Wireless Communication with Batching Method Based on Xbee-PRO S2B Module for Sensing of Wind Speed

by Asep Andang

Submission date: 09-Sep-2021 02:45PM (UTC+0700)
Submission ID: 1644351242
File name: ethod_Based_on_Xbee-PRO_S2B_Module_for_Sensing_of_Wind_Speed.pdf (766.06K)
Word count: 2651
Character count: 13202

2016 2nd International Conference on Science in Information Technology (ICSITech)

Wireless Communication with Batching Method Based on Xbee-PRO S2B Module for Sensing of Wind Speed

Nurul Hiron, Asep Andang
Electrical Engeneering Departement
Siliwangi University
Tasikmalaya, Indonesia
hiron@unsil.ac.id, andangs@unsil.ac.id

***Abstract*—Measurements of wind energy from rural areas play an important role in mapping the wind energy potential. It takes a reliable communication from sensor to server. Technique of wireless data transmission from the sensors are placed in rural areas to the server, often in trouble caused by the weather and the system so that it makes the data collected in the server becomes inaccurate, on the further condition, it is causes the lack of proper decision. This study focused on the implementation of the equation for the batching process as a fundamental coding program in the process of capture and transmission data captured from the sensors to the host node node. Communication performance testing occured on node to node (N2N) wireless communications. Data measurement variable are the wind speed, temperature and humidity. The distance between the sensor node and the server node at 100 meters. From this research, that the data generated are measured in one day from the sensor node was successfully changed in the form of 3 packages stored in the memory card is then sent to the host node. Results capture of sensor nodes during the day, which is placed in the environment of the University Siliwangi Tasikmalaya in West Java of Indonesia, to show that the highest wind speed is 5 (m/s) is at noon is 13:00 to 15:00, while the lowest rate is in the morning is 4:00 until 6:00.**

Keywords— batch processing; wireless communication; wind speed; Xbee-PRO; sensor node; host node

I. INTRODUCTION

Wireless communication studies currently being crowded discussed by researchers, many methods are applied to get a better system. In mapping need of the potential environment, where data obtained from sensors placed on rural areas, the wireless communication becomes an important part, some wireless communication topology is introduced to improve the function with the efficient energy used.

Zigbee is a module that is often used in wireless communications, today the development of ZigBee technology has the ability to communicate with up to 2km, of course it is an advantage to be implemented on wind energy potential mapping by remote measurement. The problems that arise in the remote measurement using zigbee is the stability of data communication from the host sensor node. The other hand, the weakness of the XBee-PRO is only available flash memory with 32 KB/2 KB RAM [1], certainly it is not enough to store the data capture of sensor nodes on the long term period.

There are some categories of data acquisition method, including continuous method, batch method, semi-batch method [2] and sequential method [3]. Continues method process commonly used in systems analysis which involves the integration of the two concepts, namely Statistical Process Control (SPC) [4] and engineering process control (EPC) [4]. Wireless communication system with multi-sensor communication system known as Wireless Sensor Network (WSN) [5]. WSN introduced to improve communication between sensor.

Equation batch processing, according to [2] as in (1):

$$\hat{X}_n = \sum_{k=1}^{n} \alpha_k . \tilde{X}_k \qquad (1)$$

Where $\hat{X}_n$ is amount of data measurement from batching process, and $\tilde{X}_k$ is a data measurement and α_k is a constant, and ***n*** is limitation of data capture or process. Equation (1) is interpret that only occur if the process reaches the value of "n" data. ZigBee protocol including the IEEE 802.15 family of standards along with Bluetooth (802.15.1) and WPAN (802.15.3) with the IEEE 802.15.4 standard code [6].

ZigBee network topology also has a "mesh" network so as to form a wider and more reliable data [7]. The advantages of ZigBee is operating at low power [8]. ZigBee standards applied to many embedded systems (embedded applications) such as industrial use [9], home automation systems [10]. Compared Bluetooth ZigBee has a lower transmission speed, which is 250 Kbps with the communication distance up to 200 meters, whereas bluetooth only reach 10 meters.

Table I shows that the XBee-PRO has a small ram (only 32 KB Flash/2KB). This small ram not enough for data storage for long time, and it is becoming a major problem when the device is to be in charge of storing data in long term.

TABLE I. SPESIFICATION OF XBEE TYPE [1]

Platform	XBee ZB	Xbee-PRO ZB	Programmable Xbee-PRO ZB
RF Data Rate	250 Kbps	250 Kbps	250 Kbps
Indoor/Urban Range	133 ft (40m)	1 ft (90m)	300 ft (90m)
Outdoor/RF- line-of-sight range	400 ft (120m)	2 miles (3200 m) / Int'l 5000 ft (1500 m)	2 miles (3200 m) / Int'l 5000 ft (1500 m)
Transmit Power	1.25 mW (+1 dBm) / 2 mW (+3 dBm) boost mode	63 mW (+18 dBm) / / Int'l 10 mW (+10 dBm)	63 mW (+18 dBm) / Int'l 10 mW (+10 dBm)
Receiver Sensitivity (1% PER)	-96 dBm in boost mode	-102 dBm	-102 dBm
Memory	N/A	32 KB Flash / 2 KB RAM	32 KB Flash / 2 KB RAM
Supply Voltage	2.1-3.6 VDC	2.7-3.6 VDC	2.7-3.6 VDC
Transmit Current	35 mA / 45 mA boost mode @ 3.3VDC	205 mA	220 mA
Receive Current	38 mA / 40 mA boost mode @ 3.3VDC	47 mA	47 mA
Power-Down Current	<1 uA @ 25o C	3.5 uA @ 25o C	4 uA @ 25o C

II. METHODOLOGY

System testing conducted at the University Siliwangi in west java Indonesia at coordinates 7 ° 21'1 "S 108 ° 13'22" E as in Fig.1. Data sampling taken in April 2016, where conditions around sunny and less windy. The data capture was wind speed, temperature and humidity.

Fig. 1. Location map of the area system testing

Measurement data transfer and signal strength test, between the sensor nodes and host nodes using X-CTU applications.

```
Time&Date,Humidity,Temperature
15/6/28 5:1:0,91.30,22.80
15/6/28 5:2:0,91.70,22.90
15/6/28 5:3:0,89.30,22.90
15/6/28 5:4:0,90.00,22.90
15/6/28 5:5:0,89.20,22.80
```

Fig. 2. Data packet sampling

The data capture from the sensor-node is limited to 185 bytes of data sampling consists of 5 temperature and humidity 5 data sampling, while sampling a complement data packets that shows the sampling time. The range of characters at each sampling is 26 characters as Fig. 3, following (1). Fig. 2 is schematic wireless communication sensor node to host node. Host node consists of a computer equipped with X-CTU program. Data from read temperature and humidity through the stages of batch processing as (1).

The material of this study consisted of two main parts as Fig. 2, namely the sensor node and the host node. The sensor node includes anemometer, Zigbee-Pro, Atmega microprocessor, memory card for data capture storage, anemometer as the wind speed sensor, temperature and humidity sensors SHT-10, and independence power system. while Server node consists of Zigbee pro, microprocessor ATmega.

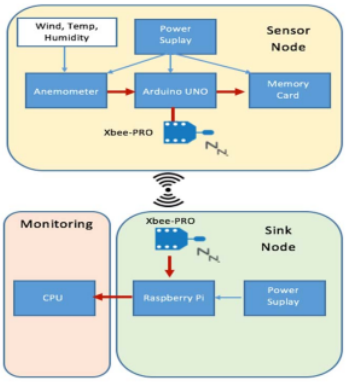


Fig. 3. Schematic wireless communication sensor node and host node

The process of data storage on a storage device (SD memory) through the command syntax is based on (1) as follows:

```
{if ((now.minute() % 1 == 0 && now.second() == 0)
|| (now.minute() % 1 == 0 && now.second() == 1))}
```

Fig. 4. Syntax for sampling data stored in storage memory card

Fig.4 is Syntax for states that the sampling data stored in the SD card memory per each minute, while measuring data transmission command syntax as Fig. 5

```
{if ((now.minute() % 5 == 0 && now.second() == 0) ||
(now.minute() % 5 == 0 && now.second() == 1))}.
```

Fig. 5. transmission command

Fig 5. Is command for states to measuring data sampling activities will be limited to once every 5 minutes, and then sent to the host node.

III. RESULT

The result from this research by communication test of sensor node to host node at varying distances held at 1 meter to 110 meters. Application X-CTU define some variable value of the successful of the data sent, the number of data are sent, and the number of errors that occur during transmission at several different distances.

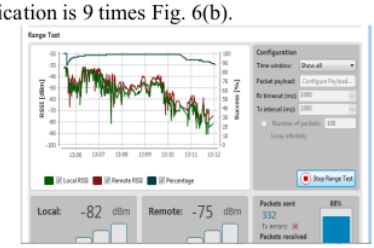
Fig 6(a) shows the analysis results of the sensor node communication to the host node at a distance of 18.5 meters with 37 packet data sent from sensor node, detected that signal strength is -31dBm and percentage of packet delivery failure is 0%. It is mean that the package of sensor nodes 100% accepted by the host node Fig. 6(a).

(a)

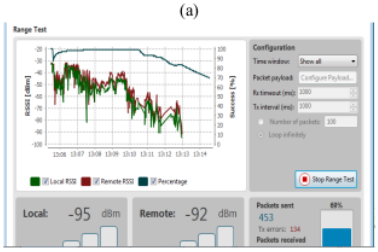
(b)

Fig. 6. Results of data transfers at a distance of 18.5 meters (a) and 58,18 meters (b).

Fig 6(b) shows the analysis results of the sensor node communication to the host node at a distance of 58.18 meters to 258 data packets. at this distance, there was 95% packet of data sent by a powerful signal smaller, which is -65 dBm to -66 dBm at the local and remote. Errors condition that occur during data communication is 9 times Fig. 6(b).



(a)



(b)

Fig. 7. Results of data transfers at a distance of 88,83 meters (a), 107.52 meters (b)

Fig 7(a) shows the analysis results of the sensor node communication to the host node at a distance of 88.83 meters to 332 data packets. at this distance, there was 88% packet of data sent by a powerful signal smaller, which is -82 dBm to -75 dBm at the local and remote. Errors that occur during data communication is 36 times Fig. 7(a). Fig 7(b) shows the analysis results of the sensor node communication to the host node at a distance of 107.52 meters to 453 data packets. at this distance, there was 69% packet of data sent by a powerful signal smaller, which is -95 dBm to -92 dBm at the local and remote. Errors that occur during data communication is 134 times Fig. 7(b).

Fig. 8 shows the signal strength test results. The decrease in signal strength affect the communication distance. The farther the distance between sensor nodes to a host node, the higher the error that occurred and the presentation of data sent becomes lower. It is known that the optimal range is from 0 to 18.5 meters, for the presentation of data sent is 100%

Fig. 8. Results of signal strangth test beetwen sensor node to host node

TABLE II. RESULTS OF THE SENSOR NODE CAPTURE AND SHARING OF DATA PACKETS FROM THE CAPTURE SENSOR

Package Data	time	Temp (C°)	Rh(%)	V(m/s)	File size
1	4:02:00	22.5	84.5	0	1kb
	5:00:00	22.8	91.8	0	
	6:07:00	22.1	90.1	0	
	7:01:00	24.1	81.8	1	
	8:03:00	25.2	74.1	1	
	9:12:00	27.2	65.3	1	
	10:10:00	29.3	56.2	2	
2	11:01:00	33.9	41.1	4	1kb
	12:00:00	35.3	33.7	3	
	13:05:00	34.8	38.9	5	
	14:05:00	33.7	42.3	5	
	15:07:00	33.6	53.2	5	
	16:00:00	28.5	56.3	4	
	17:05:00	27.4	57.1	4	
	18:10:00	25.1	63.6	2	
3	19:15:00	24.3	77.6	1	1kb
	20:02:00	23.4	81.7	1	
	21:05:00	22.4	84.9	1	
	22:15:00	21.7	89.4	1	
	23:20:00	21	99.6	2	
	0:25:00	21.5	98.7	2	
	1:00:00	21.4	99.9	2	
	2:05:00	22.5	97.9	1	
	3:04:00	22.6	95.6	1	

Fig. 8 shows that from some of the signal strength between sensor node to host node explain that the error rate and the amount of data send from the wireless communication between the sensor nodes to the host node is proportional to the distance. the greater the distance between sensor nodes to a host node will require more power, while the data packets to be increased due to address the failure of data delivery started. These conditions force sensor nodes to work harder and require more energy.

Table II shows the result of the sensors capture, where the distance between the host node and sensor node is 100 meters. Data capture is then converted into three packages, each of which includes time, temperature, humidity and wind speed.

The packet data is sent to the host node with the size of each data package up to 1 kb.

According to Fig 7, shows the graph of the wind speed on host node that capture from 4:00 in the morning until 3:00 in the morning. It was concluded that, the highest speed at a speed of 5 (m/s) is 13:00 to 15:00, while the lowest speed at 4:00 until 6:00.

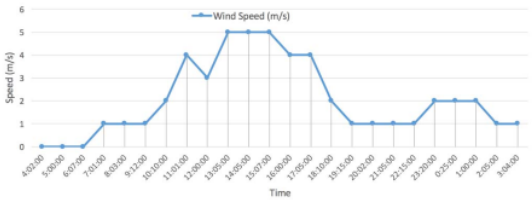


Fig. 9. Graph of wind speed along one day capture the results of wind speed sensor

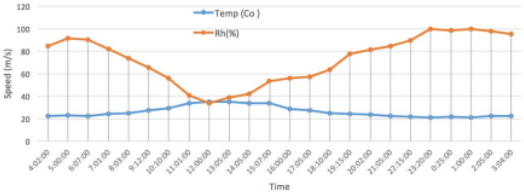


Fig. 10. Graph of humidity and air temperature sensor nodes result of capture

IV. CONCLUSION

Batch processing method that applied on wireless communications by changing the data capture into data packets, require the memory card as data storage. In this condition, online the communication between sensor node to host node does not necessary. Batch processing method also granted the accurate data from the environment effect. Data storage facility in sensor node can be used as a backup in case of system down. S2B XBee-PRO modules can be used to save data capture from the sensor at size 1 kb for each packet data.

Results capture of sensor nodes for a full day from 4:00 to 3:00 is placed Tasikmlaya area, West Java, Indonesia at coordinates 7 ° 21'1 "S 108 ° 13'22" E, to show that the highest wind speeds is 5 (m/s) is at noon at 13:00 until 15:00, while the lowest rate is in the morning at 4:00 until 6:00.

Communications test by X-CTU application, with the condition without any obstacles between sensor nodes to a host node, found that at a distance of 18 meters, wireless data communications obtained by the successful data delivery of 100%. While at a distance of 58.18 meters to send data success rate decreased to 95% and at a distance of 107m success rate of sending data down to only 69%. This study illustrates that, batch processing method only guarantee the data security sent, but does not affect the quality of wireless communication. Even though, by the data storage system stored in sensor node, it can be useful for the purposes of data updating on the server at a future

ACKNOWLEDGMENT `

This project is a research 2nd year. This research was supported by grants from the reseach grant programme of MENRISTEKDIKTI on skim *Penelitian Produk Terapan* (PPT) since 2014. We are also grateful to Engineering Department of the Siliwangi University in Tasikmalaya for its support of this research.

REFERENCES

[1] T. Obaid, H. Rashed, A. Abou-Elnour, M. Rehan, M. M. Saleh, and M. Tarique. (July 2014) "Zigbee Technology and Its Application In Wireless Home Automation Systems: A Survey". *International Journal of Computer Networks & Communications (IJCNC)*. Vol.6, No.4. Available: http://airccse.org/journal/cnc/6414cnc11.pdf

[2] C. L. Smith. *Control of Batch Processes*. John Wiley & Sons, Inc., Hoboken, New Jersey, 2014, ch 3, pp. 71-72

[3] A. Soloviev, "Utilizing Batch Processing for GNSS Signal Tracking", "*Ohio University*", Feb. 27, 2007, Publisher: Avionics Engineering Center, Published in: Calgary, Canada.

[4] W. Hachicha, I. Moussa. "Integration of Statistical and Engineering Process Control in a Batch Processes Monitoring: Case of Alkyd Polymerization Reactor". *International Journal of Control and Automation*, Vol. 5, No. 1. 2012.

[5] J. Trevathan, A. Ghodosi, T. Myers. Efficient Batch Authentication for Hierarchical Wireless Sensor Networks. *Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), Seventh International Conference on. IEEE*. November 2011. Available: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6146630&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6146630.

[6] S. A. Desai, P. H. Zope, S. R. Suralka. A Review on IEEE 802.15.4-Standard for Wireless Body Network (May 2013). International Journal of Innovative Research in Science, Engineering and Technology. Available: http://www.ijirset.com/upload/may/ 26_A%20Review.pdf

[7] P. Kinney, "Zigbee Technology: Wireless Control that Simply Works". *Communications Design Conference*. 2003, Available: http://www.itk.ntnu.no/fag/TTK4545/TTK2/PDF/ZigBee%20Technology%20-%20Wireless%20control%20that%20simply%20works.pdf

[8] J. Wang, M. Chen, V. C.M. Leung. "Forming Priority Based and Energy Balanced ZigBee Networks-A Pricing Approach". *Springer Science+Business Media*. September 2011

[9] N. A. Somani, Y. Patel. "Zigbee: A Low Power Wireless Technology for Industrial Applications" May 2012. International Journal of Control Theory and Computer Modelling (IJCTCM) Vol.2, No.3, May 2012. Available: http://airccse.org/journal/ijctcm/papers/2312ijctcm03.pdf

[10] S. S. R. Ahamed. The Role of Zigbee Technology in Future Data Communication System. *Journal of Theoretical and Applied Information Technology. Sathak Institute of Technology. 2009*. [Online]. Pp. 134 Available: http://www.jatit.org/volumes/research-papers/Vol5No2/5Vol5No2.pdf?pagewant

Wireless Communication with Batching Method Based on Xbee-PRO S2B Module for Sensing of Wind Speed

ORIGINALITY REPORT

22%	19%	13%	18%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.mouser.com Internet Source	4%
2	Submitted to Assumption University Student Paper	1%
3	networked-embedded.de Internet Source	1%
4	Submitted to Wawasan Open University Student Paper	1%
5	mafiadoc.com Internet Source	1%
6	www.semanticscholar.org Internet Source	1%
7	Submitted to Queen Mary and Westfield College Student Paper	1%
8	Submitted to University of Huddersfield Student Paper	1%
	iugspace.iugaza.edu.ps	

9	Internet Source	1 %
10	Mohd Muntjir, Ahmad Tasnim. "An Enhanced Framework with Advanced Study to Incorporate the Searching of E-Commerce Products Using Modernization of Database Queries", International Journal of Advanced Computer Science and Applications, 2016 Publication	1 %
11	repository.unika.ac.id Internet Source	1 %
12	www.compel.ru Internet Source	1 %
13	www.freepatentsonline.com Internet Source	1 %
14	archive.sciendo.com Internet Source	1 %
15	www.ctgroup.co.in Internet Source	1 %
16	Submitted to University of Sunderland Student Paper	1 %
17	Submitted to Queen's University of Belfast Student Paper	1 %
18	www.anewtech.net Internet Source	<1 %

19	Submitted to University of Southampton Student Paper	<1 %
20	text-id.123dok.com Internet Source	<1 %
21	m.earticle.net Internet Source	<1 %
22	www.digi.com Internet Source	<1 %
23	Submitted to De Montfort University Student Paper	<1 %
24	Sutisna, I Usrah, N Hiron, A Andang. "Power analyzer based arduino-uno validation using Kyoritsu KEW 6315 and Hioki 328-20", IOP Conference Series: Materials Science and Engineering, 2019 Publication	<1 %
25	Yamabe, Yuichiro, Hiroto Sasaki, Tatsuya Inatome, and Akinori Tani. "Fundamental Test of Seismic Information and Building Damage Data Gathering System using OSHW with Wireless Sensor Network", Computing in Civil and Building Engineering (2014), 2014. Publication	<1 %
26	waset.org Internet Source	<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		