ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, *Vol 9(36), DOI: 10.17485/ijst/2016/v9i36/96174, September 2016* ISSN (Online) : 0974-5645

Hybrid Energy-efficient Connected Target Coverage Algorithm for IWSNs

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Abstract

Paper is regarding the use of coverage algorithms on the static and dynamic node to resolve the problem of Coverage. **Objectives:** Main objective of this research is to minimize energy consumption. Its objective is to provide full connectivity and coverage with dynamic nodes in industrial WSN. **Methods:** Initially, deploy a number of nodes in an industrial area with the usage of MATLAB environment. Then apply two algorithms Communication Weighted Greedy Cover andOverlapped Target and Connected Coverage algorithms. Communication weighted greedy cover algorithm is used to separate movement of nodes. OTTC algorithm is used to reduce overlapped target problem. **Findings:** In Industrial Wireless Sensor Networkthe problem of Network coverage occursdue to large area coverage and heterogeneity of the network. CWCG and OTTC algorithms consume more energy while covering all the nodes. A solution is needed to develop an energy efficient network coverage algorithm which provides full coverage and connectivity. This research paper shows coverage with dynamic nodes in industrial area. Dynamic nodes reduce coverage and overlapped target problem.

Keywords: Connected Target Coverage, Energy Efficient CTC Algorithms, Industrial Wireless Sensor Networks

1. Introduction

WSNs have been largely useful to many industrial applications like as production automation smart home, large scaled structure. IWSNs show various benefits over conventionaluse wired communication in industry application to monitor and track industrial environment and physical condition of machines, early detect problem[1]. Industrial wireless sensor networks have two important issues are coverage and connectivity. Coverage is important requirement to application developing new developing strategies. In coverage determine all sensors monitor all the point in application. Coverage divided in three classes: Blanket coverage, Point coverage and Targetcoverage. Connectivity is another problem in IWSNs, which define how to transmit monitoring data from sender to receiver[2]. Connected Target Coverage problem is in a sensor area, a number of targets with static locations are need to be regularly covered, in the area by a numerous of randomly deploy sensors. The sensors monitored all data must be transmitted to a central node, or sink node. Connected Target Coverage algorithms, Communication Weighted Greedy Cover algorithm for active sensor transmit data to source to destination and inactive nodes to go the sleep mode, Optimized Connected Coverage Heuristic algorithm used to protecting nodes which monitor critical targets from forwarding data, Overlapped Target and Connected Coverage algorithm eliminating the redundancy caused by overlapped targets and Adjustable Range Set Covers algorithm reducing power consumption to minimize the sensing range[3].

2. Proposed Methodology

This section describes the methodology of the project. In this paper, focus is on increasing network lifetime and reducing energy consumption. Figure 1.

- Initially, deploy Dynamic nodes and Static nodes for the industrial wireless sensor network.
- Apply mixture of CWGC & OTTC Algorithms.
- Evaluate result.
- Compare the results static and dynamic nodes.

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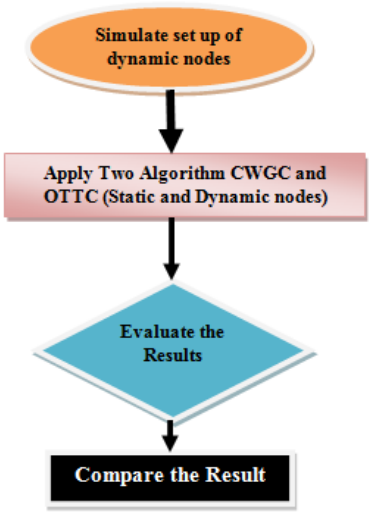
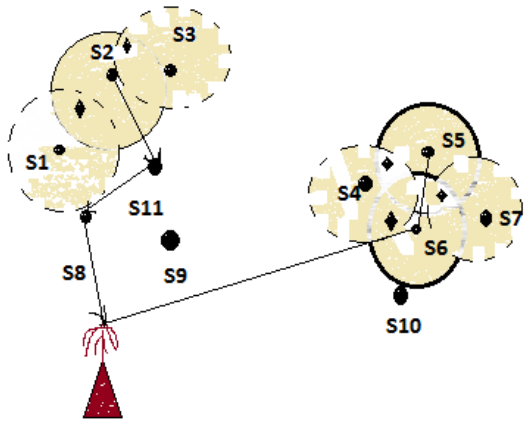


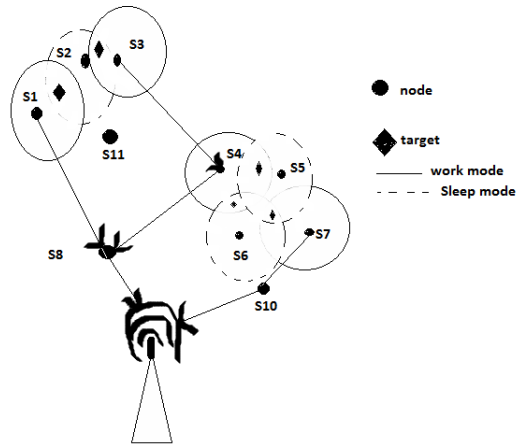
Figure 1. Proposed Methodology.

2.1 Communication Weighted Greedy Cover (CWGC)

CWGC algorithm mainly used to remove connected target coverage problem as a maximum cover tree problem. Fast heuristic algorithm is also called communication weighted greedy cover algorithm. CWGC used to maximize the cover sets. Greedy algorithm also used in CWGC to select the target covers sets and reduce communication cost. Describe the CTC issue in Figure 2, 10 sensor nodes, 5 targets and one base station in the sensor area. The sensor nodes that can cover one or more targets are representeduse circle, hard circles for active source sensors and others for inactive sensors go to sleep mode. Arrows used to present routes transmit data sender to receiver. Two methods are explained in (a) and (b)[4].



(a)

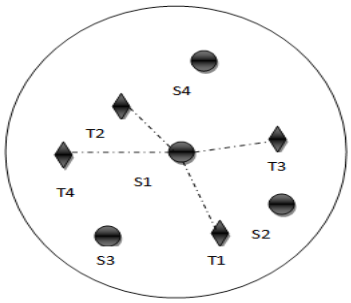


(b)

Figure 2. Maximum Cover Tree.

2.2 Overlapped Target and Connected Coverage (OTCC)

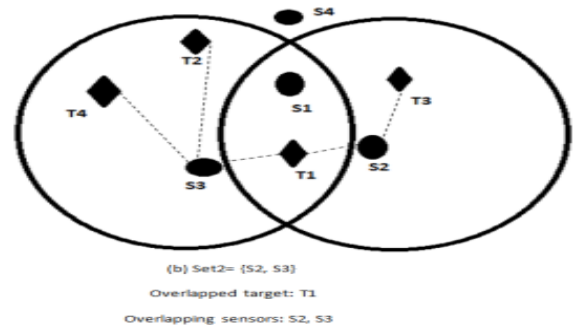
Explain the overlapped target issue[5]. In overlapped issue two sensor nodes monitor same location at same time and send the data source to destination. Both sensor nodes consume same amount of energy to send same location data to base station. Multiple transmissions of the same data are redundant and cause the sensors to waste energy. Figure 3, adjacent nodes may collect same data in same location from targets transmit to the base station. OTCC algorithm to protect redundant coverage and transmission, it is sufficient that data created from an overlapped target is transferred only one time. OTTC extend network lifetime. Redesign the overlapped target and connected coverage issue and create MCNTG problem by creating graph model called Cover and Transmission. To removed MCNTG problem using a heuristic algorithm known as the SPT-Greedy Algorithm. In this algorithm find unique route from all target to the base station and make maximum number of active sensor nodes[6].



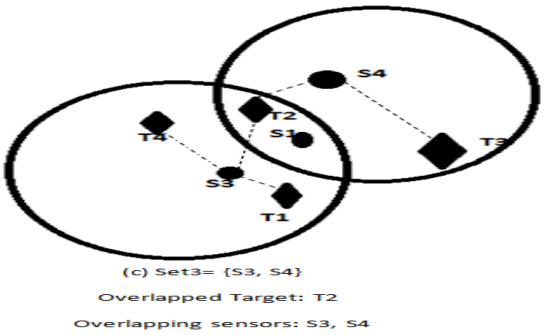
(a) Set1={S1}

No Overlapped Target

(a)



(b)



(c)

Figure 3. Overlapped Target and Corresponding Overlapping Sensors in Joint Sets.

3. Simulation Environment

This paper uses MATLAB environment for simulation. Firstly, declare the deployment area with 30 nodes deployed randomly for the simulation of OTTC and CWCG algorithms for network coverage. This work implemented the principle of the algorithm with the static node by firstly placing the nodes and then the calculation of the distance to be adjusted is done using the distance table. The strategy is repeated for OTTC and CWCG algorithms in which the node is kept dynamic where the node keeps on moving in the network which is taking full advantage of the enhanced coverage. Simulation parameters are listed in Table 1.

Table 1. Network parameters.

Parameter	Value
Network Area	600*600
Number of nodes	30
Initial energy of nodes	300 mJ (Milijoules)
Energy of coverage calculation ECC	1 – 50 mJ
Energy of movement EM	1 – 100 mJ
Node Distance	40m

3.1 Evaluation Metrics

In order to evaluate the algorithms comprehensively their properties through the following five metrics:

- **Energy Consumption**- Itis the total of energy used by a sensor done the activities of sensing, computing and communicating in the network.
- **The ratio of dead nodes**- The ratioof the number of nodes that run out of energy to the number of deployed nodes.
- **Average Throughput**- It is calculate the average rate of successful message receive across a network
- **Average End to End delay**-It determines the delay in transmits of the information i.e. the time gap between the transmission and reception of the packet from a source node to the sink.
- **Average Jitter**- It is network determine the variation in network.

3.2 Performance Analysis

In this paper, the focus on analysis and compared with existing work on static nodes in IWSN and the new approach using dynamic nodes using various parameters such as energy consumption, the ratio of dead nodes, Through put, End to End delay, jitter. Figure 4 represent dynamic sensor nodes deploy using CWGC and OTTC algorithm and dynamic nodes collect the data randomly move different coverage areas. Figure 5 present previous work static nodes deploy using CWGC and OTTC algorithms. In this base station set fixed location to collect data.

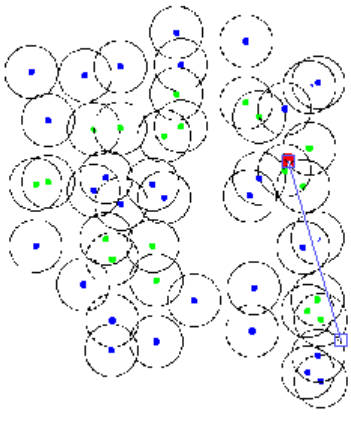


Figure 4. Coverage with Dynamic Node.

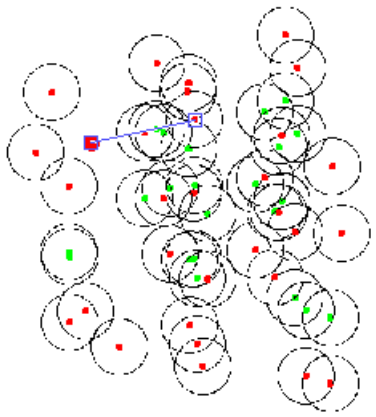


Figure 5. Coverage with Static Node.

3.2.1 Energy Consumption

In Figure no. 6, energy consumption can be calculated that under a condition that 30 nodes randomly deployed in a 600*600 network size, every node distance minimum 40m in the network. The average energy consumption is large because most of the nodes require being awakened for sensing. To solve large energy consumption problem, need of coverage and connectivity. In terms of CTC, only some of the nodes have energy consumption for data sending and receiving. Figure 6 shows the two algorithms performance CWGC and OTTC in static nodes and dynamic nodes. In static nodes, CWGC and OTTC algorithm consume more energy to data sensing. In dynamic nodes, both algorithms combine CWGC+OTTC for data sensing and relaying. Dynamic nodes consume less energy than static nodes.

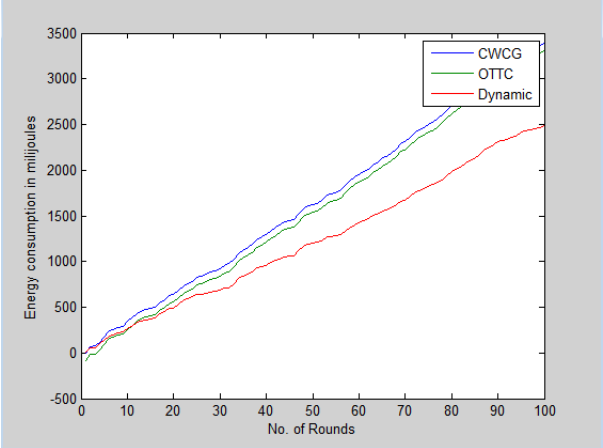


Figure 6. Energy consumption.

3.2.2 Number of Dead Nodes

In IWSNs some nodes are dead due to large amount of energy consumption. Figure 7 shows dynamic node performs better because the network energy efficient.

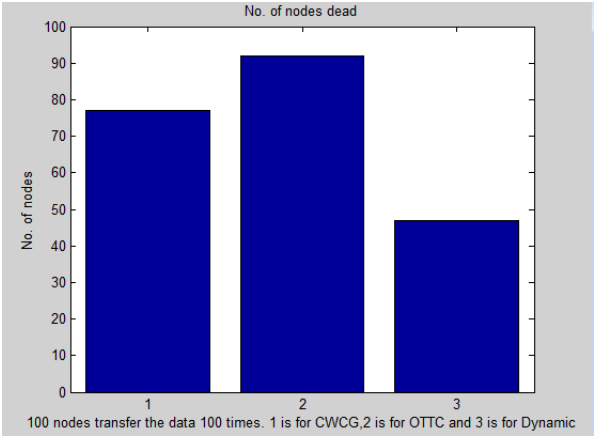


Figure 7. Ratio of Dead Nodes.

3.2.3 Average Throughput

In the throughput since the energy consumption is small, the transmissions are more effective so the network does not go under any congestion and the network also has very high packet transfer rate. So the throughput is very high in case of the dynamic sink. Shown in Figure 8 using static nodes CWGC and OTTC algorithms the value of throughput is low while in the case of dynamic nodes value is high.

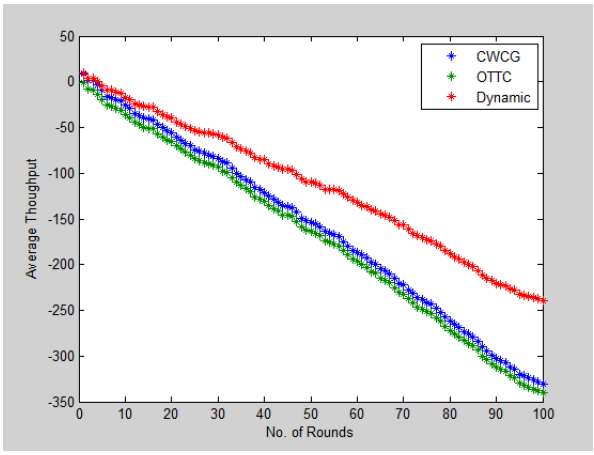


Figure 8. Average throughput.

3.2.4 Average End to End Delay

Figure 9 described the graph of an E2E delay. In CWGC

and OTTC for static nodes end to end delay value high and in the case of dynamic nodes the end to end delay between packets is very low because throughput value high in the case of dynamic node.

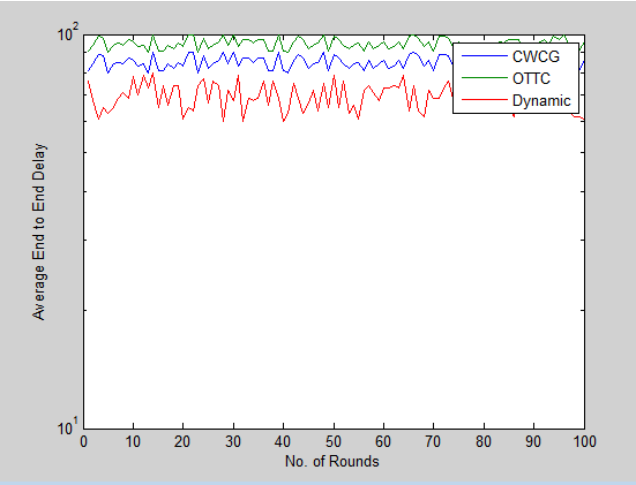


Figure 9. Average end to end delay.

3.2.5 Average Jitter

In figure no. 10 shows that the value of average jitter is high in case of CWGC and OTTC algorithm for static nodes than dynamic nodes. In dynamic nodes jitter, the delay is very less and the rate is very constant, it is that the jitter in the E2E delay is very less. Delay because the throughput is high in the case of CWGC+OTTC the delay between the packets is very less the and hence the E2E delay is very less as in Figure 10.

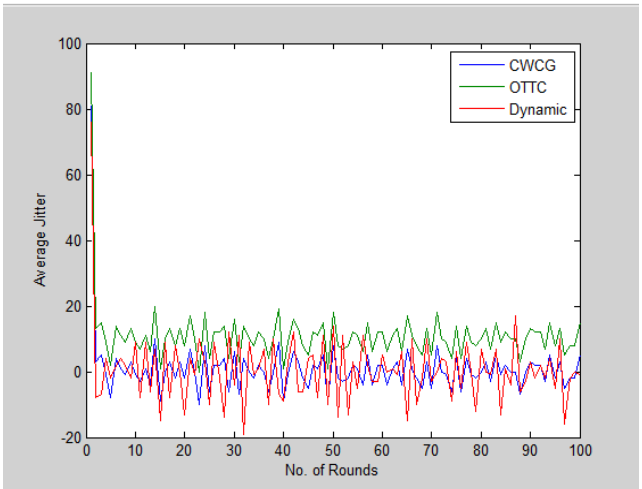


Figure 10. Average jitter.

4. Conclusion and Future Scope

In this paper analyzeenergy efficient connected target coverage algorithm for static and dynamic nodes in industrial wireless sensor networks. CWGC (Communication Weighted Greedy Cover) to reduce communication cost and maximum source cover sets and OTTC to eliminated redundancy caused by overlapped targets selected to increase network lifetime and maintain coverage and connectivity. Previous work authors introduced static sensor nodes in IWSN using four algorithms CWGC, OTTC, OCCH (Optimized Connected Coverage Heuristic), AR-SC (Adjusted Range Set Cover). In new approach deploy dynamic nodes using CWGC and OTTC algorithm. Energy-efficient connected target coverage approaches to ensure that selected nodes are prioritized and remain connected to the control sink even if other nodes die out, while also working towards extending the energy lifetime of the essential nodes and the network as a whole. In this paper,use Energy consumption, Number of dead nodes, throughput, end to end delay and jitter. In all five parameters, theobtained results show improvement. In future work network lifetime, energy consumption. End to end delay can be further improved by hybrid multipath routing algorithm.

5. References

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