OPPA-AC: Optimal Path Planning based on Ant Colony Algorithm for Temporary Isolated Node in WSN

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Abstract

In real wireless sensor network application (WSN), several nodes may suffer from link failure problem. Link failure is a problem that may exist in the presence of obstacles which blocked the wireless connection between nodes. While the link between nodes is blocked, the node will be temporary isolated from the cluster; thus, their data will not reach the destination node. The temporary node isolation problem becomes more challenging if the data should be arrived on time. The traditional clustering algorithm (LEACH) is not considered the temporary isolated node, which cause longer waiting time for data delivery in certain rounds. In order to solve this problem, we proposed the ant colony-based optimal path planning algorithm (OPPA-AC). The OPP-AC was improved the LEACH algorithm by providing alternative path for temporary isolated nodes and guarantee their data arrived in the destination. Based on the experimental result, the OPP-AC surpassed the traditional algorithm in term of waiting time.

Keywords: temporary isolated node, ant colony, OPP-AC, WSN

1. Introduction

In wireless sensor network application (WSN), the nodes may suffer from link failure problem due to the environmental effects, such as: radiation, temperature rising, fog, rain and obstacle. Link failure is a problem that may exist in the presence of obstacles which blocked the wireless connection between nodes. Therefore, those nodes cannot send data through the original forwarding path for a period of time (or temporal) because their communication range is decreased [2-5] or blocked.

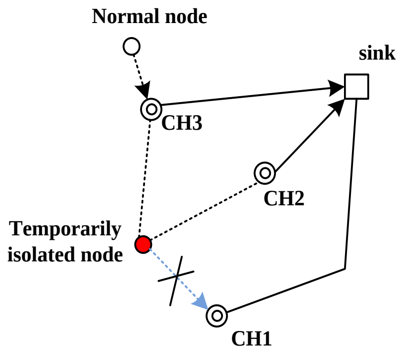

Fig. 1 Temporary isolated node

Since LEACH was not considered this problem, those nodes are temporarily isolated from their CH. The temporary node isolation problem becomes more challenging if the data should be arrived on time. Moreover, the temporarily isolated nodes (Fig. 1) cause packet drops, increase the average delay, and increase the energy consumption; in turn, the performance of network become degrades [3].

Recently, there has been a few related works in temporarily node isolation problem [2-5]. However, those existing works focused on connection reestablishment. Therefore, we present the ant colony-based optimal path planning algorithm (OPPA-AC) to select the forwarding path for temporarily isolated nodes. Our objective is to reduce the waiting time and congestion in WSN.

2. Method

The structural synthesis of CCPGTs will be performed based on the creative design methodology process [7-8]. The proposed algorithm

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consists of two steps: (a) clustering process, (2) data transmission. In the first step, we adopt LEACH for the CH selection [1]. The second step involves the proposed path selection mechanism in order to reduce the end to end delay and packet drops in WSN.

In order to determine the forwarding path for temporarily isolated nodes, we used link quality as the pheromone of ants by favoring received signal strength indication (RSSI). The RSSI value is collected each time the temporarily isolated node receive ADV message from nearby CHs. RSSI values is normalized for further calculation by OPP-AC, and it given by:

$$RSSI_{norm} = \frac{RSSI_i}{RSSI_{max}} \quad (1)$$

The objective function is the link quality (LQ) which depends on RSSI value. Therefore, the isolated node will selects the path with better LQ. Moreover, ant colony algorithm select a CHs node with probability $P_{ij}^{\ k} = \tau_{ij}^{\ \alpha} \eta_{ij}^{\ \beta} / \sum_{s\in list_k} \tau_{is}^{\ \alpha} \eta_{is}^{\ \beta}$ for j∈ $list_k$, otherwise $P_{ij}^{\ k} = 0$. Moreover, $\eta_{ij} = 1/d_{ij}$ and the pheromone ($\tau_{ij} = \frac{1}{RSSI_{norm}}$), α=0.7 and $\beta = 0.3$.

3. Results and Discussion

We validated the proposed algorithm through simulations and comparison with the LEACH in term of end to end delay. We simulated 35 nodes in 50x50m^2 square area, the data length ia 30 byte, ε_{elec} = 50nJ/bit, E_{DA}=0.5nJ/bit, ε_{amp}=50nJ/bit/m^4, and ε_{fs}= 10pJ/bit/m^2.

Based on the experimental result (Fig. 2), the OPP-AC surpassed the LEACH algorithm in term of end to end delay.

4. Conclusions

In this paper, three new designs of the CCPGT have been generated in a systematic methodology. The feasibility of the new designs is verified by conducting kinematic simulation. The result has shown that the new designs can produce a more wide range of non-uniform output motion than the existing design. Therefore, they are better alternatives for driving a variable speed input mechanism.

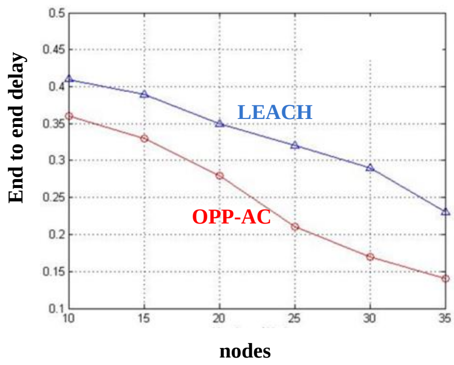

Fig. 2 End to End Delay

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