A Study on Time Synchronization and Position Identification in Wireless Sensor Networks

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In this paper, new method of time synchronization and position identification in wireless sensor networks is described. Many existing methods require a lot of communication packets according to the increase in the number of nodes. The communication band consumption in time synchronization and position identification causes obstruction to application communication. In order to overcome this problem, in this paper, new method to achieve efficient utilization of the communication band is proposed. Proposed method consists of three schemes:

1) Optimization of the communication band consumed by time synchronization: The communication packets of time synchronization are reduced by controlling relay timing and selecting relay nodes by a receiver node on the basis of the information about neighbor nodes. This scheme can synchronize time of all nodes by a constant amount of communication packet independently of node density. For this reason, it is possible to suppress the influence on the application communication even if the time synchronization is periodically repeated to keep synchronization accuracy.

2) Improvement of stability and accuracy in position identification: This scheme solves nonlinear simultaneous equations in the multilateration as an initial value problem of the ordinary differential equation. It can identify the node position stably and accurately in comparison with the least squares solution when anchor node is few. For this reason, it is possible to reduce the communication packets used to obtain the information of distance between anchor node and target node.

3) Integration of time synchronization and position identification: This scheme integrates time synchronization and position identification by applying Time of Arrival (ToA) and achieves efficient utilization of the communication band. Moreover, the solution can be stably obtained by using the scheme developed in 2). In addition, by using the scheme developed in 1), time synchronization and position identification can be achieved simultaneously and also number of communication packets can be decreased.

In this paper, details of above three schemes are described, and effectiveness of each scheme is also discussed according to the result of actual implementation and computer simulation.