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# The Enhancement of Network Lifetime by Mobile Node in OPP Routing of Wireless Sensor Network

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**Abstract:** One of important challenge issue in the wireless sensor networks is limitation energy in battery of intermediate nodes, so using a suitable routing algorithm can improve this problem. In the wireless sensor network, sink node uses neighbour in order to sending interest message into network. The neighbour nodes around of the sink have important duties. The neighbours of sink all times are using by sink node in order to receiving data, so it will consume more energy from sink node. Moreover, when neighbour nodes of sink go to dead mode, sink node could not propagate its packet. In this paper we have proposed a new algorithm by using mobile sink nodes to prevent energy wasting and also increase network lifetime. The result of simulation showed that life time has increase in an efficient way and has increase about two times in the compare of OPP algorithm.

**Keywords:** Direct Diffusion, One phase pull, mobile sink, wireless sensor network.

## 1 Introduction

Wireless sensor networks (WSN) are used to monitor a site where many sensor nodes gather data and send them to a sink or sinks nodes via wireless transceiver. The sensor nodes energy resource is limited battery while sink nodes usually are rich in energy. For sensor nodes often it is impossible or difficult to replace their batteries, so efficient utilization of energy for promote network life time is a challenge in wireless sensor networks.

Within previous years, many algorithms and protocols have proposed with the aim of decrease energy usage among intermediate nodes. Direct diffusion [1–5] is an important one. It uses data oriented protocol and gathers desirable data by query. As a result, many packets are transfer in each period of time and it causes save energy. In this algorithm query of data is done by sink, and it establishes an effective path according to gradient which intermediate nodes make according to received data from their neighbors. The gradient concepts represent which sink is accessible toward the neighbors. In the wireless sensor networks, all data will send from sensor nodes to sink by using routing paths and routing map, so making and keeping the gradient value are the most important duty of each sensor node. Management of these gradients is done by sink with frequent flooding diffusion in different period of time.

Most of the implementation in wireless sensor networks use stable sink. Stable sink provide security and safety for network but it has a big problem because the sensors which are neighbors of sink has an efficient role to make a path from other nodes to the sink. They should send more packets to the sink and it causes to exhaust their energy immediately. By dead of these nodes, the path from an event to sink will be destroyed and the network may be useless while there are many alive nodes.

In this paper we propose a new algorithm based on direct diffusion protocol family and try to solve this problem in an effective way. We propose mobile sinks with limit path in the edge of site which sensor nodes are scattered there. With this manner we don't have security problems of mobile sinks. In the contrary, it is safe

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because they are not go through the sensor nodes. By change the location of sinks they could make new path and prevalent from hurried death of neighbor nodes.

The rest of this paper is organized as follow. Section (2) provides a review (of) related works and shortly discus about them. In section (3), we propose an overview about direct diffusion and introduce its protocol family. In section (4), we propose our algorithm and (illustration) of the results of simulation are provided in section (5). Section (6) is about conclusion of our research.

## 2 Related work

Different algorithms are proposed according to the direct diffusion and mobile sinkin recent years. We provide a brief of them as follow. In [6–11], authors offer a data centric routing with the name of Minimum Cost Forwarding Algorithm. In this approach the least cost to the sink is estimated in each node. When a node receives a message about an event from a neighbor then check that is it in its short path or not? If it has the short path, it will broadcast the message. This period is done till the sink inform about event.

In [12–16] an algorithm with the name of Rumor routing was proposed which has the same idea as direct diffusion. In this algorithm an agent, a long lived packet, announced other about new event. Each node which recognizes an event could establish an agent and add this event to its event table. This packet propagated to the network until its TTL will be expired. This query flooding reduces the energy of nodes and after while large number of agent and huge event table could cause some problems.

In [7, 17–19], authors provided a method according to direct diffusion based on diameter of hexagon. In this paper, sensor nodes have a fix location in the corner of some hexagons and main information is send and receives in the diameter of hexagons. In order to providing tolerable energy consumption among all nodes, the established routes are occasionally changed. For saving more energy, they assume that each node after sending data will be change from active mode to idle one. In order to reduce energy consumption in flooding message in direct diffusion, new algorithm with the name of passive clustering is proposed in [7]. Authors achieve this goal by reducing messages overhead. The results of simulation show that direct diffusion algorithm has better performance with this algorithm. In [18], authors have proved that network lifetime could have increase if sink moves among the sensor nodes. They discussed that if the network can provide load balancing on sensor network by mobile sink therefor network life time will increased. They choose the shortest path for minimize the traffic load of network.

In [8], authors proposed an algorithm based on randomize movement of some agents with the name of MULE. In this approach there are mobile agents which move in the site and collect data. When these agents are in the board of sink, deliver them to the sink. Movement of the agents is modeled as a random walk. Queue in mobile agents and sensor nodes are finite and this approach could provide high delay and sometimes high packet lost.

## 3 Overview of direct diffusion

Direct Diffusion (DD) is a data-centric routing algorithm for wireless sensor networks. This algorithm creates the best path according to the needs in three steps.
A) An interest is propagated in the network by flooding.
B) Each node which receives the interest, check its cache and if there is not any entry for it, make an interest entry for it and make a gradient. This gradient determined the neighbor which this interest is received from it.
C) A path is established based on the gathered information [20–24]. These three steps are illustrated in Fig. (1).
Packet flooding is not an efficient method for dense and large scale networks. In [13] the Directed Diffusion protocol family was introduced, which includes:

1-Two phase pull diffusion: It is the original direct diffusion algorithm. The sink propagates interest to find the sources. Intermediate nodes, make the gradient according to received interest from neighbors, and sink enforce the best path according to the information and gradients.
2-push diffusion: in this method sinks are passive and sources are active. Information is sent through the network in one phase and sensor created gradients which are not used. Push diffusion could be optimizing for some applications which has many sources and sinks, and sources produces data occasionally.
3-One phase pull diffusion: in this algorithm, when an interest is received, it sends data on the preferred gradient. This preferred gradient is chosen from the neighbors, and it is one that sends first matching interest, so it have the lowest latency path. The one phase pull assumes that there is symmetric communication link between nodes, which could be not true in an unstable wireless network.

The main problem with these approaches is that the short path between sinks and sources are selected, which seems sensible in the first glance. Using this constant path causes that energy of nodes through this path decrease immediately. If we use different paths during some periods of time, we could improve this situation but after while nodes which are around of sink and also nodes around of event would lose their energy immediately which is not suitable at all. By dead of nodes around sink or event, we cannot gather information about event and it could cause disasters. For solving this problem, we propose a new method in which sink could move in the

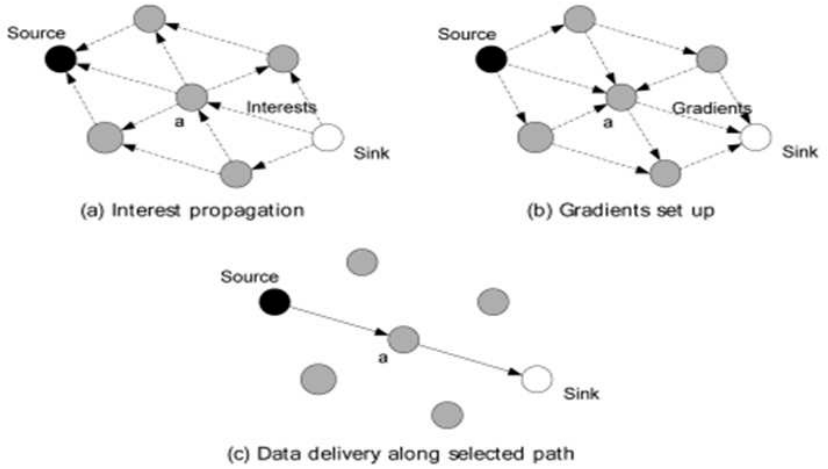


**Figure 1:** directed diffusion concept

edge of site. With this manner they could establish different paths in various places and prevalent from dead of nodes around of themselves and promote the life of network.

## 4 Proposed Algorithm

In One Phase Diffusion protocol, there could be some sources and sinks which should establish some ways from sources to sinks. In most proposed algorithms, each event makes a way to all sinks and it is in communication with them. This situation means that more nodes would exhaust their energy which is not necessary. If each node has a path with just one sink, it could transmit its data to sink. For this purpose, in our proposed algorithm, we suggest to partition the site according to the number of sinks. Each node relates to a partition and has radio communication with the sink of that. Nodes make the gradient based on neighbor which is in a same location with them. When there is an event in a part of area, nodes of habited there transport information to the sink.

Another problem with the DD is that nodes which are near to the sink has an important role and could be a connector to many nodes. The problem with these nodes is that they should transport many information from various parts of the site and it causes they lost their energy immediately. With death of these nodes sink loses its relationship with other nodes of its scope. If it is possible, another path could establish from sink to event, but it is a temporary solution and after while nodes of this new path will dead too. For solving this problem, we propose to use moveable sink. When the energy of nods which are neighbor with sink reaches a threshold amount, sink could move and change its location. It could choose the new location based on the information which are transmitted and chose the nearest location to the event.

The main problem with moveable sink is its security. If sink wants to move among the intermediate nodes, its security could be in dangerous. For prevalent from problems of moveable sink, we propose that our sink chose their location just in the edge of the site and they never go throughout intermediate nodes.

## 5 Simulation

We used Matlab software for examine our proposed algorithm. We assumed that we have 100 nodes which are scattered in a site. We have 4 sinks and in the beginning they are in the corners of the square site. Each node makes its gradient according to the OPP algorithm and the short path is established from each node to the related sink. Fig. (2) shows this concept. Circles are the intermediate nodes and $x$ signs are sinks in this figure. In this scenario site is divided to 4 partitions and nodes from each are shown with various colors.

In our proposed algorithm each sink could move in the outside edge of its location. Sink (0, 0) could move in $x$ axis from zero to 50 and also could move in $x$ axis from zero to 50. Sink (0, 100) could move in $x$ axis form 50 to 100 and could move in the $y$ = 100 line from (0, 100) to (50, 100). Sink (100, 100) could move in the $y$ = 100 line from (50, 100) to (100, 100), and could move in $x$ = 100 line form (100, 50) to (100, 100). Sink (100, 0) could move in $x$ = 100 line form (100, 0) to (100, 50), and it could move in $x$ axis from 50 to 100. When the energy of sink neighbors reach to 40 percent of its whole energy, sink change its location. We chose threshold amount 40 because they could have role in another routing path.

We assumed that an event is occurring and evaluate the network when we use one Phase Pull and when use propose algorithm. Fig. (3) and (4) show the amount of alive nodes after simulation for proposed algorithm and

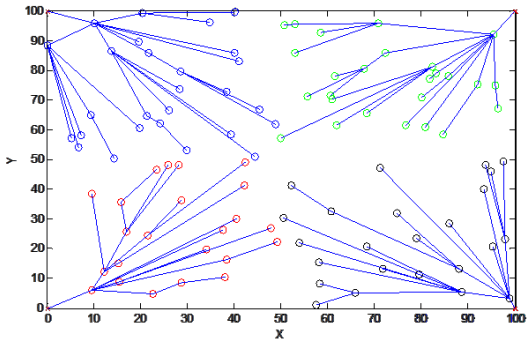


**Figure 2:** Partition site and make shortest path from each node to a sink

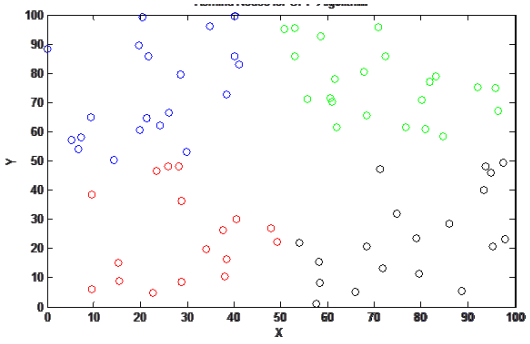


**Figure 3:** Remained nodes after simulation for proposed algorithm in a 100 × 100 site

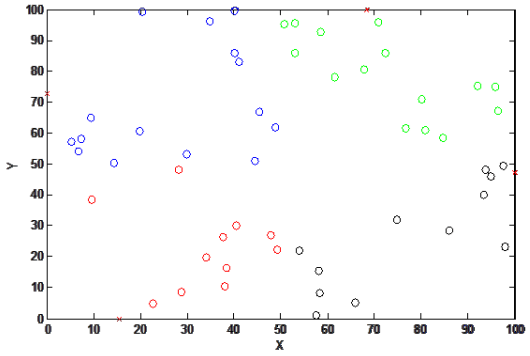


**Figure 4:** Remained nodes after simulation for OPP algorithm in a 100 × 100 site

OPP respectively. Fig. (4) shows alive nodes in each time slice and Fig. (5) shows (demonstrate) average energy of network in each slice time.

With compare of figures, we can find that in OPP after a short period of time nodes around the sinks or events are dead and the path from an event and related sink is destroyed. It causes the network will be useless and the

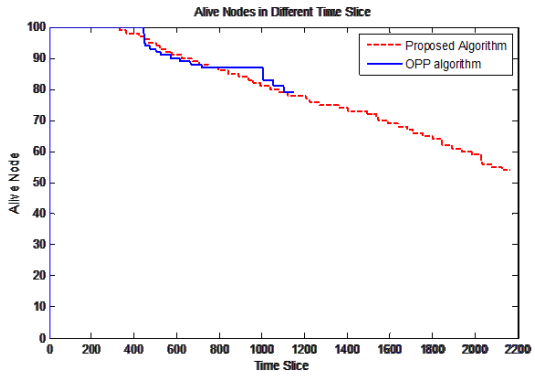


**Figure 5:** Alive node in each time slice

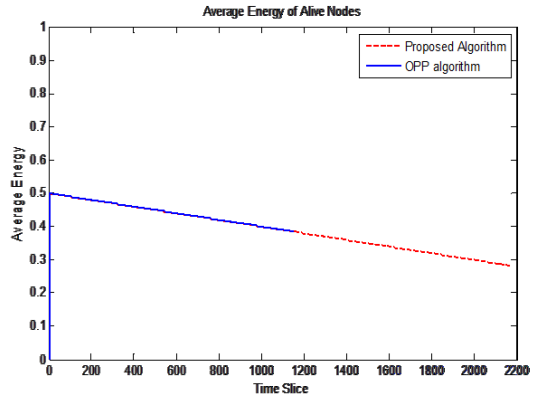


**Figure 6:** Average energy of network in each slice time.

life time of network will be short while there is a lot of alive nodes yet. On the other hand in the proposed algorithm, because supporting mobility of sinks, they can use more alive nodes and provide longer life time for WSN than previous situation of network.

In Fig. (3) the last position of sinks are shown with *x* sign in the edge of square and amount of alive nodes are less than amount of alive nodes in the Fig (4). It proves that our proposed algorithm uses nodes effectively and do not let them to divide some useless parts, which is happened in the Fig (5). Fig (5) shows that our algorithm has longer life time and as a result we could use network effectively. Fig. (6) shows the average life time of alive nodes in different time slices. By our algorithm, the network is active until the most of nodes are alive.

## 6 Conclusions

In this paper we proposed a new algorithm based on the one Phase Pull algorithm. We suggested for partitioning the location and each node communicates with just one sink. According to the created gradient in each node,

short path from node to the sink is established. In order to (to prevent the energy wasting) of neighbor nodes of each sink, we offered mobile sinks which could change their location to the near of an event. Sinks could choose their new place in the outside edge of each location and they could not go through the intermediate nodes. With this strategy we do not have the problems of mobile sinks. The results of simulation showed that our algorithm provided long life time for the network more than twice in the compare of OPP. Network could use alive nodes more effectively.

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