



Neural Network for Wave Height Prediction (Study Case: Java Sea)

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Abstract: Global market in Indonesia to rely on marine transportation to distribute commodity import-export. One of the obstacles on the path to the sea is a wave heights, the wave can cause in accidents sea that the ship sank. To minimize accidents, this study will make a neural network algorithm to predict wave heights in the next hour. The advantages of this neural network that has a black box that can process data input and output. The prediction results show that the neural network has small's RMSE.

INTRODUCTION

Neural Network (NN) is one of an algorithm an Artificial Intelligence (AI) that imitates the concept of nerve network system on the human body. Neural network is structures in mathematics with an element the process or nodes that are easy (Sugianto, 2012), neural network is the method efficient to relations complex input-output (Jain and Deo, 2008). Another argument said that the network artificial neural involves the information distribution parallel and able to process nonlinear systems well (Paras *et al.*, 2015). The height of waves is a system that complex and nonlinear, so as to predict the height of waves match using artificial neural network. Research previous studies algorithm artificial neural network to predict rainfall (rf) and moisture (rh) using data temperature minimum-maximum, rainfall and moisture (Paras *et al.*, 2015), algorithm artificial neural network can predict is better than algorithm nlarx (Hermawan, 2006), a prediction wave height use the neural network and compare it with the regression methods (Gunaydin, 2008), a prediction the wave and wind speed with

3 varians input (Paplinska-Swerpel and Paszke, 2006) and by prediction wave height to the interval 12 and 24 h 5 and 10 days (Makarynskyy *et al.*, 2004).

Waves is one of the important to cruise .Waves can be profitable and disadvantages. A wave profitable can help ships to sail while a wave harm may be sink the ship, so, wave high is an important in sea transport. Wave height is high average of 1/3 the highest and used as a guide cruise. The term is starting from world war II (waltermunk) use the waves to declare high estimation waves (Aisjah, 2012). Meteorology, Climatology and Geophysics (BMKG) served as an observer weather predict in a conventional (statistics and dynamic). Previous studies predict the waves on the java sea using fuzzy logic and produce the accuracy of 74.82%, the accuracy of improved 1 next year to 81.84% (Aisjah, 2012).

With reference to research-previous studies, hence, this research will to optimize syaaf replicas network, so, it can predict the height of waves, so can produce that small error.

MATERIALS AND METHODS

Tinjauan Pustaka

Waves: Waves are closely to sea transport. The fluid dynamic is that has distinctive patterns that can be formulated mathematically considering rules and a law. Waves is a major factor in the best layout port. The cruise and building planning coast (Londhe *et al.*, 2016). One of the causes of the waves is wind.

Which the wind blows out of the water will move their energy on water (Londhe *et al.*, 2016). Which the wind blows to constantly would cause for ripple shown in Fig. 1 and will continue to evolve into new waves. The bigger wind speed the prevailing but the larger the waves formed (Makarynskyy *et al.*, 2004). A great speed (storm) occurring above sea level power to raise the water fluctuations great sea.



Fig. 1: Ripples (Londhe *et al.*, 2016)

Wave height: Wave height is the variable that influence the feasibility shipping and being affected by elevation a high wave. $H_{1/3}$ on Eq. 1 is plain flattened 33.3% waves the highest of recording waves. $H_{1/3}$ is high waves used as guidance shipping and called also waves significant h_s . Used waves highest because waves low not much affect shipping 2. The height of waves significant is the variable that influence the feasibility a voyage:

$$H_s = \frac{N}{3} \sum_{i=1}^{N/3} H_i \quad (1)$$

Criteria high waves that affects shipping is (Hakim, 2010):

- 1.25-2.0 m: dangerous to fishing boats
- 2.0-3.0 m: dangerous to fishing boats and a barge
- 3.0-4.0 m: dangerous to fishing boat, a barge and ferry
- >4.0: dangerous to all ships

Neural network: Neural network is an artificial intelligence algorithms that imitates the concept of neural network system in human body, to a node-node that deals between of one by another (Mandal, 2010). The node connected through the links which is called by weight. Neural tissue network is distributed in parallel (Gunaydin, 2008). The basic shape there are neurons in Fig. 2 where the input is the input that will be used for training and validation, weight or weights burden that is always changing every given input as learning, processing unit is a place of the process of the introduction of the occurrence of objects based on the weighting given and output is output of neural network (Gunaydin, 2008).

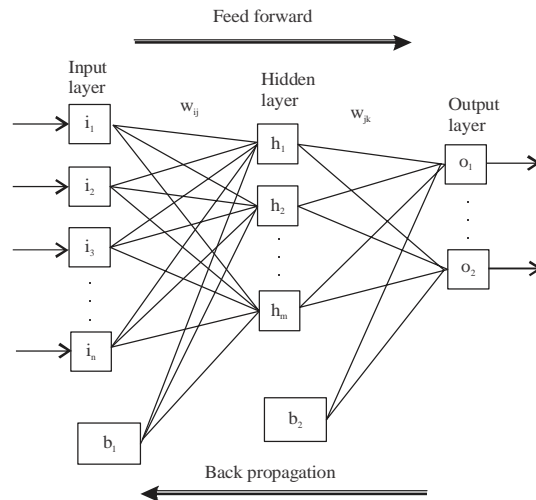


Fig. 2: Basic form neuron (Gunaydin, 2008)

Excess method neural network (Makarynskyy *et al.*, 2004):

- Can be used to forecasting nonlinear systems
- Easy output mapping system without knowing process that occurred (black-box)
- Have the ability to learn a process based on data provided training (Triatmodjo, 1999)
- Represents received information during the training (Triatmodjo, 1999)

Well be a model artificial neural network determined by Triatmodjo (1999):

- Architecture network, it was a pattern of architecture determine between neurons
- Method of learning, the methods used to determine and change weights
- Activation function
- Selection input (Paplinska-Swerpel and Paszke, 2006)

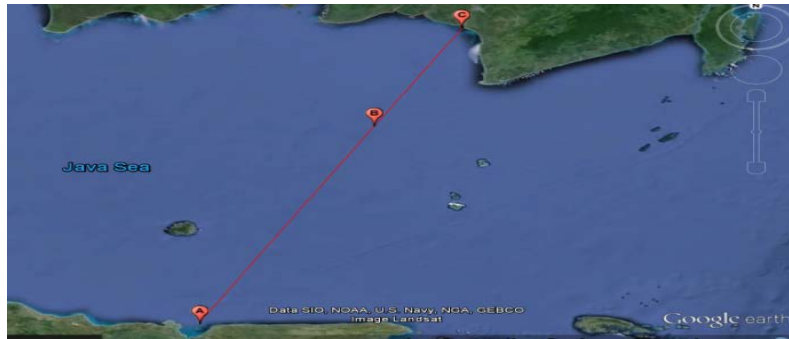


Fig. 3: Location data acquisition

Performance network: Performance produced by artificial neural network will be evaluated using Root Mean Square Error (RMSE) is an indicator of average error on analysis. The less RMSE produced, the more valid value the model (Gunaydin, 2008):

$$RMSE = \frac{\sum_{i=1}^N (y_i - x_i)^2}{N} \quad (2)$$

Where:

N = Data

x_i = Measurement

y_i = Prediction

Data acquisition: Some research mention that the height of waves affected by wind speed and elevation previous waves (Paplińska-Swempel and Paszke, 2006; Mandal, 2010) this was evidenced by the small Square Root Mean Error (RMSE) resulting. In a literature review has also mentioned that the height of waves affected by wind speed (Makarynsky *et al.*, 2004). Then to research this time, data taken is the data on wind speed (vw) and the wave height (hs) in 2006-2010 and 2013. Data retrieval wind speed and altitude waves carried on three points, first on longitude: 112.747800 E latitude: 6.874824 S (surabaya point A), both in longitude: 113.908800 E latitude: 4.648136 S (the java sea) point B, and third to longitude: 114.484300 E latitude: 3.540425 S (banjarmasin point C) as in a Fig. 3.

RESULTS AND DISCUSSION

Data analysis

Wind and wave height: The data performed on research is the wind speed (vw) and altitudes waves (hs) year 2006 until 2011.

Wind: Wind on this study the tides caused by the wind. The data used was data wind speed and the height of the year 2006 until 2011. Used data wind speed the altitude waves influenced by wind speed the prevailing. The less

wind speed the prevailing, so, the lower the waves happened. But the larger wind speed the prevailing, the higher the level (Paplińska-Swempel and Peszke, 2006). Figure 4 is a wind speeds are occurred in 2006 until 2011 about 46.016 data wind speed.

Can be seen on a chart that side of wave patterns up and down as many as five times because wind speed was taken for 5 years. Where in indonesia is only are 2 seasons that is the rain season and dry season. During the rainy season, wind speed higher than the dry season. So, formed pattern up and down (waves) for five the period. Flattened wind speed per year there are in Table 1-3.

We can pull out from Table 1 until 3 that wind speed every year the highest average happened between december until january or on rainy season.

Wave height: In addition to the velocity wind, the waves height is also influenced by the height of waves itself at an earlier time. So, that this research need data the height of waves in 2006-2011 as many as 46.016 data the height of waves. A Fig. 5 is a chart the height of waves. There are three the collection locations data the height of waves on these graphs it first on longitude: 112.747800 E latitude: 6.874824 S in Surabaya (point A) a blue color, second in longitude: 113.908800 E latitude: 4.648136 Sin Java Sea (point B) a red color and the third to longitude: 114.484300 E latitude: 3.540425 Sin Banjarmasin (point C) magenta color. Off the charts can be seen that who have a height of waves highest namely that is colored red (B).

Table 4-6 represents data wave level in their one point based on the average of per year and altitudes waves million per year. Equal to wind speed, the maximum waves happened in december-february coincide with rainy season.

Prediction: After conducted training and validation, algorithm JST it produces weights which will used to

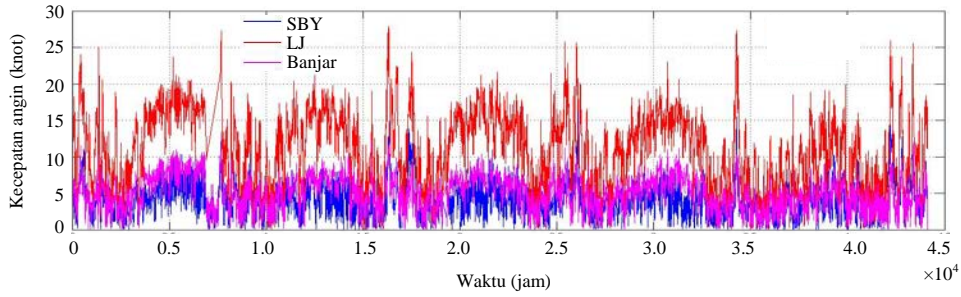


Fig. 4: Wind speed 2006-2011

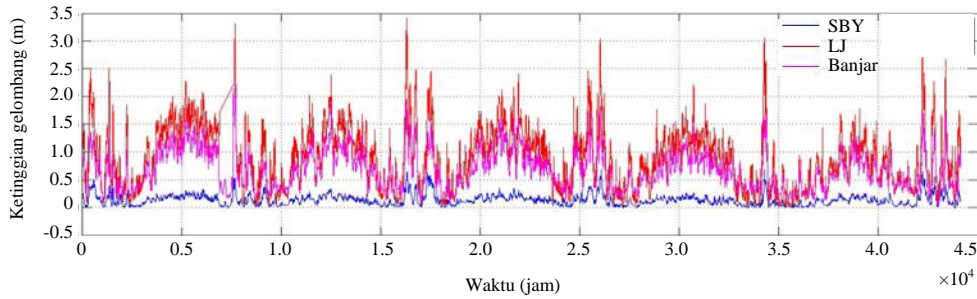


Fig. 5: Wave height

Table 1: Wind speed point A data's

Parameters	2006	2007	2008	2009	2010	2011
Average	3.9	3.8	4.04	3.72	4.07	6.18
Maximum	11.06	14.89	13.86	16.81	10.19	14.35
Date	25 January	29 December	9 February	7 February	31 December	12 January

Table 2: Wind speed point B data's

Parameters	2006	2007	2008	2009	2010	2011
Average	12.4	10.81	11.64	8.05	6.04	10.56
Maximum	25.04	27.92	24.38	22.77	15.98	25.94
Date	27 February	27 December	15 February	9 January	10 February	12 January

Table 3: Wind speed point C data's

Parameters	2006	2007	2008	2009	2010	2011
Average	5.36	4.93	5.1	4.97	3.53	4.25
Maximum	11.49	13.36	10.36	11.21	10.86	12.28
Date	18 January	3 January	8 February	5 February	13 January	12 January

Table 4: Wave height point A data

Parameters	2006	2007	2008	2009	2010	2011
Average	3.9	3.8	4.04	3.72	4.07	6.18
Maximum	11.06	14.89	13.86	16.81	10.19	14.35
Date	25 January	29 December	9 February	7 February	31 December	12 January

Table 5: Wave height point B data

Parameters	2006	2007	2008	2009	2010	2011
Average	1.2	0.9	0.98	0.75	0.56	0.94
Maximum	2.51	3.42	2.48	3.04	1.4	2.92
Date	27 February	27 December	15 February	9 January	10 February	12 January

Table 6: Wave height point C data

Parameters	2006	2007	2008	2009	2010	2011
Average	0.73	0.68	0.72	0.64	0.51	0.61
Maximum	2.14	2.31	1.61	1.82	1.71	1.75
Date	18 January	3 January	8 February	5 February	13 January	12 January

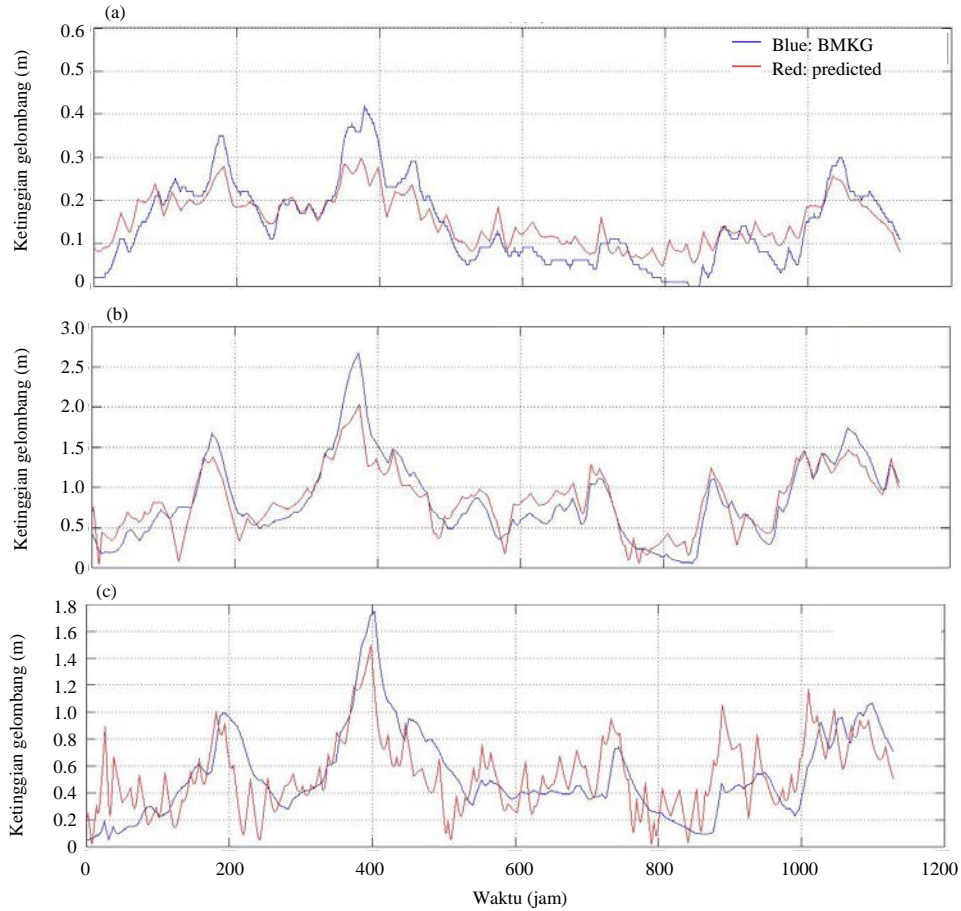


Fig. 6: Wave height point A, B and C Prediction (a) $hs(t+1)$ sby, (b) $hs(t+1)$ Laut Jawa and (c) $hs(t+1)$ banjar

prediction height waves. A Fig. 6 is a chart prediction height waves each in waters surabaya (point A), the java sea (point B) and waters banjarmasin (point C). Blue is the height of waves of data BMKG and red is the height of waves the results of a prediction JST based on wind speed, the height of waves now and heights of the waves an hour before.

Root Mean Square Error (RMSE) used to assess the relative the predictions. The less RMSE produced, the more both based on a prediction obtained (Papilinska-Swerpel and Paszke, 2006). RMSE prediction in point A is 0.04, RMSE prediction in point B is 0.21 and RMSE prediction in point C is 0.23.

CONCLUSION

This research can be concluded, that algorithm neural network influenced by architecture network and input-output. Algorithm neural network the best there are at a point namely by RMSE 0.04. In literature review it was mentioned that the less RMSE, the more both based predictions.

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