WATER WAVES WITH MULTI-SENSOR SYSTEM BASED ON MOBILE APPLICATION USING SUPPORT VECTOR MACHINE ALGORITHM

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Abstract
Indonesia is an island nation that has 17,499 islands with a total area of Indonesia is about 7.81 million km2 and only about 2.01 km2 in the form of land and the rest are about 3.1 million km2 of territorial sea and 2.7 million km2 of exclusive economic zones. The ocean is widely used by people for marine activities, but in the region of the ocean there are often high waves. High waves are a very important factor for marine activities. If there are often high waves, it can cause disruption of marine activities that impact the community.
For that, knowing the condition of the wave is very important. By knowing the condition of the waves, people can plan marine activities better to anticipate high waves or to avoid them.
From the problem, this system was made to be able to monitor the condition of ocean waves in realtime. This system uses Support Vector Machine algorithm in determining the classification of seawater wave conditions. The result of the classification has an accuracy of 55%.
keywords—Mobile Application, Sea Waves, Support Vector Machine

1. Introduction

Indonesia is the largest archipelago in the world with 17,499 islands with an area of about 7.81 million km2. The total area of 3.25 million km2 is ocean and 2.55 million km2 is the Exclusive Economic Zone. Only about 2.01 million km2 is landmassed[1]. Waves are a very important factor in marine activity. High waves are the cause of disruption of fishing activities, sea transportation between islands that have an impact on communities on land, such as lack of food on some remote islands and disruption of the development process due to the inhibition of necessary construction materials[2].

As a result of these high waves can be reduced or prevented if the characteristic information or conditions of waves in each area of Indonesian waters can be known, so that marine activities can be better planned. Therefore, information about the characteristics or conditions of high waves in Indonesia is very important to support various marine activities[2].

Because of these problems, this system was created that aims to be able to monitor the condition of ocean waves in real time. With this system, the public can know the characteristics or conditions of the waves of the waters to plan various marine activities better and efficiently. This system also uses mobile applications because there are already many people who have smart phones. According to the Ministry of Communication and Information, the number of smartphone users reached 167 million people or 89% of the total population of Indonesia[3].

2. Related Work

A. Tsunami Early Warning Detection Using Bayesian Classifier (Dewi Yanti Liliana and Dewi Yanti Liliana,2019)

This paper describes the tsunami's early warning system. This system works at interval times after an earthquake happen. At this time, the system will work to commemorate people to evacuate from the danger of tsunami. This system predicts tsunami's potential using machine learning techniques. The technique this system use is bayesian classifier. Tsunami training data from this system is taken from the website of InaTews, a national project from Indonesia involving many institutions. The parameters used to train the data are 3: magnitude, epicenter, and location.

B. Influence of Word Normalization and Chi-squared Feature Selection on Support Vector Machine (SVM) Text Classification (Ardy Wibowo Haryanto, Edy Kholid Mawardi, Muljono, 2018)

SVM (Support Vector Machine) is a supervised learning used for statistical approaches. SVM is commonly used to complete regression and classification. The SVM concept can be explained simply to find the best hyperplane that serves as a two-class separator in the input space.

3. Literature Review

A. Ocean Waves

Waves of seawater are movements in seawater by not moving mass from the sea water. There are several things that cause sea waves, one of which is due to the wind[4]

B. Tsunami

'Tsunami' is a term that originated in Japan. The term describes a situation in which an enormous wave of seawater reaches land caused by an earthquake with a shallow epicenter in the ocean. Indonesia's geographical location is included by the confluence of the Indo-Australian plate, the Eurasian plate, and the Pacific plate. These plates meet on the ocean floor hence in the event of an earthquake of shallow depth, it has the potential to cause a tsunami[5]. In addition, tsunamis can also be caused by volcanic eruptions[6].

C. Support Vector Machine

Support Vector Machine was first proposed by Vapnik and has taken a lot of attention in the research community[7]. Support Vector Machine is a supervised algorithm commonly used for statistical approaches[8]. Support Vector Machine uses a soft margin criterion that allows multiple samples to be on the wrong side of the hyperplane so that in the training phase achieves higher generalization accuracy[9]. How hyperplane works in SVM is shown in Figure 1.

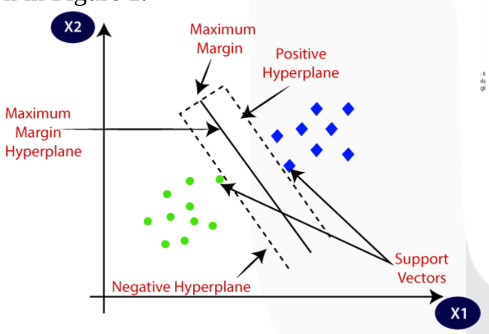

Figure 1 Hyperplane in SVM[10]

Data on a dataset is given variable xi, while for classes in the dataset is given the variable yi. The SVM method divides the dataset into 2 classes. The first class separated by a hyperplane is worth 1, while the other class is worth -1[10].

$$Xi.W + b \geq 1 \text{ for } Yi = 1 \quad (1)$$

$$Xi.W + b \leq -1 \text{ for } Yi = -1 \quad (2)$$

Information:

Xi = data-i

W = vector support weight value perpendicular to hyperplane

b = bias value

Yi = data class-i

Vector Weight (w) is a perpendicular line between the central points of the coordinates of a hyperplane line. Bias (b) is a line relative to a coordinate point. The equation (3) is an equation for calculating values (b). The equation (4) is an equation for calculating the value of w[10].

$$b = -\frac{1}{2}(w \cdot x^{+} + w \cdot x^{-}) \quad (3)$$

$$w = \sum_{i=1}^{n} \alpha_i y_i x_i \quad (4)$$

Information:

b = bias value

$w.x+$ = weight values for positive data classes

$w.x-$ = weight values for negative data classes

w = vector weight

αi = data weight-i

yi = class data-i

xi = data-i

The H1 is a support hyperplane of the +1 class that has a function $wx1 + b = +1$[10].

$$\text{Margin} = |dH_1 - dH_2| = \frac{2}{\|w\|} \quad (5)$$

Information:

dH1 = hyperplane range support class +1

dH2 = hyperplane range support class -1

Then to determine the optimal hyperplane of both classes using the following equations[10]:

$$\text{Minimize } J_1[w] = \frac{1}{2}\|w\|^2 \quad (6)$$

$$\text{With } y_{i(x_i \cdot w+b)-1\geq 0,i} = 1, \dots, n \quad (7)$$

Then calculate the Hessian matrix[10].

$$Dij = y_i y_j \left(K(x_i, x_j) + \lambda^2\right) \quad (8)$$

For $i,j=1,\dots,n$

Information:

xi = data-i

xj = data-j

yi = class data−i

yj = class data-j

n = amount of data

$K(xi,xj)$ = kernel functions used

The next stage is carried out repeatedly until the maximum iteration is reached or max ($|\delta\alpha i|$)< ε ($epsilon$)[10].

$$E_i \sum_{j=1}^{n} \alpha_j Dij \quad (9)$$

$$\delta\alpha_i = \min\{max[\gamma(1 - E_i), -\alpha_i], C - \alpha_i \quad (10)$$

$$\alpha_i = \alpha_i + \delta\alpha_i \quad (11)$$

Information:
αj = alfa-j
Dij = Hessian matrix
Eij = Error rate
γ = Gamma constant
C = C constant
$\delta\alpha i$ = delta alfa-i

D. Earthquake Intensity Scale

The Earthquake Intensity Scale is taken from Badan Meteorologi, Klimatologi, and Geofisika (BMKG) is a scale to measure how much impact is generated by earthquake disasters. The arranged scale consists of 5 scales that can be seen in Figure 2.

Scale	Color	Simple Description	Detailed Description	MMI scale	PGA (gal)
I	White	Not Felt	Not felt or felt by only a few people but recorded by tools.	I-II	<2.9
II	Green	Felt	Felt by the crowd but did not cause any damage. Light objects were hung swaying and glass windows shook.	III-V	2.9-88
III	Yellow	Slight Damage	Non-structural parts of the building suffered minor damage, such as hair cracking on the walls, the roof shifting downwards and partly falling.	VI	89-167
IV	Orange	Moderate Damage	Many cracks occur in the walls of simple buildings, some collapse, glass breaks. Some of the wall plaster came off. Most of the roof shifts down or falls. The structure of the building suffered minor to moderate damage.	VII-VIII	168-564
V	Red	Heavy Damage	Most of the walls of the building permanently collapsed. The structure of the building suffered heavy damage. The railway tracks are curved.	IX-XII	>564

Figure 2 Earthquake intensity scale[11]

4. Research Method

A. System Overview

In Figure 3, the system will be divided into several important components. These components are hardware that sends the necessary data and is sent to ThingSpeak. After that, the program on the web server will retrieve the data stored in ThingSpeak. Then, the data that has been retrieved will be processed by the algorithm on the web server. Finally, the data that has been processed will be taken by a mobile application whose function displays the results of the data process.

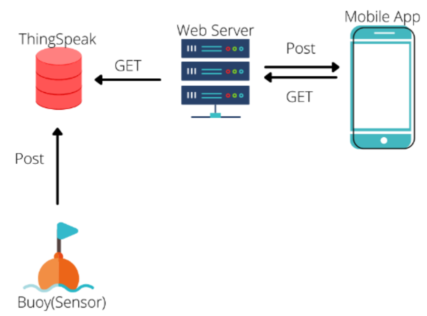

Figure 3 System Overview

B. Overview of SVM Classification

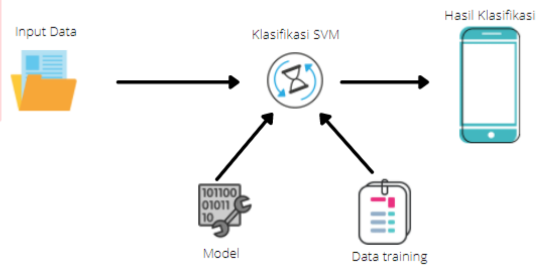

Figure 4 Overview system of SVM classification

From Figure 4, shown the SVM classification process to determine ocean conditions, here is the process the system occurs.

- The first is data input. Data derived from the sensor will be retrieved through ThingSpeak and will be entered into the SVM classification in the form of JSON files. Sensor data parameters are the height of water waves in the dock and in the middle of the sea, the speed of water waves, and vibrations.

- Furthermore, the data will be processed using the SVM algorithm model which is based on training data and sent to the database.

- Finally, the processed results of data that have been sent to the database will be displayed in the mobile application.

C. SVM Algorithm Implementation

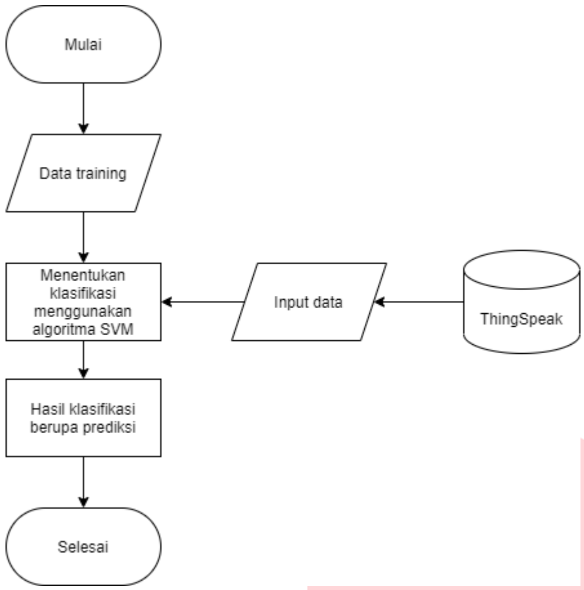

Figure 5 SVM flowchart

To display data on a mobile app, the system uses an SVM algorithm or Support Vectoring Machine to classify ocean wave conditions. The classification process of the SVM algorithm can be seen in Figure 5.

5. Testing and Result

A. Naïve Bayes Algorithm Testing

The test was conducted using 20 data. Data has been validated by BMGK. The results of the data classification test can be seen in Table 1.

Table 1 Data classification result

No	Data Testing				St	DT	Inf
	TD (m)	TT (m)	KC (m/s)	GN			
1	0.7	2.2	4.5	0.2	TB	B	N
2	0.2	1.1	2.9	107	TB	B	N
3	2.1	4.0	5.2	611	TB	B	N
4	2.1	3.7	3.4	97	TB	B	N
5	1.4	2.4	15	0	TB	B	N
6	0.7	1.4	0.2	0.8	B	B	V
7	0.1	1.1	2.6	264	B	B	V
8	0.2	1.1	1.1	100	B	B	V
9	0.4	1.1	8.9	131	B	B	V
10	0.6	1.2	4.0	1.4	TB	B	N
11	0.6	1.1	16	2.7	TB	B	N
12	0.6	1.1	3.2	0.8	B	B	V
13	0.9	1.9	0.2	56	B	B	V
14	1.0	2.0	10	1.8	B	B	V
15	0.9	1.6	5.4	80	TB	B	N
16	0.1	1.6	14	503	TB	B	N
17	0.3	1.4	10	69	B	B	V
18	0.1	1.6	17	102	B	B	V
19	1.1	1.8	6.8	15	B	B	V
20	1.1	1.9	3.3	1.7	B	B	V

Information:
TD : Wave Height at the Pier
TT : Wave Height in the middle of the Sea
KC : Wave Speed
GN : Vibration
TB : Not potential
B : Potential
V : Valid
N : Invalid
DT : Test results on the algorithm

From the above experiment, the accuracy of the SVM Algorithm is obtained as follows:

$$Accuracy = \frac{11}{20} x100 = 55\%$$

5. Conclusion

Based on the results of testing and analysis in this Final Task research can be concluded as follows:

- The Sea Wave Monitoring System which uses SVM algorithms with 'potential' and 'no potential' outputs has an accuracy of 55%.

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