International Journal of Multimedia and Ubiquitous Engineering
Vol.11, No.10 (2016), pp.111-118
http://dx.doi.org/10.14257/ijmue.2016.11.10.10

The Development of Web-Based Framework of Vessel Information System using AIS Data

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Abstract

In this paper we describe the development of a web-based framework of vessel information system using AIS data to monitor the movement of ship or vessel. The system consist of data acquisition module, data storage module, data management module, visualization and monitoring module. The data acquisition module functions to receive AIS data from all vessels within certain radius and stored in the database by storage module and data management module. Then, the visualization module will display interactively the movement of the vessels. The results show that marine traffic can be visualized by the system and information can be provided in a real time manner through web technology.

Keywords*: Vessel Monitoring, Automatic Identification System (AIS), Web-Based Applications*

1. Introduction

The potential resources are present in the oceans, ranging from fish resources and marine plants to oil and gas contained in the bottom layer of the sea. To be able to utilize these resources, vessel as a means of transportation is required. Based on international regulation, vessel with the size and weight above a certain value are required to install a device called AIS to know the identity and position of the vessel.

AIS data consist of 3 groups of data, which is data non-geostationary, data geostationary, and navigation data. With these data, port authorities can make an application to perform vessel scheduling, vessel loading and unloading. Additional information such as goods that being transported can provided to all stakeholders, especially for sender and receiver.

The purpose of this research is to create a web-based framework of vessel information system using AIS data to monitor the movement of vessel.

2. Related Works

Ristic, *et al.* [1], built a model based on AIS historical data. Their model was used to detect the anomalies of vessel movement in port or open sea in real time manner. Vessel movement was monitored from AIS real time data. Pallota, *et al.* [2] built a system that has been called Traffic Route Extraction and Anomaly Detection (TREAD). TREAD was used to detect the anomalies such as sudden turn of vessel movement, and to predict the route of vessel. The anomaly here can be interpreted as an attempt to avoid an obstacle (sea objects or other vessels) or an attempt to delay transit to destination.

ISSN: 1975-0080 IJMUE

AIS transmitter – receiver can only communicate through VHF signal and have distance limitations (up to 25 miles). Yang, *et al.* [3] built a system that combine AIS data and satellite imagery. With satellite imagery data, their system can tracked vessel in area A3. A3 is the sea region which has distance more than 150 miles from the sea shore. Cervera, *et al.* [4] established a Low Earth Orbit (LEO) satellite based AIS to overcome the distance limitations of conventional AIS. Their research was focused on setting the message rate and message collision when the data was transmit through Low Earth Orbit (LEO) satellite.

Tetreault, *et al.* [5] proposed the Maritime Domain Awareness (MDA) concept. All information that that has been obtained can be used to build a maritime information system. The information that has been processed by system or to be called awareness can enhance all monitoring function in maritime domain, such as detecting, classifying, identifying and tracking function all vessel.

Lin, *et al.* [6] and Tang, *et al.* [7] proposed an interconnected AIS system to monitor all marine traffic and to process all marine data in distribution system.

3. Vessel Information System

Vessel Information System consists of several main components, which are data acquisition module, data storage module, data management module, visualization and monitoring module. Figure 1 show the main components of system being developed. Several data acquisition modules can supply data to management module. All of the data can be stored in one or several storage modules to support scalability and redundancy. In order to view and monitor all of the data that has been collected and processed, we have been developed visualization module. Acquisition modules and visualization modules are connected to storage module through our Application Program Interface (API).

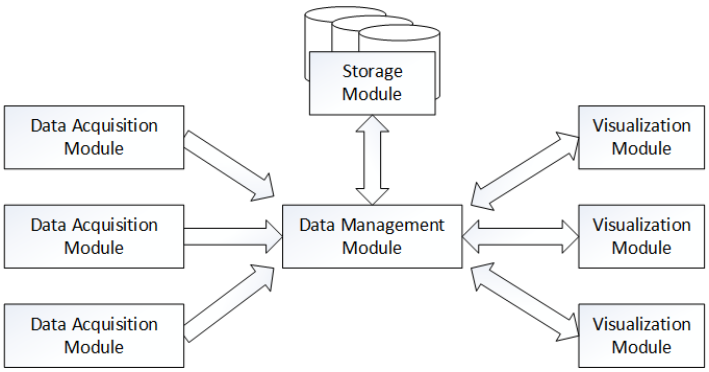

Figure 1. The Main Components of System Being Developed

The data that has been sent by acquisition module are vessel and port data. Vessel data contain static and dynamic data. Static vessel data describe all specification about the vessel and dynamic vessel data describe the information about position and navigation of the vessel. Port data contain information about port specification and port call. Port call is the port data that related to the vessel such as total vessel inside port, vessel departure time, vessel arrival time. Based from all those data, we design the relational database as shown in Figure 2.

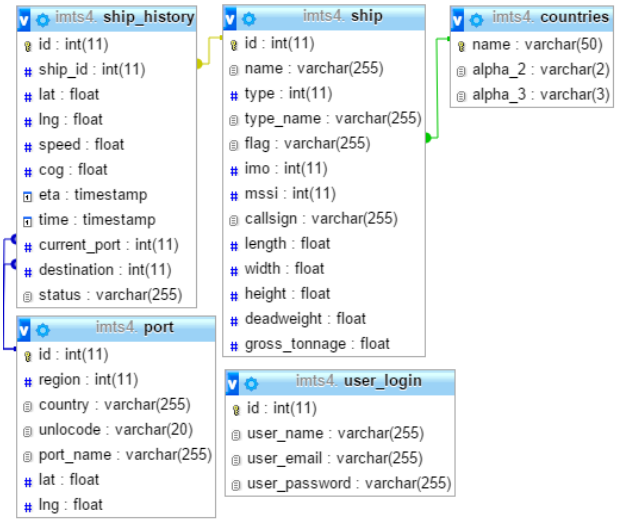

Figure 2. Table Relation Diagram

Several of vessel data need to be processed before inserted into our database, such as vessel direction, vessel movement state, and vessel position state in port. Some of those data, vessel direction and vessel movement state, have already been provided by AIS receiver. But there are several scenario where our AIS receiver didn't send those data, so we need to calculate direction and movement state manually. Vessel direction can be obtained from comparing the current vessel position and last vessel position. Vessel movement state can be obtained from analyzing all port data and position based from specific radius from vessel current position. Vessel movement state can be seen in Figure 3.

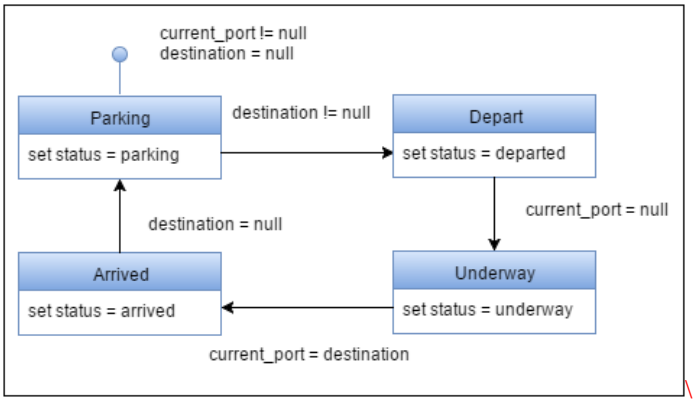

Figure 3. Vessel State Diagram

3.1. Data Acquisition Module

Data related to the vessel is emitted continuously by AIS transmitter and modulated using Time Division Multiplexing (TDM). AIS receiver capture those signal and convert it into data related those vessel. Data from those vessel can be used various stakeholders.

Data acquisition module is used to accommodate all sensor needed for the system. Currently the main sensor used in the system is Automatic Identification System (AIS). AIS receiver is able to capture radio signals containing important information. All the data that has been obtained by acquisition module will be sent to management module through our API

3.1. Data Storage and Management Module

This module is devote to store and process the data required by the system. All the input data is obtained from data acquisition module. This module acts as a bridge of several modules that are built so that it can work in synergy. This is done by our API, illustrated in Figure 4, so that the system can communicate with other programs using HTTP methods such as POST, GET, PUT, DELETE via URL with parameters which are specified. POST call to vessel and port API can be used to retrieve vessel data, port data and vessel history which can be seen in Table 1 and Table 2.

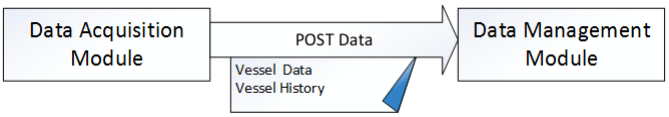

Figure 4. Acquisition – Management Web Service

```
POST http://server_address/api/ships
```

Table 1. POST Ship (Vessel) Specification Parameters

Parameter	Nilai	Description
data	1	ID for ship specification
name	string	Ship Name
imo	integer	IMO
mssi	integer	MSSI
callsign	string	Callsign
flag	string	Country Code
type	string	Ship Type
deadweight	float	Deadweight
gross_tonnage	float	Gross Tonnage

Table 2. POST Ship (Vessel) History Parameters

Parameter	Nilai	Description
history	1	ID for ship history
id	integer	ID (unique) for ship
lat	float	Ship Latitude
lng	float	Ship Longtitude
speed	float	Ship Velocity
current_port	integer	ID (unique) for current port
destination	integer	ID (unique) for port destination

API will deliver a successful response if the data sent in accordance with specified parameters, otherwise it will raise an error response.

3.3. Monitoring and Visualization Module

This module is built specifically to handle how to visualize the data that has been processed and the data obtained from data acquisition module. The main information displayed on this module is a geographic information system (GIS). Figure 5 show all layers that has been supported. Table 3 show all parameter that need to be specified in order to get vessel or port data.

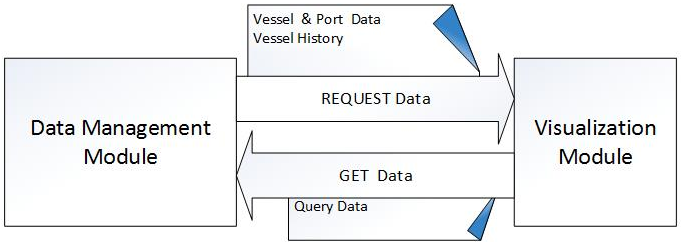

Figure 5. Management – Visualization Web service

```
GET http://server_address/api/ships
GET http://server_address/api/ports
```

Table 3. GET Vessel or Port Parameters

Parameter	Nilai	Description
Id	integer	Port / ship Unique ID
lat1	float	viewport position in map
lat2	float	
lng1	float	
lng2	float	
portcall (port only)	"ship_in", "arrivals", "departures", "expected_arrivals"	Ship – port status

Figure 6 show the services that supported by data management module to visualization module with their purpose.

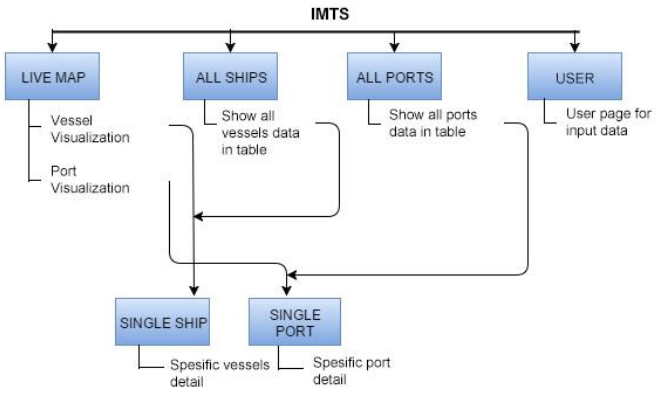

Figure 6. Visualization Page Diagram

3.4. Administration Web Services

This module provides an easy data access for administrator and developer. All the data with sufficient authentication can be modified into certain degree. All basic operation for each data has been supported. Our system has support Create Retrieve Update Delete (CRUD) model for each table. Figure 7 show relationship between administrator client and all of our modules. User with sufficient authentication can do CRUD operation in all of our data.

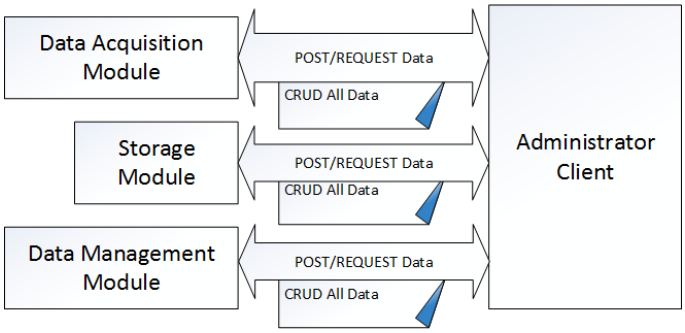

Figure 7. Administration Web Services

At user page, administrator may insert and edit a new vessel and port data. As a developer who wants to connect with our system through our API, authentication key is needed for every API call.

3.5. Web Client

Web-based vessel monitoring system has been developed for online purpose to support all stakeholders who required to monitor their vessels and ports. Figure 8 show user interface of the system to view sea region with their vessel and port. Our system already provided almost all ports around the world and more than 5000 data of vessel.

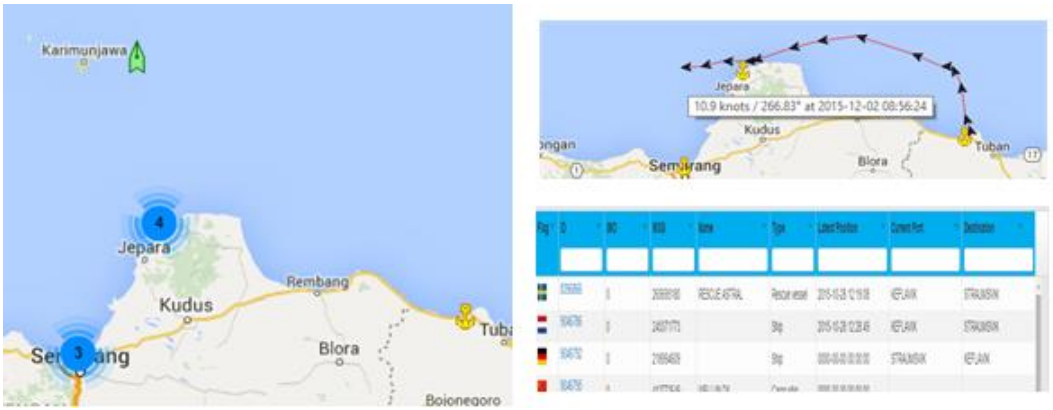

Figure 8. Map Visualization Page

Figure 8 shows vessel was visualized using an icon ship as a marker. Color marker vessel varies according the type of vessel. When there are several markers were too close together, there will be grouping on those markers into a cluster marker with the info number of markers present in that group. When user focus on one group, the map will automatically be enlarged to a level where the position marker in the group are separated.

At the right top of Figure 8 also shows the history of each vessel that visualized through stripe lines which is connected from one location to the other. At right bottom of Figure 8 show user interface (UI) for all vessel and port in table view. Those tables can be used for searching and filtering for each column that has already been provided.

4. Conclusion

We have presented the development of Web-based Framework of marine traffic Information System using AIS Data. The system consists of the data acquisition part and data processing part in the center part. Data from a single acquisition device utilizing AIS receiver can deliver vessels movement dynamically, and the data processing part in the

server can visualized the vessels movement in a real time manner. Adding another acquisition can be done and the proposed system can visualize wider area. This result confirms that adding acquisition device is trivial. Hence, development of Web-based Framework of marine traffic Information System using AIS Data is feasible.

Acknowledgments

We thank to Directorate General of Higher Education, DIKTI, Ministry of Research Technology and Higher Education for providing grant to this research.

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