# WSNs Virtual Node Time Synchronization Algorithm based on Flooding Broadcast

Yijun Wang[a,]*, Yulin Gong, Kai Gao

School of Electronic & Information Engineering, Changchun University of Science and Technology, Changchun 130022, China

[a]wyjs-107@163.com

**Abstract.** The current time synchronization algorithms for wireless sensor networks have some defects, which include sensitive error data, huge energy consumption and long synchronization convergence time. In this paper, to meet large-scale networks requirement, multi-hop network time synchronization mechanism is constructed by the virtual synchronization root node based on voronoi synchronization model. The analysis on simulation result indicates that the algorithm decrease energy consumption and synchronization convergence time over other algorithms.

**Keywords:** Synchronization Algorithm, Flooding Broadcast.

## 1. Introduction

Wireless sensor network (WSNs) is composed of a large number of sensor nodes deployed in monitoring area to communicate with each other to form more than a jump self-organizing network system. It is an important technology of the Internet of the underlying network form [1]. Therefore it is very suitable for battlefield target positioning [2], planetary exploration, physiological state of data collection and monitoring, and many other areas [3]. Time synchronization algorithm is a key mechanism in multi-sensor data fusion under the fundamental framework of WSNs [4].

## 2. Time Synchronization Model based on Voronoi diagram

The p and q are any two points in planar region, and the Euclidean distance between two points can be written as:

$$dist(p,q) = \sqrt{(x_p - x_q)^2 + (y_p - y_q)^2} \tag{1}$$

Where (xp,yp) and (xq,yq) is the plane coordinates respectively of p and q. Assuming that P={p1,p2,… ,pn} is n different points in the planar F , P corresponding voronoi diagram is defined as the plane is divided into n sub regions, and each region has the following properties: point pi region corresponding to the sequence of arbitrary point q, if and only if corresponding to the arbitrary pj $\in$ P,j $\neq$ i, it has dist(q,pi) < dist(q,pj). Based on this, setting V (PI), is (n-1) public intersections of half plane, and it is also a convex polygon (convex polygon) region, and also have (n-1) vertexes and (n-1) edges along the border [5].

Therefore, each line is a pair of reference nodes between the perpendicular bisector of a segment in area; each vertex is an intersection of perpendicular bisector.

In order to understand the characteristics of each side of the voronoi diagram and vertex, definitions and theorems are given:

Definition 1: for any point in the area of q, q centered round, when the round inside do not include any benchmark node in the Voronoi region P, when forming the great circle, we make the circle q about P to be the biggest hollow round , and remember as SP(q).

Theorem 1: set P={p1,p2,… ,pn},n $\geq$ 3 ,the corresponding Voronoi graph is Vor(P) , point q is a vertex Vor(P), if and only if point q in the biggest hollow circular SP(q), there are at least three benchmark node.

## 3. Virtual Node Algorithm

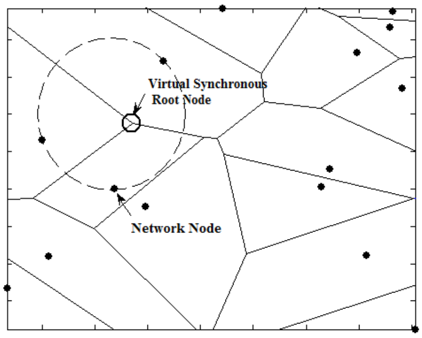
Virtual node time synchronization algorithm based on Flooding Broadcast (FBST) is at the aim of the whole network, within the scope of the time synchronization by cluster analysis which can compensate the error caused by deviating from the data, so as to improve the precision of time synchronization.

### 3.1 Construct Virtual Synchronization Root Nodes

According to the model of WSNs time synchronization based on Voronoi diagram, all the nodes in the network construct the points set of the Voronoi diagram; and based on this construct Voronoi polygons, each network node is deployed in cyberspace Voronoi diagram. At the same time Voronoi diagram form can get each polygon vertex coordinates, the coordinates at the same time by the vertex maximum recorded three nodes on the hollow circular. The vertices defined as virtual synchronous root node, as shown in Fig. 1. Each virtual synchronous root node in the network built at the same time. The sink node sends the only ID to virtual synchronous root node. When the sink node communicates with the virtual root node, its three largest hollow circular network node can use the ID number records synchronization time stamp. It is important to note that such virtual synchronous root node have no specific executive ability, not as a real network node forwarding and receiving synchronous information. So the virtual synchronized root node saves its own time synchronization information which is stored in the hollow circle on the three biggest network node.

### 3.2 Multi-hop time synchronization based on virtual synchronous root node

When the WSNs topology and virtual synchronization root node have been constructed, sink node send time synchronization messages within the scope of communication area periodically. The time synchronization messages include synchronization time stamps, virtual synchronous root node ID number, the number of initial jump, and serial number. Each virtual root node of largest hollow circular network node are in charge of the recording time synchronization messages. The theorem 1 shows that a virtual synchronous root node can make at least three network nodes synchronization at the same time. For virtual synchronous root nodes that are beyond the scope of the Sink node communication area, the network node does not get in the first time clock synchronization messages. At this time, such virtual synchronous root nodes can indirectly receive time synchronization, through the nearest two (or more than two) at the same time in the largest hollow circle which have the network node of the synchronous message received on a synchronous message, and will spread the message to the local maximum hollow circular for other nodes. Finally the WSNs realize the multi-hop time synchronization of the whole network, multi-hop time synchronization diagram as shown in Fig.2.



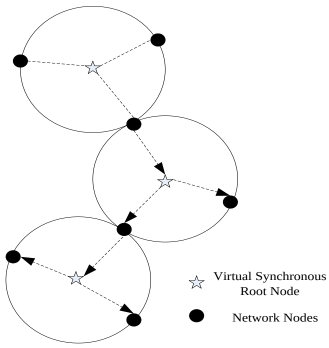




Fig. 1 Location of virtual synchronization root node Fig.2 Multi-hop time synchronization schematic

## 4. The Simulation Analysis

We use OMNeT++ to verify the synchronization precision, energy consumption and convergence time, and to demonstrate the effectiveness of FBTS algorithm performance compared with other algorithms. The relevant simulation conditions are as follows: sentence number is 250 times, delay between two sentences is 6.5 seconds, the simulation time is 35 minutes, the maximum communication distance is 80 m.

Fig. 3 shows the power consumption for three algorithms. From Figure 3, Energy consumption of FBTS is about 1/3 compared with the other two algorithms. Along with the number of nodes increasing, FBTS algorithm energy consumption trends to increasing steadily, which is an important advantage of FBTS algorithm.

Statistical convergence time is shown in Fig.4. With the number of nodes increasing, the convergence time of FBTS and FTSP [6] algorithm is shorter than RBS [7] algorithm, and FBTS has a little advantage compared to the FTSP algorithm. RBS convergence time linear growth trend is obvious, and the other two algorithms are gradually stable.

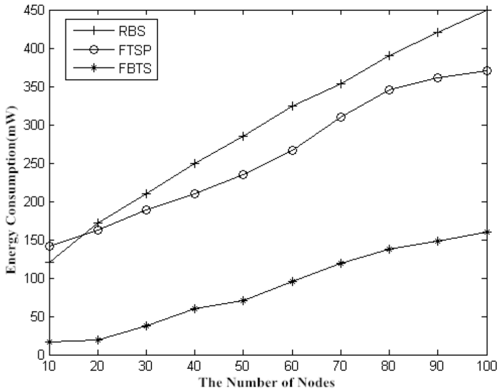



Fig.3 Comparison of energy consumption

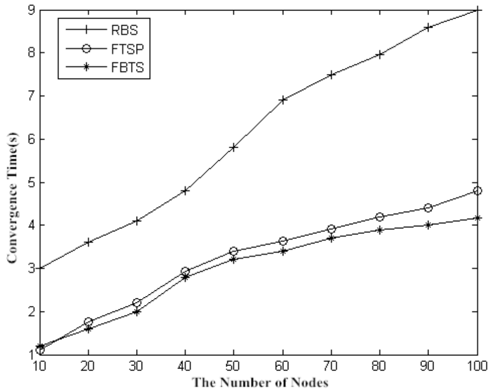



Fig.4 Comparison of convergence time

## 5. Conclusion

Based on the analysis of the existing problems, this paper proposes virtual synchronous root nodes time synchronization strategy based on Voronoi diagram. The simulation experiments prove that the algorithm improved energy consumption and convergence time relative to other traditional WSNs time synchronization algorithm. In the subsequent research work, the algorithm will be combined with the IEEE 1588 protocol, and enhance accuracy of time synchronization further.

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