Design of the Node Coordinator Based on WSN Network as Fisherman Vessel Monitoring System

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Abstract- Fishermen in Indonesia in general are traditional fishermen who use boats weighing less than 30 GT and are not equipped with adequate navigation equipment. This becomes a technical obstacle when important information could not be directly obtained from the fishermen. An alternative that can be used to identify the position of traditional fishing boats is a vessel monitoring system (VMS). A component in a fishing boat monitoring system is a node coordinator using Wireless Sensor Network (WSN) technology. By installing the node coordinator, the position information of the fishing boat sent by the boat node in the GPS data can be accessed within the scope of the coordinator. The coordinator node has two LoRa devices as the receiver and sender of data and an Arduino as a data processor. Data received from the boat node will be processed and added to the location of the coordinator crossed by the boat in the boat data format and then sent to the central in real time. The coordinator node has a coverage area of 0.45 miles in radius (coordinator A) and 0.35 miles (coordinator B) with 96% accuracy rate of data reception and 100% data processing.

Keywords: WSN, VMS, real time, node coordinator

1. Introduction

Traditional fishermen using fishing vessels weighing less than 30 GT with the sea reaching less than 4 miles from the coastline are estimated to be 80% of the population [1]. There are still many fishing boats that have not been equipped with navigation tools so that when the fishermen are fishing, their position could not be monitored in real time. Indonesian government regulated vessel monitoring system in Permen Nomer 42/PERMEN-KP/2015 tentang Sistem Pemantau Kapal Perikanan, SistemPemantauKapalPerikanan (Fishery Vessel Monitoring System). The Fishery Vessel Monitoring System is not set up for fishing vessels weighing under 30 GT [2].

However to provide information about the existence of traditional fishing boats is necessary because in general there are many boats that are not equipped with navigation equipment. Investment in improving the Indonesian Vessel Monitoring System (VMS) towards real time monitoring and improved system interface has very large net benefits and is a very viable investment for the Indonesian government [3]. The application of navigation systems and communication
activitiesfishery at Bitung Fishery Port is still lackingoptimal where the system runs partially which cause overlapping information [4].

Vessel Monitoring System has been used as a fishing vessel monitor in various countries. The research related to the fishing boat monitoring system is conducted by Duc-Tuyen (2013) that examines the improvement of ad hoc wireless networks based on GPS capable of providing emergency location and services for small fishing boats by fixing the weakness of radio links from sea to land from ship to center station on land [5]. The research review of Manoufal i (2013) examines wireless communications technologies to build a reliable maritime mesh network, challenges and requirements to ensure high quality maritime mesh communications [6]. There are also other system based on GPS as intelligent system for tracking and border alert for fishermen [7,8,9,10] and secured maritime alert system based on RSSI localization scheme [11].

Limitations for traditional fishermen to provide monitoring tools are a matter to be solved. An alternative fishing boat monitoring system should have at least a function that can monitor the movement of fishing boats. The system used is based on WSN (wireless system network). Node coordinator is a tool of a fishing boat monitoring system that can receive position information of a fishing boat in the form of GPS data within the scope of the coordinator and forward it to the central node for data processing.

2. Method

This research was conducted in three stages which are system design, model making and testing. The global design of fishing boat monitoring system is shown in Figure 1. There are four parts: sensor nodes (fishing boats), coordinator nodes, central and monitoring servers.

![Figure 1. Monitoring global system of fishermen boat](image)

The nodes coordinator as part of the research are designed and created using Wireless Sensor Network (WSN) technology to communicate between the sensor nodes with the node sink as the data collection center of the sensor node [12]. Sink node as well as base station is the interface between user and network. Node sensors that have movement can be connected to GPS devices and location information so that location information can be monitored by the base station [13]. The WSN method is chosen because it is possible to get boats movement data that are difficult to obtain by conventional method. The sensor nodes usually consist of four main components: the sensor itself, the processor, the radio, and the energy supply [14]. The coordinator node is designed using the LoRA shield component as a transceiver and Arduino as a data processor equipped with an energy source for the device.

The node coordinator that acts as a transceiver uses two Arduino mounted in series form using I2C multipoint serial communication and two LoRa shields are used as a receiver and a transmitter. Figure 2 shows the block diagram of the coordinator node design.
The data input and the data form output of the nodes coordinator are shown in Figures 3 and 4.
3. Result and Discussion

Testing the system is aims to know that the device node coordinator has been running in accordance with the provisions and to know the device running according to the program created.

3.1 Data Receiving Test

The data receiving test is aims to know the data sent by multipoint-to-point node boats can be received by the coordinator node. The description of the data reception test can be seen in Figure 7.

The test results of the data receiving in the coordinator as shown in Table 1 and Table 2.
Table 1. Data Receiving in The Coordinator A

| No | KODE KAPAL | LINTANG | BULUR | TANGGAL    | WAKTU    |
|----|------------|---------|-------|------------|----------|
| 1  | KN004      | -6.812568 | 110.526237 | 2017-08-21 | 15:30:26 |
| 2  | KN001      | -6.812970 | 110.527006 | 2017-08-21 | 15:39:34 |
| 3  | KN001      | -6.812383 | 110.525605 | 2017-08-21 | 15:39:56 |
| 4  | KN001      | -6.812722 | 110.527046 | 2017-08-21 | 15:40:04 |
| 5  | KN001      | -6.812027 | 110.527465 | 2017-08-21 | 15:40:34 |
| 6  | KN001      | -6.809547 | 110.525856 | 2017-08-21 | 15:49:30 |
| 7  | KN001      | -6.809526 | 110.528640 | 2017-08-21 | 15:50:06 |
| 8  | KN001      | -6.811773 | 110.523635 | 2017-08-21 | 15:50:29 |
| 9  | KN001      | -6.809512 | 110.525879 | 2017-08-21 | 15:50:37 |
| 10 | KN004      | -6.811773 | 110.526115 | 00:00:00 | 00:00:00 |
| 11 | KN002      | -6.809508 | 110.528818 | 2017-08-21 | 15:51:07 |
| 12 | KN002      | -6.809514 | 110.525450 | 2017-08-21 | 15:51:37 |
| 13 | KN002      | -6.809516 | 110.528996 | 2017-08-21 | 15:52:07 |
| 14 | KN002      | -6.809522 | 110.528299 | 2017-08-21 | 15:52:07 |
| 15 | KN002      | -6.809545 | 110.525236 | 2017-08-21 | 15:52:35 |
| 16 | KN002      | -6.809569 | 110.528190 | 2017-08-21 | 15:54:08 |
| 17 | KN002      | -6.809584 | 110.528144 | 2017-08-21 | 15:54:38 |
| 18 | KN002      | -6.809587 | 110.528030 | 2017-08-21 | 15:55:38 |
| 19 | KN001      | -6.809767 | 110.529121 | 2017-08-21 | 15:55:58 |
| 20 | KN002      | -6.809587 | 110.527969 | 2017-08-21 | 15:56:08 |

Table 2. Data Receiving in The Coordinator B

| No | KODE KAPAL | LINTANG | BULUR | TANGGAL    | WAKTU    |
|----|------------|---------|-------|------------|----------|
| 1  | KN004      | -6.812088 | 110.524795 | 2017-08-21 | 15:40:27 |
| 2  | KN004      | -6.811777 | 110.528628 | 2017-08-21 | 15:40:20 |
| 3  | KN004      | -6.811773 | 110.523635 | 2017-08-21 | 15:49:59 |
| 4  | KN003      | -6.811682 | 110.526605 | 2017-08-21 | 15:50:56 |
| 5  | KN004      | -6.811773 | 110.523635 | 2017-08-21 | 15:51:26 |
| 6  | KN004      | -6.811773 | 110.523635 | 2017-08-21 | 15:51:30 |
| 7  | KN004      | -6.811773 | 110.523635 | 2017-08-21 | 15:52:00 |
| 8  | KN003      | -6.811695 | 110.523567 | 2017-08-21 | 15:52:03 |
| 9  | KN004      | -6.811773 | 110.523635 | 2017-08-21 | 15:52:30 |
| 10 | KN004      | -6.809514 | 110.528343 | 2017-08-21 | 15:52:37 |
| 11 | KN004      | -6.811777 | 110.523635 | 2017-08-21 | 15:53:00 |
| 12 | KN003      | -6.811695 | 110.523567 | 2017-08-21 | 15:53:11 |
| 13 | KN004      | -6.811778 | 110.528635 | 2017-08-21 | 15:53:30 |
| 14 | KN004      | -6.811780 | 110.526228 | 2017-08-21 | 15:54:00 |
| 15 | KN003      | -6.811698 | 110.523567 | 2017-08-21 | 15:54:12 |
| 16 | KN004      | -6.811782 | 110.523628 | 2017-08-21 | 15:54:30 |
| 17 | KN004      | -6.811785 | 110.523628 | 2017-08-21 | 15:55:31 |
| 18 | KN004      | -6.811785 | 110.523628 | 2017-08-21 | 15:56:01 |
| 19 | KN003      | -6.811717 | 110.523574 | 2017-08-21 | 15:56:13 |
| 20 | KN004      | -6.811787 | 110.523628 | 2017-08-21 | 15:56:31 |

Note: The sample data is taken the first 20 data from 126 data received. The red data is defect data.

3.2 Data Processing Test

Data processing test is aimed to know the position information data sent node boat can be done addition of data format coordinate code or not to be forwarded through I2C serial communications to be sent to the central node. The result is shown in Table 3 and Table 4.
Table 3. Data Processing in The Coordinator A

| No | KODE KAPAL | LINTANG  | BUJUR   | TANGGAL | WAKTU   | KODE KOORDINATOR |
|----|------------|----------|---------|---------|---------|------------------|
| 1  | KN004      | -6.812568| 110.526237| 2017-08-21 | 15:39:26 | A                |
| 2  | KN001      | -6.812970| 110.527008| 2017-08-21 | 15:39:34 | A                |
| 3  | KN004      | -6.812383| 110.525505| 2017-08-21 | 15:39:56 | A                |
| 4  | KN001      | -6.812722| 110.527046| 2017-08-21 | 15:40:04 | A                |
| 5  | KN001      | -6.812927| 110.527465| 2017-08-21 | 15:40:34 | A                |
| 6  | KN002      | -6.809547| 110.528686| 2017-08-21 | 15:49:36 | A                |
| 7  | KN002      | -6.809526| 110.528840| 2017-08-21 | 15:50:06 | A                |
| 8  | KN004      | -6.811773| 110.528585| 2017-08-21 | 15:50:29 | A                |
| 9  | KN004      | -6.809512| 110.528579| 2017-08-21 | 15:50:37 | A                |
| 10 | KN004      | -6.811773| 110.511115| 0000-00-00 | 00:00:00 | A                |
| 11 | KN002      | -6.809506| 110.528518| 2017-08-21 | 15:51:07 | A                |
| 12 | KN002      | -6.809514| 110.528450| 2017-08-21 | 15:51:17 | A                |
| 13 | KN002      | -6.809516| 110.528396| 2017-08-21 | 15:52:07 | A                |
| 14 | KN002      | -6.809522| 110.528289| 2017-08-21 | 15:53:07 | A                |
| 15 | KN002      | -6.809545| 110.528236| 2017-08-21 | 15:53:38 | A                |
| 16 | KN002      | -6.809569| 110.528190| 2017-08-21 | 15:54:08 | A                |
| 17 | KN002      | -6.809584| 110.528144| 2017-08-21 | 15:54:38 | A                |
| 18 | KN002      | -6.809587| 110.528030| 2017-08-21 | 15:55:38 | A                |
| 19 | KN001      | -6.809767| 110.529121| 2017-08-21 | 15:56:58 | A                |
| 20 | KN002      | -6.809587| 110.527969| 2017-08-21 | 15:56:08 | A                |

Table 4. Data Processing in The Coordinator B

| No | KODE KAPAL | LINTANG  | BUJUR   | TANGGAL | WAKTU   | KODE KOORDINATOR |
|----|------------|----------|---------|---------|---------|------------------|
| 1  | KN004      | -6.812088| 110.524795| 2017-08-21 | 15:40:27 | B                |
| 2  | KN004      | -6.811777| 110.523628| 2017-08-21 | 15:49:29 | B                |
| 3  | KN004      | -6.811773| 110.523635| 2017-08-21 | 15:49:59 | B                |
| 4  | KN003      | -6.811668| 110.523605| 2017-08-21 | 15:50:56 | B                |
| 5  | KN003      | -6.811693| 110.522605| 2017-08-21 | 15:51:26 | B                |
| 6  | KN004      | -6.811773| 110.523635| 2017-08-21 | 15:51:30 | B                |
| 7  | KN004      | -6.811773| 110.523635| 2017-08-21 | 15:52:00 | B                |
| 8  | KN003      | -6.811695| 110.523567| 2017-08-21 | 15:52:03 | B                |
| 9  | KN004      | -6.811773| 110.523635| 2017-08-21 | 15:52:30 | B                |
| 10 | KN002      | -6.809514| 110.528343| 2017-08-21 | 15:52:57 | B                |
| 11 | KN004      | -6.811777| 110.523635| 2017-08-21 | 15:53:00 | B                |
| 12 | KN003      | -6.811695| 110.523567| 2017-08-21 | 15:53:11 | B                |
| 13 | KN004      | -6.811778| 110.523635| 2017-08-21 | 15:53:30 | B                |
| 14 | KN004      | -6.811780| 110.523628| 2017-08-21 | 15:54:00 | B                |
| 15 | KN003      | -6.811698| 110.523567| 2017-08-21 | 15:54:12 | B                |
| 16 | KN004      | -6.811782| 110.523628| 2017-08-21 | 15:54:30 | B                |
| 17 | KN004      | -6.811785| 110.523628| 2017-08-21 | 15:55:31 | B                |
| 18 | KN004      | -6.811785| 110.523628| 2017-08-21 | 15:56:01 | B                |
| 19 | KN005      | -6.811717| 110.523574| 2017-08-21 | 15:56:15 | B                |
| 20 | KN004      | -6.811787| 110.523628| 2017-08-21 | 15:56:31 | B                |

3.3 Area Coverage Test

Area coverage test is aims to find out how far the coverage area node coordinator. The results of coverage area testing and node coordinator placement at sea can be seen in Figure 8. The tests result are shown in Figure 9.
Figure 8. Equipments positioning in area coverage test

Figure 9. Area coverage of Coordinator A
The data receiving test result shows that at the coordinator A of 20 data sample test, there is 1 data defect when the process of receiving data from the node of the fourth boat, whereas at coordinator B of 20 test sample data, data can be accepted with no defective data. The data processing test result shows that from 20 sample data from the test results of each coordinator obtained that the process of adding coordinator code to the input data can run well. The defect data received also gets the addition of the coordinator code (automatically in the same format and system). The area coverage test results obtained that each coordinator has a range of different areas of distance range of coordinator A is 0.45 miles (732.12 m) and the farthest range of coordinator B is at a radius of 0.35 miles (566.11 m) in radius.

4. Conclusion

The coordinator node successfully receives the boat or ship position information within the scope of the coordinator with a success rate of 96%. The node coordinator successfully added coordinator code on boat position information with 100% success rate. Adding node coordinator is useful to mark a part of territorial waters. Maximum distance of area coverage of coordinator A is 0.45 miles and coordinator B is 0.35 miles in radius.

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