International Journal on
"Technical and Physical Problems of Engineering"
(IJTPE)
Published by International Organization of IOTPE

ISSN 2077-3528
IJTPE Journal
www.iotpe.com
ijtpe@iotpe.com

September 2014 Issue 20 Volume 6 Number 3 Pages 44-51

MULTI-PERSPECTIVE TARGET COVERAGE IN VISUAL SENSOR NETWORKS USING A GAME THEORETICAL APPROACH

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Abstract- Nowadays the problem of multi-perspective sectors coverage of the circular target in the monitoring area which tries to access further information about the target is one of the open research issues in visual sensor networks (VSNs). The main goal of this problem is to put some camera nodes in active mode, which the activation of these nodes will guarantee the maximum target coverage with minimum possible redundancy. According to literature, it can be concluded that the multi-perspective target coverage problem has been solved by applying exact and centralized methods. Since delivering information to the sink and activating the selected camera nodes by the returned messages in centralized methods are time consuming, they cannot be suitable for large scale VSNs with mobile targets. Therefore, in this paper, we propose a distributed algorithm named Game-theory based Multi-perspective Target Coverage (GMTC) which is based on the game theoretical approach. In the proposed algorithm each camera node decides to be active or not only by using the received information from its neighbor nodes. The simulation results demonstrate that our proposed algorithm performs more efficiently in providing the maximum multi-perspective target coverage at the minimum possible time and with the reasonable overlapping rate in comparison with centralized algorithms**.**

Keywords: Visual Sensor Networks, Multi-Perspective Target Coverage, Game Theory, Distributed Scheduling Algorithm.

I. INTRODUCTION

Visual Sensor Networks (VSNs) are a novel extension of Wireless Sensor Networks (WSNs) with camera nodes supplied by image sensor component for satisfying video capturing tasks besides communicational and computational unites. Unlike traditional sensor nodes, camera nodes are able to capture a large amount of visual information. Therefore VSNs are a suitable case for satisfying most of the applications ranging from monitoring and surveillance of the environment, public places, disaster and military areas to virtual reality and also health care and remote assistance for the elderly or physically disabled people [1-2].

Previous studies have shown that emerging of VSNs which include nodes with limited resource capabilities and different quality-of-services (QoSs) for realizing the applications, has raised new challenges and open research issues such as providing new medium access control and routing protocols, coverage and also transmission of visual data algorithms [1, 2 and 3]. Nowadays intelligent methods usually are used for solving the mentioned challenges [4, 5 and 6]. Considering the wide range of these challenges, in this paper, we focus on the multi-perspective target coverage problem. The goal of this problem is providing the maximum coverage of the target with minimum possible redundancy. Also it's worth mentioning that providing multi-perspective coverage from the target causes to access further information about the target. This information facilitates some tasks such as recognition and tracking of objects.

Based on literature, it can be resulted that works focusing on the multi-perspective target coverage and modeling the target as a circular target model can be divided into two groups. The first group focuses on providing the maximum arc coverage of the circular target; in other words, this group has tried to cover the circumference of the target [7, 8, 9 and 10]. However, in order to access more information about the circular target, the second group has concentrated on providing the maximum sector coverage of the circular target. In fact, the second group has tried to cover the area of the circular target [11, 12 and 13].

There are two approaches towards achieving the maximum sector coverage of the circular target in literature. In the first one, researchers have relied on the camera nodes placement methods [11, 12]. Although using the placement methods provides maximum sector coverage of the circular target, it suffers from some constraints. For instance, applying these methods on harsh environments and disaster areas is inefficient. Hence, in the second viewpoint, instead of using the placement methods, the scheduling methods have been used [13]. Scheduling methods in traditional works have relied on the exact and centralized algorithms such as dynamic programming and Binary Integer Programming (BIP) algorithms. Since information delivering to the sink and activating the selected camera nodes by the returned messages from sink in centralized methods are time consuming, these methods cannot be suitable for large VSNs with mobile targets.

In this paper, we aim to solve multi-perspective target coverage problem by relying on distributed scheduling algorithm in order to avoid the delay of message passing between the sink and activated nodes. Our proposed algorithm, "GMTC", is based on game theoretical approach and has a mathematical base. Simulation results proves the efficiency of GMTC in providing maximum multi-perspective coverage of the target at minimum possible time and reasonable overlapping rate comparing with a centralized and exact method.

The rest of the paper is organized as follows. Section II provides an overview of the related works on scheduling algorithms for multi-perspective target coverage. Section III describes multi-perspective target coverage problem, proposed algorithm, selection game, computing the mixed strategy Nash equilibrium of the game and the different phases of the proposed distributed algorithm. Section IV evaluates and compares the GMTC algorithm with the centralized and exact algorithm. Finally, conclusion is remarked in section V.

II. RELATED WORKS

Authors in [7] have studied the *angle coverage* problem in visual sensor networks where camera nodes are scattered randomly overall the network. They aimed at finding a set of camera nodes which uses least amount of transmission energy while covering all the angles of view. In order to reach the goal, the problem has been transformed to a well-known problem which called the shortest path problem. This problem can be solved by the Dijkstra's algorithm. But the authors developed a distributed algorithm which is more efficient than the conventional distance vector algorithm. Also the simulation results show that the proposed algorithm in [7] can save a lot of energy and achieve an important reduction in transmission cost.

In order to provide the full angle coverage of the desired object continuously, the scheduling problem of the camera nodes is studied in [8]. The goal of the authors in [8] is to increase the network lifetime. In order to reach their goal, they have used their Minimum Cost Cover algorithm which is explained in [7] and also the Minimum Cover algorithm which is a distributed algorithm to specify the minimum set of camera nodes in order to provide full angle coverage in visual sensor networks; and then they have developed several coverage-preserving scheduling schemes. The simulation results show that one of the developed schemes which named Conditional Scheduling metric helps to increase both of the network lifetime and the time of the first node failure.

In [9], the authors have focused on a specific coverage problem which named the perimeter coverage problem. Authors in this paper have concentrated on the perimeter coverage of a big object which needs to be monitored. Also, they assumed each camera node can just cover a single continuous part of the perimeter. The goal of the authors in [9] is to schedule the camera nodes in order to maximize the wireless sensor network lifetime. At first the authors have demonstrated that the perimeter coverage scheduling problem can be considered as a NP-hard problem. But since there is a polynomial time solution for this problem in some special cases, they have specified the suitable parameters for a scheduling algorithm to convert this algorithm to a 2-approximation solution for the mentioned problem. Further they have proposed a simple distributed 2-approximation scheduling algorithm with a small message overhead.

The simulation results show the efficiency of the generated scheduling algorithm in [9]. Also the comparison of this algorithm with the optimal schedules shows that a network lifetime in [9] is at least half of the network lifetime of the optimal schedules.

Camera actuation problem for providing multi-perspective event coverage in WMSNs (Wireless Multimedia Sensor Networks) has been studied in [10] where a lot of camera nodes are deployed randomly overall the network. The authors in [10] have proposed a distributed algorithm for solving this problem. The proposed algorithm turns on the minimum number of camera nodes during an event in order to reduce the amount of redundant multimedia data and achieve to the adequate coverage.

The camera nodes which access to the event information exchange their FoVs with the camera nodes in their neighborhood before deciding about actuation. If the part of the event area that covered by a particular camera node has not been covered by other camera nodes and the size of the event area is big enough, the camera node will be actuated. Also it is worth mentioning that algorithm in [10] determines the size of the area by counting the number of scalar nodes which are randomly deployed in the network.

Simulation results show that if all the camera nodes within the region or within the neighborhood of the event are actuated, by tuning the parameters of the algorithm, it will be possible to minimize the amount of redundant multimedia data while achieving to the adequate coverage. Also the results show that the proposed algorithm in [10] can be beneficial for centralized placement strategies which want to reach the full coverage of the region, especially in terms of FoV utilization.

In [11], the sensor placement problem in visual sensor networks with considering that there is no knowledge about the location and orientation of targets has been studied. The authors in [11] have aimed to provide the full-angle coverage of the targets. In order to solve the mentioned problem, they have introduced the notion of profile-based coverage. In this solution the points that the target is most likely located there, have been considered for generating the profile.

In order to guarantee the full-angle coverage of the targets, after the generation of profile-based abstraction, a simple clustering mechanism has been introduced. This mechanism encircles the proximal points within one cluster. After clustering, each cluster is considered as a virtual circular target. Therefore the profile-based coverage is reduced into a circular target coverage problem. Then the resultant problem has been solved by using a Binary Integer Programming (BIP) method. Also authors in [11], proposed a maximal occlusion-based coverage algorithm in order to utilize the coverage in a situations that a camera node loses to see a part of a target because of the obstruction by other targets.

This algorithm calculates the unblocked angles of view of the camera nodes and then chooses the most suitable set of camera nodes which their cardinality is less than a given threshold. The simulation results show that with increasing the number of clusters the number of chosen nodes is increasing. Also the results of simulations conducted in order to evaluate the performance of Maximal occlusion-based Coverage algorithm show that maximal target coverage increases when more camera nodes are used for target coverage. Totally, the authors claim that their placement method can find the optimal configuration with high coverage accuracy.

The coverage problem for video panorama generation in wireless Visual Sensor Networks (VSNs) with heterogeneous nodes has been investigated in [12]. In this problem camera nodes can have different price, resolution, field-of-view (FoV) and depth-of-field (DoF). In this paper by knowing a minimum average resolution, area boundaries, and the differences between camera nodes, a deployment algorithm that guarantees full multi-perspective coverage of the area while minimizing the total cost and the minimum required resolution is proposed. This algorithm is based on a new bi-level solution which modeled as mixed-integer program. The first level is named *master-problem* and the second level is referred to as *sub-problem*.

The authors in [12] claim that their proposed approach guarantees full coverage by distinguishing the uncovered points and refining the current camera nodes locations in order to cover the uncovered points. Authors' evaluations have resulted that by increasing the average resolution, the cost is increasing linearly. The reason is that by increasing the number of high resolution camera nodes for increasing the average resolution, the total cost will be increased.

Sensor selection problem in visual sensor networks has been studied in [13]. The goal of this paper is selecting an optimal subset of directional camera nodes in order to cover all of the targets while minimizing the total cost of the network. Authors in [13] have introduced a circular based target modeling as a solution for VSNs target coverage problems like: full angle coverage, partial angle coverage and k-coverage. The authors modeled these problems as a binary integer programming (BIP) problem.

The simulation results show that for partial and full angle coverage, there is need four camera nodes per target in order to cover all of the targets while in k-coverage problem, even with 11 camera nodes per each target, it's not possible to reach the coverage of more than 90%. Also the results of the simulations conducted with 1, 5 and 10 targets show that for 5 targets more camera nodes per target are required. Also it's shown that for 10 targets because of the possibility of multi-target coverage for each camera node, the efficiency of the proposed scheme is increased. The authors in [13] claim that their circular target model can select the camera nodes in a more efficient manner.

III. PROPOSED DISTRIBUTED ALGORITHM

A. Multi-Perspective Target Coverage Problem

The main goal of this problem is selecting the camera nodes which the activation of these nodes provides the coverage of the maximum number of the sectors from the appearing target while achieving the minimum angular overlapping rate.

Regarding the presented definition for multi-perspective target coverage problem, we can consider that the multi-perspective target coverage problem is the reduced form of the Set-Covering problem by using a polynomial time algorithm. Therefore regarding that the Set-Covering problem is a NP-Hard problem [14], providing a suitable solution for multi-perspective target coverage problem can be considered as one of the open research issues in VSNs. Hence we focus on proposing a distributed algorithm to solve this problem.

It is worth mentioning that in our proposed algorithm, the needed equations in order to calculate the covered sectors from the target by each camera node are taken from the presented equations in [13].

B. Game Theory Based Multi-Perspective Target Coverage Algorithm

In this section, the functionality of the GMTC algorithm will be explained. At first the selection game will be modeled and then the activation probability for each node will be calculated by computing the mixed strategy Nash equilibrium of the selection game. Finally the different phases of our proposed algorithm will be explained.

B.1. The Selection Game

The selection game is played by the camera nodes in the VSNs in order to choose the suitable camera nodes and declare them as an active one. This game can be defined as Selection Game-Theory (*SGT*) = $< N, S, U >$, which N is the set of players (camera nodes), S is the set of strategies that each player should choose one of them for playing, and U is the set of utility functions. In this game it is presumed that N is the set of camera nodes that the target is in their FoVs. The S includes two feasible strategies and if a node decides to declare itself as an active node, it chooses the DA strategy. Otherwise, it chooses the DI strategy which means declare itself as an inactive node. The U includes the payoff of the camera nodes.

If a camera node plays DI strategy and no other nodes play DA strategy, its payoff will be zero (the target is not covered). If a camera node plays DI strategy and just one of its neighbors chooses DA strategy, the payoff of this player will be equal to $(V - C_1)$. In this situation, since the maximum target coverage has not been provided, the cost of C_1 which is equal to 180 has been considered for the player. The consideration of this amount for C_1 is because of the responsibility of each camera node for coverage of the 180 degrees of the target. Therefore in this situation since the camera node has declared itself as an inactive node, the considered cost for this camera node will be equal to 180 (C_1).

If a camera node plays DI strategy and at least two of its neighbors choose DA strategy, the payoff of this player will be equal to (V). In this situation, because without any necessity for declaration of this node as an active node the maximum target coverage has been provided, without considering any cost, the payoff of V has been considered for this player which V is an initial gain and is equal to a big amount. Finally, if a camera node plays DA strategy, its payoff will be equal to ($V-C$). When the camera node plays DA strategy, since it is uncertain for the camera node to achieve the maximum target coverage or not, so the cost of C has been considered for this node. The considered amount for C is equal to 180 which is reduced by the amount of covered angular rate from the target by the camera node. With considering this amount for C, by increasing the covered angular rate from the target by the camera node, the contribution of this node in achieving to the maximum target coverage will increase and consequently the cost of C for this node will decrease. It is worth mentioning that the cost of C_1 has been considered more than the cost of C ($C_1 > C$). The payoff table for the three players is shown in Table 1.

Table 1. The payoffs for the simple three camera nodes

Player1	Player2	Player3	Payoff1	Payoff2	Payoff3
DA	DA	DA	$V-C$	$V-C$	$V-C$
DI	DA	DA	V	$V-C$	$V-C$
DA	DI	DA	$V-C$	V	$V-C$
DI	DI	DA	$V-C_1$	$V-C_1$	$V-C$
DA	DA	DI	$V-C$	$V-C$	V
DI	DA	DI	$V-C_1$	$V-C$	$V-C_1$
DA	DI	DI	$V-C$	$V-C_1$	$V-C_1$
DI	DI	DI	0	0	0

B.2. Probability of Being Active and Nash Equilibrium Calculation

To calculate the activation probability of each camera node, the Nash equilibrium of the selection game has to be calculated. According to table 1, it seems that the game is a symmetrical game and the payoffs don't depend on the players and just depend on the strategies that are chosen by the players. The (DA, DA, DA) strategy is not a Nash equilibrium because each player intrinsically prefers to play the DI strategy to gain more payoff ($V > (V-C$)).

For the same reason, (DI , DI , DI) strategy is not Nash equilibrium of the selection game too, because each player prefers to play DA strategy to gain much more payoff (($V-C$)) > 0). The (DI , DI , DA) and (DI , DA, DI) and (DA, DI , DI) strategies are not Nash equilibrium of the selection game too, because the player which plays DI strategy prefers to play the DA strategy in order to gain more payoff (($V-C$) > ($V-C_1$)).

But if two players declare themselves as an active node and plays DA strategy while the other player plays DI strategy, none of the players wants to change their strategies. Therefore the (DI , DA, DA) and (DA, DA, DI) and (DA, DI , DA) strategies are the Nash equilibrium of our selection game. It is observable that any pure Nash equilibrium does not exist in this game.

To enlarge the game for N players, we assume the $S=\{s_1, s_2, ..., s_N\}$ as the vector of strategies played by the players. This vector shows that the first player plays s_1 strategy; the second one plays s_2 strategy and so on. If all of the players play DI strategy, the payoff of all will be zero. If one player plays DA strategy and the rest of the players (N -1 players) play DI strategy, the payoff of player which declares itself as an active node will be $(V-C)$ and the payoff of the rest of the players will be $(V-C_1)$. If at least two of the players declare themselves as an active node, their payoff will be ($V-C$) and the payoff of the rest of the players will be V . In a summary, the payoff of the camera nodes is computed as shown in Equation (1):

$$U_i(s)=\begin{cases} 0 \quad \text{if} \quad s_i \in DI, \ \forall \ i \in N \\ V-C \quad \text{if} \quad s_i \in DA \\ V-C_1 \quad \text{if} \quad s_i \in DI \quad \text{and} \quad \text{only one node} \in DA \\ V \quad \text{if} \quad s_i \in DI \quad \text{and} \quad \text{at least two nodes} \in DA \end{cases} \tag{1}$$

As mentioned before, any pure Nash equilibrium does not exist in this selection game. Hence the mixed strategy Nash equilibrium of the selection game has to be computed and the players must be permitted to play their mixed strategies. In this situation, the players select their strategies based on a probability distribution. It means that each camera node declares itself as an active node with a computed probability. Let name the probability of playing DA strategy as p, and the probability of playing DI strategy as $q=1-p$.

B.3. Computing the mixed strategy Nash Equilibrium of the Selection Game

In order to compute the mixed strategy Nash equilibrium of the selection game, according to the methodology which is presented in [15], at first the expected payoff of each strategy should be calculated. The expected payoff for DA and DI strategies are computed by using Equations (2) and (3):

$$\begin{aligned} U_{DI} &= p\{\text{no one declares itself as an Active node}\}.0+ \\ &+p\{\text{one node declares itself as an Active node}\}.(V-C_1)+ \\ &+p\{\text{at least 2 nodes declare themselves as an Active node }\}.V \end{aligned} \tag{2}$$

$$U_{DA} = V-C \tag{3}$$

To calculate equilibrium, the following equation should be solved. In this equation the payoff of the two DA and DI strategies are placed equal with each other.

$$(\text{-}V+C_1).q^{N\text{-}1}+(\text{-}C_1).q^{N\text{-}2}+V=V\text{-}C \tag{4}$$

Solving the Equation (4) results in the probability p which matches to the mixed strategy Nash equilibrium:

$$P=(\text{-}V+C_1).q^{N\text{-}1}+(\text{-}C_1).q^{N\text{-}2}+C \tag{5}$$

B.4. Different Phases of GMTC Algorithm

The different phases of GMTC algorithm will be explained as follows:

i. Initially the camera node with target in its FoV, computes the covered angular rate from the target. Then it calculates its activation probability using Equation (5) and enters to the second phase.

ii. In this phase a random number between 0 and 1 with uniform distribution is generated. Then it is compared with the normalized activation probability of the camera node. If the generated random number is less than the normalized probability of the node, the node will be known as a permissible node to be active. Then in order to decide definitely about the activation of the node, this node will enter to the third phase. Otherwise the node will not be permissible to be active and will enter to the fourth phase.

iii. In this phase a permissible node readies its activation message which the part of this message consists the angular rate from the target covered by this node. Then in order to access to the channel and transmit the activation message, the node competes with the other permissible nodes. If the node succeeds to access the channel, the activation message will be transmitted and the node will be known as an active node. So the node will change its mode to the active mode and the algorithm for this node will finish. Otherwise the node will enter to the fourth phase.

iv. The node which is not been permissible in the second phase or which has not succeeded to access the channel in the third phase has entered to this phase. If this node receives an activation message from the other nodes, it will update its angular coverage rate from the target based on the angular coverage rate of the activated node from the target. Then this node will enter to the fifth phase. But if the node does not receive an activation message from the other nodes, it will return to the second phase and the algorithm will repeat again.

v. In this phase, if the updated angular coverage rate of the node from the target is more than zero, this node will compute its activation probability again by Equation (5). After calculation of the probability (p), the node will return to the second phase and the algorithm will repeat again. Otherwise the updated angular coverage rate of the node from the target is equal to zero which it means that the covered area by this node, now is covered by the activated nodes. Therefore there is no need for activation of this node. Hence this node will be known as an inactive node and will change its mode to the inactive mode and the algorithm for this node will finish.

IV. SIMULATION RESULTS AND PERFORMANCE EVALUATION

A. Simulation Setup

In order to evaluate the performance of the Game-theory based Multi-perspective Target Coverage (GMTC) algorithm, simulations are conducted using MATLAB-8.0 and also are executed on the personal computer with Pentium Dual-Core CPU 3 GHz. In the simulations, the dimensions of the monitoring area are assumed 120×120 m and the camera nodes are scattered all over the network randomly and with uniform distribution. Also, it is assumed that only one target is appeared in the monitoring area at the same time. Other attributes of the camera nodes and target are considered according to the Table 2. For demonstration of the efficiency of the proposed algorithm, the simulation results of this algorithm are compared with the simulation results of the exact and centralized method.

Table 2. The considered attributes for the camera nodes and target

Attribute	Value
θ	72º
R_F	35 m
R_N	5 m
R_T	5 m

B. Covered Sectors from the Target

In order to calculate the number of covered sectors from the target and compare the result with the exact method, the appearing target is placed 250 times overall the monitoring area randomly and with uniform distribution. In each time of the target placing in the monitoring area, the number of the covered sectors based on the number of the active camera nodes is calculated for both of the GMTC and exact algorithms. Then, the sum of the obtained results is divided by the total number of the appearing targets in the monitoring area and then the average number of the covered sectors from the target is achieved for both of the GMTC and exact algorithms. Figure 1 shows the results of the simulation which has done by increasing the number of the camera nodes in the monitoring area. In our proposed algorithm if the camera node can cover only one sector from the target which has not been covered by the other active camera nodes, this node will declare itself as an active node to cover that sector. Therefore, the GMTC algorithm like the exact algorithm tries to cover the maximum number of sectors from the appearing target.

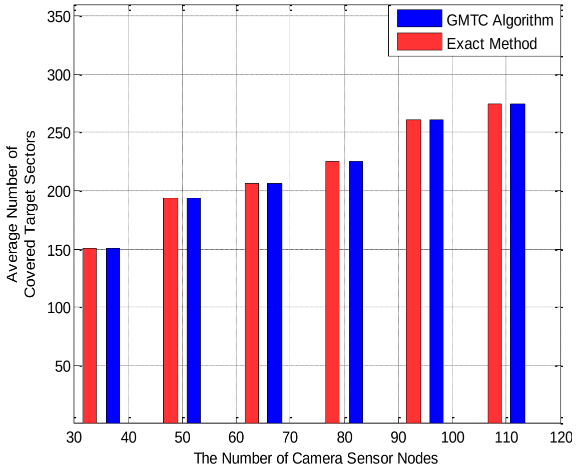

Figure 1. The average number of covered sectors from the target

C. Delay for Declaring the Active Nodes

In this section, delay means the time duration in which all of the camera nodes with target in their FoVs declare themselves as an active or inactive node. Since the exact algorithm is executed in the sink, the information of the camera nodes which the target is in their FoVs are transmitted to the sink and then the activation message is returned back from the sink to the selected camera nodes. Therefore, the delay in this method is the duration of time between transmission the information of the first camera node to the sink and delivering the activation message from the sink to the last selected camera node. It is worth mentioning that in delay calculation, the execution time of the exact algorithm in the sink is ignored.

In our proposed algorithm, the camera nodes which the target is in their FoVs decide to be active or not by executing the distributed algorithm and if one of them decides to be active, it will send its activation message to all of the nodes in its radio range. Therefore, the delay in the proposed algorithm is the time duration between placing the target in the FoV of the camera nodes and transmission of the activation message by the last selected camera node.

Considering the above explanation, in order to calculate the delay, the 802.15.4 (Zigbee [16]) standard has been used for transmitting the activation messages. In our simulations the activation messages sent to all of the nodes in the radio range of the active camera node, the activation messages returned back from the sink to the selected camera nodes, and also messages transmitted to the sink have the lengths 24, 22 and 24 bytes, respectively. Also since the routing algorithms are needed for transmitting and receiving the information in the exact algorithm, in the simulations, the modified LEACH algorithm in [17] has been used. It is worth mentioning that in delay calculation for both of the algorithms, the time for finding the location of the target by camera nodes has ignored.

In order to calculate the delay in the proposed algorithm and compare the result with the exact algorithm, the appearing target is placed 250 times overall the monitoring area randomly and with uniform distribution. Then in each time of the target placing in the monitoring area, the time duration for providing the target coverage by the selected camera nodes is calculated for both of the GMTC and exact algorithms. Finally, the average of the obtained results is calculated and the delay for both of the GMTC and exact algorithms is achieved. Figure 2 shows the results of the simulation which has done by increasing the number of the camera nodes in the monitoring area.

The investigation of the results shows that by increasing the number of the camera nodes from 35 to 110, our proposed algorithm has achieved, on average, 56.75 percent better performance in comparison with the exact algorithm in terms of delay. Also the investigation of the results in Figure 2 demonstrates that by increasing the number of the camera nodes, growing of delay rate in the exact algorithm is more than the GMTC. For instance, when the number of the camera nodes is increased from 95 to 110, the delay in the exact algorithm is grown from 6.4 ms to 7.7 ms while the delay in the proposed algorithm is grown from 2.85 ms to 3.25 ms.

D. Sectors with more than once coverage

In this section, after putting suitable camera nodes in the active mode by both of the GMTC and exact algorithms, the number of the sectors with more than once coverage is calculated for both of the algorithms. Then, the average of the obtained results is calculated and the number of the sectors with more than once coverage is achieved. The investigation of the simulation results in Figure 3 shows that our proposed algorithm in terms of the overlapping sectors reduction has, on average, 41.33 percent lower performance than the exact algorithm. Anyway, since our proposed algorithm is a distributed one and its efficiency in terms of coverage and delay is high, for the applications with mobile targets, 41.33 percent more overlapping sectors is acceptable.

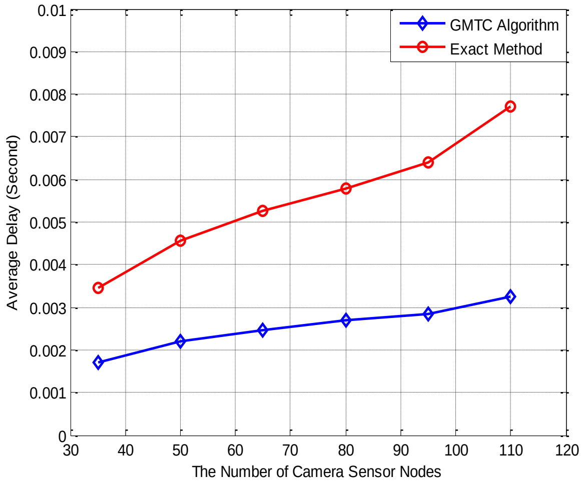

Figure 2. The average delay

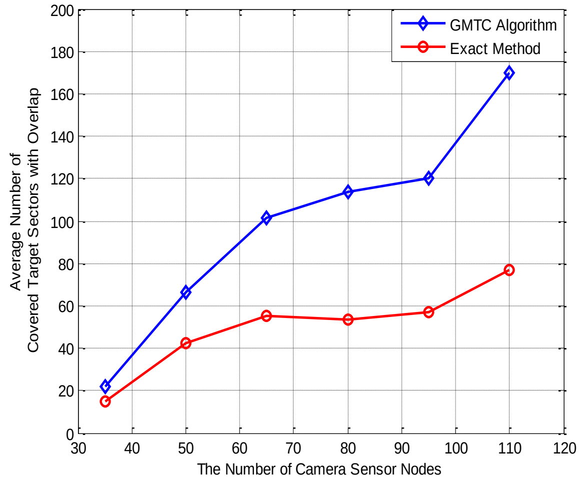

Figure 3. The average number of the sectors with more than once coverage

V. CONCLUSIONS

In this paper, initially the problem of multi-perspective target coverage has been introduced. The main goal of this problem is to select the camera nodes whose activation will provide maximum target coverage with minimum possible redundancy. Then, the investigation of the traditional works for solving the multi-perspective target coverage problem resulted that this problem has been solved by applying exact and centralized methods. Since in large scale VSNs with mobile targets, information delivering to the sink and activating the selected camera nodes by the returned messages in centralized methods are time consuming, centralized methods for these applications are not efficient.

Therefore, in this paper in order to reduce the delay, a distributed algorithm named Game-theory based Multi-perspective Target Coverage (GMTC) has been proposed. This algorithm is based on the game theoretical approach and in this algorithm each camera node only by using the received information from the neighbor nodes decides to be active or not.

Comparing the simulation results of our proposed algorithm with the exact and centralized method demonstrates that our algorithm has provided maximum multi-perspective target coverage as same as exact and centralized method, while it has achieved up to 56.75 percent better performance in terms of delay. Since our algorithm is a distributed one, it has, on average, 41.33 percent lower performance than the exact approach in terms of the angular overlapping reduction. Considering the mobility of the appearing targets in the monitoring area, 41.33 percent more angular overlapping can be acceptable in contrast to achieving up to 56.75 percent lower delay which causes to provide the coverage of the target more quickly and consequently access to the further information about the target.

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