mathrm{ij}} = D_j(t), \forall j = 1,2,\ldots,J \tag{2.11}$$

$$\sum_{k=1}^{K} c_{ik} = K, \forall i = 1,2,\ldots,I \tag{2.12}$$

$$S_i(t) = 0, \forall S_i(t) \in Slp(t) \tag{2.13}$$

$$\sum_{i=1}^{N} S_i(t) = |Act(t)| \tag{2.14}$$

$$c_{\mathrm{ij}} \leq \sum_{l\in K} W_{ilj}, \forall i = 1,2,\ldots,I \text{ and } j = 1,2,\ldots,J \tag{2.15}$$

$$c_{\mathrm{ij}} \geq W_{ilj}, \forall i = 1,2,\ldots,I, l = 1,2,\ldots,K \text{ and } j = 1,2,\ldots,J \tag{2.16}$$

$$X_{\mathrm{ij}} \leq \sum_{j\in J} c_{\mathrm{ij}},\ \forall i = 1,2,\ldots,I \text{ and } j\ =\ 1,2,\ldots,J \tag{2.17}$$

$$X_{\mathrm{ij}} \geq c_{\mathrm{ij}}, \forall i = 1, 2, \ldots, I, l = 1, 2, \ldots, K \text{ and } j = 1, 2, \ldots, J \tag{2.18}$$

$$W_{ilj}, c_{\mathrm{ij}}, a_{ik} \in \{0, 1\} \tag{2.19}$$

The first term $\sum_{i=1}^{N+L} \sum_{j=1}^{J} X_{\mathrm{ij}} E_{\mathrm{ij}}$ in the objective function equation (2.9) calculates the energy consumed for execution of all the missions of all type j assigned to each sensor i and the second term $\sum_{i=1}^{N+L} \sum_{j=1}^{K} c_{ik}(a_{ik} Eold_{ik} + \sum_{l=1, l \neq i}^{N+L} a_{lk} Enew_{lk})$ in the objective function calculates the data transmission energy, in which $Eold_{ik}$ denotes the energy needed to transmit the measurement of mission of type k if it is assigned to the same sensor i that is already measuring the same type for other missions whereas $Enew_{ik}$ denotes the transmission energy of mission of type k if it is newly assigned to sensor i. If the mission of type k is assigned to sensor i which is already handling the mission of same type, then the measurement results are combined and transmitted to the server as one packet not as separate packets. The energy consumed for combined transmission differs from separate transmission. Constraint (2.10) ensures that sensors capacity will not be violated. Constraints (2.11) and (2.12) holds equality only if the number of exact sleeping sensors needed to handle all missions equal the number of activated sensors, that is, $EN = L$. But it is not always possible to have $EN = L$. If $EN > L$, then replace the constraint (2.11) as below

$$\sum_{i=1}^{N+L} X_{\mathrm{ij}} = D_j(t)\alpha_j, \forall j = 1, 2, \ldots, J \tag{2.20}$$

where α_j is the real number in the interval $[0, 1]$ denoting the threshold percentage of the demand of mission type j. The value of α_j can be changed every time the problem is not solvable. Constraints (2.13) and (2.14) ensures the use of all active sensors and the remaining sensors will be triggered to sleeping mode. Constraints (2.15) and (2.16) checks the redundancy in execution of missions. That is, the execution of mission type j is performed by the sensor i if and only if there exist a mission l which demands sensor i for the execution of type j. Constraints (2.17) and (2.18) checks the redundancy in data transmission. That is, the transmission of the data after execution of mission of type j is performed at sensor i if and only if type j is assigned to sensor i.

3. Simulation and test results

In order to test and evaluate the proposed two stage decision making approach for sensor mission assignment, simulation results are considered. Taking into account the issues related to computation efficiency, the proposed method is simulated for a small size wireless sensor network. The following assumptions are made for simulation set up:

- Assume that a small size wireless sensor network is deployed in the rectangular field with a dimension of 180 m × 100 m. Let the area to be monitored in the field be taken as two circular regions Area 1 and Area 2 as shown in Figure 1.
- Let the 21 sensors deployed in the field be evenly distributed and in order to reduce the energy loss due to idle listening and self-discharge, 8 sensors are kept in active mode while the remaining 13 sensors are kept in sleeping mode. If a sensor completes all the sensing task assigned to it then it will automatically go to sleeping mode until it requires for another assignment. In Figure 1 black nodes represents sleeping sensors and white nodes represents active sensors.
- Each sensor in the field are capable of measuring all the types of missions under consideration.
- Assume that three quantities (type $J = 1, 2, 3$) are to be monitored and measured in the field.
- The measurement data is encoded using two bytes and assume no failure is permitted at each sensor in the network.
- Assume data transmission can be done properly and it will reach the destination on time.

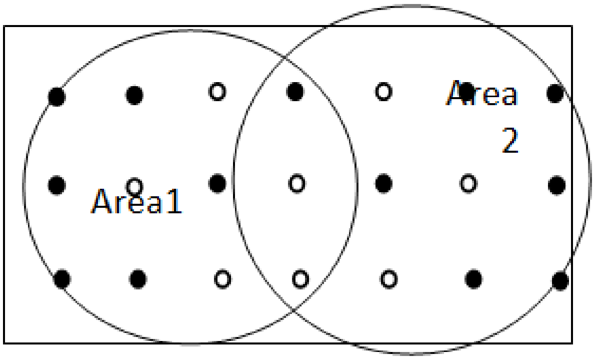

Figure 1. Wireless sensor network field.

Table 3. Simulation parameters.

Parameter	Value
Time interval T	17 280 s
Energy for each measurement of quantity of any type j	7.6 mJ
Energy of each data transmission	0.0108 mJ
Length of the data packet	23 bytes
Length of the packet buffer	10
Command sending interval	1s

- Assume the measurement of three quantities required by the missions are independent and not cooperative. So input-output ordering need not be taken into account.
- Assume sensor feedback is not taken into consideration.
- A mission represents a sensing task that requires information of a certain type in the Area 1 or 2, which may be contributed by exactly one sensor.

The simulation parameters used are given in the Table 3. The demand of the mission is processed and the corresponding data packets are first buffered and then sent to the base station when it is not busy. Depending upon the size of the sensor network, length of the buffer may be chosen and here it is set as 10. One second delay is chosen after sending each missions demand to avoid the collision during assignment process.

A simulation program is developed to create the proposed two stage formulation and CPLEX solver is used to solve it. The proposed approach is capable to detect overloaded and under loaded situation in stage 1 process. Simulation results for the first stage at different point of time during the time period $T = 17\,280$ s can be seen in Table 4. Zeros in the last column of Table 4 implies that the situation is under loaded during the period of consideration and there is no need to activate any sleeping sensors. During 900th second and 12 586th second, same number of missions are received, but in 12 586th second, three additional sleeping sensors to be activated when compared with 900th s. This is due to the reason that mission's demand vary for each type and also it vary from time to time. From stage 1 formulation, the number of sleeping sensors to be activated is known and the decision maker can decide whether to activate all the required sleeping sensors or less than that. For simplicity, assume the decision maker prefers to activate all the required number of sleeping sensors.

By running the solver for stage 2 formulation, the result shows the optimal energy consumption during entire time period T is 116541.35 mJ and the execution time taken by the solver to find the optimal solution is 263.367 s. The sensor network prolongs for the entire time period $T = 17\,280$ s.

TABLE 4. Simulation results for stage 1.

Time T (s)	Execution Time (seconds)	Received Missions			Active Sensors	Available Sleeping Sensors	No. of sleeping sensors to be activated		
		Area 1	Area 2	Total			In Area 1	In Area 2	Total
280	19	6	3	9	8	13	0	2	2
900	24	3	5	8	10	11	3	0	3
2242	30	10	8	18	13	8	1	3	4
3800	18	5	7	12	12	9	0	0	0
4543	16	6	2	8	9	11	1	1	2
5568	28	2	2	4	8	13	1	2	3
7584	26	6	4	10	11	10	3	3	6
9857	25	8	8	16	17	4	0	1	1
12 586	14	3	5	8	14	7	4	2	6
15 897	13	1	3	4	20	7	1	1	2

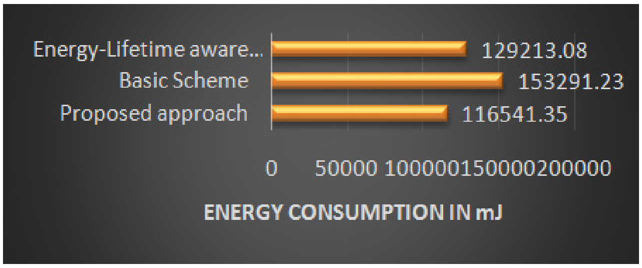

FIGURE 2. Comparison of energy consumption.

3.1. Benchmark assignment schemes

Apart from a simulation-based performance evaluation of the proposed approach, a comparative performance evaluation is done based on the two schemes namely Basic scheme, Energy-Lifetime aware scheme proposed in [18]. In Basic scheme, sensors propose to any mission within their range. In Energy-Lifetime aware scheme, assignment task considers the network lifetime and the available energy of the sensors using different weighting factor. These schemes in [18] are not modeled to handle sleeping sensors. So, while computing the evaluation factors based on these schemes, the simulation setup is modified by assuming that all the sensors are in active state.

The performance of the proposed approach is evaluated with respect to two factors (i) total energy consumption and (ii) network lifetime. The total energy consumption based on the Basic scheme is 153291.23 mJ and the execution time taken by the solver is 244.22 s. The sensor network prolongs for the time period $T = 15\,420$ s. It means that the networks lifetime ends before the predefined time duration.

The Energy-Lifetime aware scheme tries to conserve the available energy resources of the sensors to prolong the network lifetime. However, this can be achieved only if it ignores many missions. The total energy consumption based on the Energy-Lifetime aware scheme is 1 19 213.08 mJ and the execution time taken by the solver is 272.63 s. The sensor network prolongs for the time period $T = 16\,528$ s.

Figures 2 and 3 shows the comparative performance evaluation of the proposed approach with respect to two factors the energy consumption and the networks lifetime respectively. It is clear from the Figures 2 and 3 that the energy consumption by the proposed two stage decision making approach is less whereas the network life

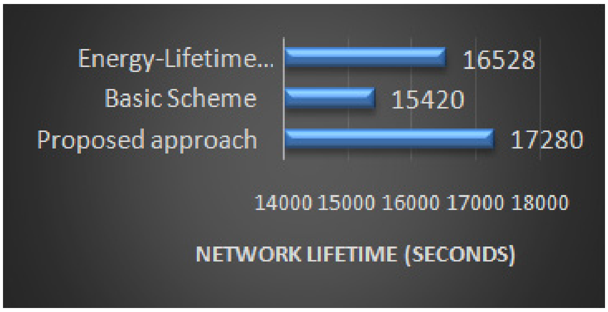

FIGURE 3. Comparison of networks lifetime.

time is more than that of the Basic scheme and the Energy-Lifetime aware scheme [18]. The proposed two stage decision making approach outperforms the existing schemes more significantly. Thus, the proposed approach is energy efficient and also it prolongs the network lifetime for the predefined finite duration.

4. CONCLUSION

In this paper, a new framework for the problem of sensor mission assignment is given and the proposed method regroups the characteristics of Generalized Assignment problem and decision making approach. The proposed method facilitates to detect overloaded and under loaded situations. Sleeping sensors are activated only if missions demand exceeds the capacity of active sensors. Either the situation is overloaded or under loaded, all the active sensors appear in the optimal solution. The decision maker or the system administrator knows in advance the exact number of sleeping sensors to be activated to handle all the received missions. This helps to prolong the network lifetime. The proposed two stage decision making approach is applied to a small size wireless sensor network. The proposed approach provides a clear scenario about the number of sensors to be activated to the decision maker in stage 1. It provides the flexibility to decide the number of sensors to be activated and the simulation results shows that the proposed approach is energy efficient and it prolongs the network lifetime for a predefined finite duration. This work is only the first step to integrate the sensor mission assignment problem with the decision making tool.

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