International Journal of Advances in Computer Networks and its Security – IJCNS
Volume 4 : Issue 1 *[ISSN 2250 – 3757]*
Publication Date: 09 January 2014

Animal Tracking Using Checkpoint Method in Wireless Sensor Network

Chanwit Suwannapong
Department of Computer Engineering,
Faculty of Engineering,
Khon Kaen, 40002, Thailand
E-mail: kunkoro_ss@hotmail.com

Chatchai Khunboa
Department of Computer Engineering,
Faculty of Engineering,
Khon Kaen, 40002, Thailand
E-mail: chatchai@kku.ac.th

***Abstract*— A small node of wireless sensor with low power consumption is helpful to study the animal behavior and walking. In addition, this system is also capable of tracking movement of animals to prevent loss by using checkpoint method. We propose a simple checkpoint method. In this methodology, we installed multiple base station nodes as wireless sensor fences in farm. Thus, when our animals such as cow come near by a base station, nodes will exchange information such as node id to the base station. Our experiment study shows that the design of the 13 developing nodes can work efficiently with our tracking methodology.**

Keywords—Wireless Sensor Network; Animal Tracking.

I. INTRODUCTION

The beef industry is the big domestic business that involve among of million farmers thus we cannot deny that livestock technologies important to this business. However, although agriculture is the major foundation of the national food production and revenue, the present-day farmers still lack training to acquire livestock technology, which nowadays is still self-reliant in terms of information recording and tracking animal. Farmers cannot produce sufficiently to meet the demand, while costs also increase.

Wireless Sensor Network [1] can be effectively applied in the livestock sector in order to increase productivity, decrease costs, and upgrade livestock product standards. Wireless sensor network is an efficient technology with its outstanding minute size, low power consumption and long and continuous operating hours owing to its small batteries. It allows short-length communication or the dubbed wireless personal area network. This network is capable of both high and low speed data sending and receiving. Our research applies the IEEE 802.15.4 [2] standard – a low-speed short-range sensor network of the frequency of 2.4 GHz, with a capacity of 250 Kbps [3].

Wireless sensor network can be utilized in tracking and positioning animals in the livestock sector. Farmers can work more conveniently and the national livestock industry can be more efficient. This paper presents the relevant theories and research, research instruments and methodology, findings and discussion, and the research conclusion.

The rest of this paper is organized as follows. Section 2 presents related work on animal tracking. Sections 3 present tools and research methodology. Sections 4 present system overview. Finally some conclusions and future work are given in Section 5.

II. RELATED WORKS

A. Great Duck Island

Great Duck Island (GDI) is an area in the southern of Mount Desert Island, Maine. The scientists had applied the sensor nodes to the underground nest for monitoring the habitat of seabird nesting environment using 32 sensor nodes on a small island off the coast of Maine and the data collections were shown on the web. GDI system architecture consists of sensor nodes for collecting the data then transmits their data through the sensor network to the sensor network gateway. The gateways would transmit the sensor data to local transit network and the base station will connect to the database and across the internet. Finally, the data would be shown to the scientists through a user interface [4].

B. Wireless sensor devices for animal tracking and control

This research explains the development of sensor nodes used in livestock and environmental work. The node is developed within 916 MHz. The developed sensor nodes were attached on the cattle's collar in order to receive data from the sensor. The data is then sent to the base station to specify the path of the cattle and each animal's activity, such as stooping (for eating) or raising head (walking), etc [5].

C. Energy- Efficient Computing for Wildlife Tracking: Design Tradeoffs and Early Experiences with ZebraNet

This research applies the peer-to-peer wireless communication in the mobile node to support wild animal tracking in biological experiments. The research design involved 30 sensor nodes at Mpala Research Center, Kenya. This system is dubbed the ZebraNet System. A collar with a node was attached to each animal grazing in a vast area. The collar has been designed to incorporate GPS flash memory, radio signal sender and receiver and a small computer [6].

The main purpose of the research was to collect data from each collar and send it to the base station. However,

since the collars were not within similar length, direct transmission was not possible. Other collars had to be applied as the medium in data sending. We improved the flooding protocol and history-based protocol for data collection in this research.

III. TOOLS AND RESERCH METHODOLOGY

A. *Tools*

The sensor nodes used in sending and receiving data were IC CC2530 [7] of Texas Instruments. The nodes function at 2.4 GHz as shown in Figure 1. 6LoWPAN (IPv6 over Low power WPAN) [8] was also used. This is a protocol supporting IPv6 to work in the IEEE 802.15.4 standard to enable communication between sensor nodes on

Figure 1. Wireless sensor network device.

IPv6

The mobile component of this network are worn by the animals seem as the collar including CC2530 module, 3V battery and water resistant coverage as shown in Figure 2.

Figure 2. Collar on animal.

1) Animal tracking using the checkpoint method

In this research, we introduce the concept of using the checkpoint in wireless sensor networks. The fence is designed for wireless sensor networks to track and study the behaviors of animals. A large livestock can hold the random walk of animals and by using checkpoint animals will automatically be indicated of their locations and time period – being checked at the nearest checkpoint. Wireless sensor fence is used instead of conventional fence or electronic fence due to the cheaper price, easy installation, no limitation of animal size, and resistance behavior of animal's reduction.

This section describes tracking animals by using checkpoint. The example is shown on Figture 3 - sensor in wireless system which has three types: (1) border router which receives information from checkpoints, (2) base station which is a checkpoint, and (3) node sensor that is attached on animals.

At time t0: node 1 is at various locations which has not exchanged information with the base station

At time t1: node 1 moves to base station B and exchanges information with base station B to memorize meeting time, and the information will be sent to border router.

At time t2: node 1 moves to another checkpoint, base station C, to exchange information and save the time, then sends information to border router.

When we save information of animals that meet checkpoint for a big number, we can use that information to analyze their walk path, and to help in the case of animal loss upon the wireless sensor fencing – check the last checkpoint that met that animal; it surely helps to track animals in the easiest way.

IV. SYSTEM OVERVIEWS

Animal tracking and positioning used in the livestock sector comprises 2 parts, namely, wireless sensors and base stations and web servers. This can be shown in Figure 4.

There are 3 types of wireless sensors: border router, base station nodes for checking and nodes attached on animals.

The base station MySQL comprising 2 tables contains the following data:

Sensor node – for compiling details of each node in the network . Neighbors are used for recording details of adjacent nodes .

The results checked by the sensors will be shown through web browser in 2 patterns, i.e., tabulation as illustrated in Figures 5.

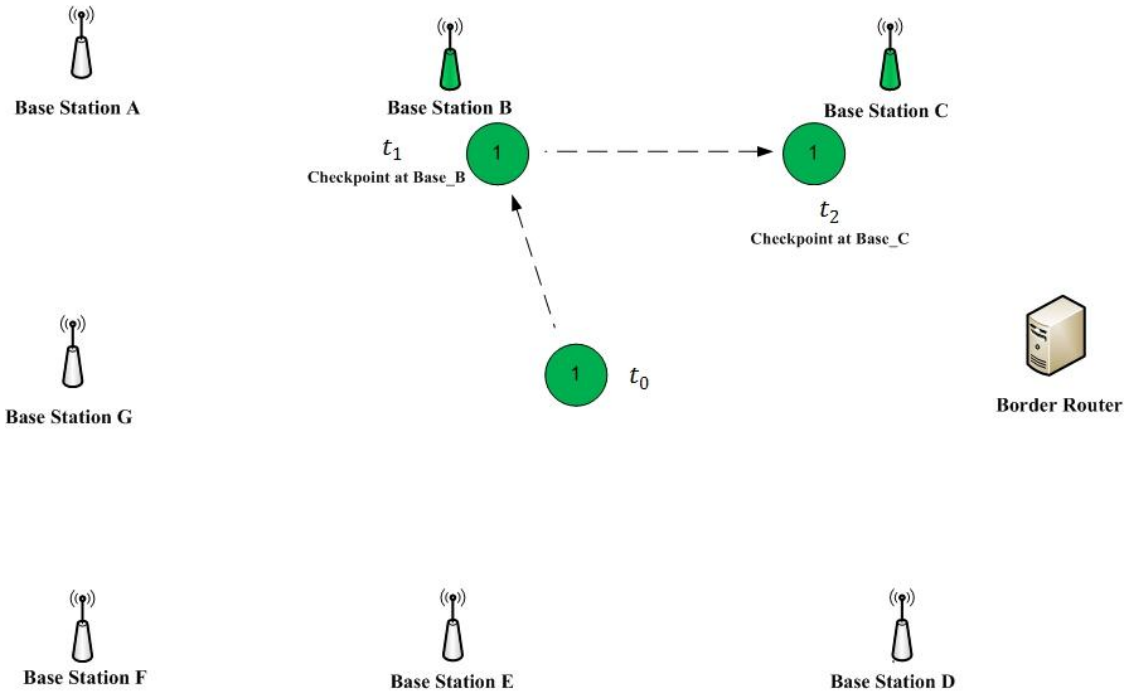

Figure 3. Example of animal tracking using checkpoint method.

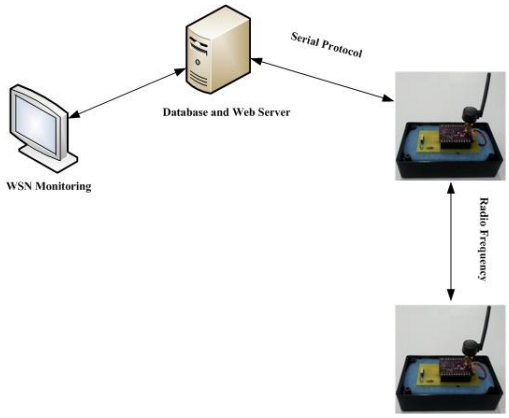

Figure 4. Holistic view of the system.

Cows Position in Livestock System

This is the current date and time (updates every 5 seconds):

Cow Position.

Node_id	Base_id	DB_time	Current_Clock(*10)
1	83	2013-01-31 10:32:33	0
2	0	2013-01-30 20:35:42	0
3	0	2013-01-31 17:39:08	0
4	83	2013-01-31 10:29:49	0
5	0	2013-01-30 22:21:47	0
6	0	2013-01-31 06:21:55	0

Neighbor Nodes.

Node_id	Base_id	Neighbor	DB_time	Current_Clock(*10)
6	81	1	2013-01-30 23:19:15	45
1	81	2	2013-01-30 19:43:08	139
1	83	3	2013-01-31 06:54:37	290
1	83	4	2013-01-31 06:54:37	289
1	83	5	2013-01-30 18:50:47	8
1	83	6	2013-01-30 23:18:55	138

Figure 5. Tabulation of the results.

V. EXPERIMENT AND RESULTS

In this section, we discuss the experimental results based on the observation datasets from the sensor networks. We used 13 wireless network devices divided into 7 base stations and 6 sensor nodes. Each bases station was 55 meters apart. The dataset came from six cows with CC2530 collars that run during a seven-day period from 24-31 January 2013. The data were collected when the animals were moving freely within a paddock within about 110m x 110m.

Sensor nodes are collecting data during 8:15am to 9:22am for 7 days. Then analyze animal checkpoint by checkpoint method. The walking pathway of animal #001 and #003 from checkpoint method that show in figure 6 and

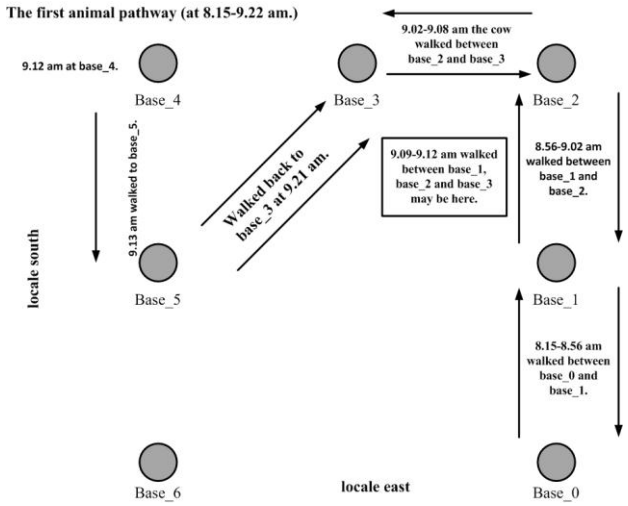

Figure 6. The walking pathway of animal #001.

7.

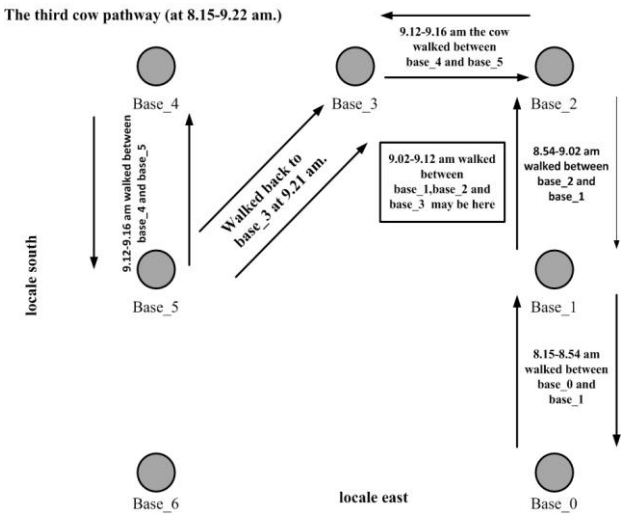

Figure 7. The walking pathway of animal #003.

TABLE 1. NUMBER OF CHECKPOINTS.

Cow#ID	Base 0	Base 1	Base 2	Base 3	Base 4	Base 5	Base 6
#0001	82	126	71	24	37	14	0
#0002	79	130	69	18	32	12	0
#0003	87	127	68	19	35	16	0
#0004	83	131	70	26	33	12	0
#0005	85	132	65	22	36	15	0
#0006	80	134	67	23	32	14	0

The 1st table shows the number of checkpoints of the animals. Because of the abundance, the most frequently base station that animals went to is the 1st Base Station.

VI. CONCLUSION

The animal tracking study was based on the design by using wireless sensor networks to find the walking pathway of animal.

As the results, we found the animal tracking and position identification concepts by checkpoint method and know the site where the animal walked frequently that can be full of grass more than other sites.

References

[1] C. Khunboa, "Wireless sensor network and appliction. Journal of Academic Service Center", Khon Kaen University 19(3-4) , 2011.

[2] IEEE Standard for Information technology, "Local and metropolitan area networks– Specific requirements– Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low Rate Wireless Personal Area Networks (WPANs)" . IEEE Std 802.15.4-2006 (Revision of IEEE Std 802.15.4-2003), pp .1 –320, 2006.

[3] T.S. Rappaport. "Wireless Communications: Principles and Practice", 2 ed, Prentice Hall PTR:Saddle River, 2002, NJ, USA.

[4] R. Szewczyk, A. Mainwaring, J. Polastre, J. Anderson and D. Culler, "An analysis of a large scale habitat monitoring application", in Proceedings of the 2nd international conference on Embedded networked sensor systems, New York, NY, USA, 2004, pp. 214–226.

[5] P. Sikka, P. Corke and L. Overs, "Wireless sensor devices for animal tracking and control", in 29th Annual IEEE International Conference on Local Computer Networks, 2004, 2004, pp. 446 – 454.

[6] P. Juang, H. Oki, Y. Wang, M. Martonosi, L. S. Peh and D. Rubenstein, "Energy-efficient computing for wildlife tracking: design tradeoffs and early experiences with ZebraNet", SIGOPS Oper. Syst. Rev., pp. 96–107, 2002.

[7] Texas Instruments. 2012. CC2530 Datasheet, "A True System-on-Chip Solution for 2.4-GHz IEEE 802.15.4 and ZigBee Applications". Avilable : www.ti.com/lit/ds/symlink/cc2530.pdf. [Feb. 20, 2013].

[8] X. Ma and W. Luo, "The Analysis of 6LowPAN Technology", in Pacific-Asia Workshop on Computational Intelligence and Industrial Application, 2008. PACIIA '08, 2008, pp. 963 –966.