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Implementation of the Support Vector Machine Method for Early Detection of Stunting Based on Anthropometric Features

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Abstract— Stunting describes chronic undernutrition during the growth and development period from the beginning of life. This situation is represented by a z-score for height for age (TB/A) less than -2 standard deviation (SD). The current method used to detect stunting in toddlers is to use KMS. The way to do this is to weigh the under-fives every month, the weighing results are recorded in the KMS, and between the points of weight from last month's weighing results and the results of this month's weighing are connected with a line. The series of child growth lines forms a child growth chart. This procedure is of course less effective. Based on these problems, the research conducted is the Implementation of the Support Vector Machine Method for Early Detection of Stunting Based on Anthropometric Features. The SVM method consists of a training process as system learning and testing to obtain classification results. The parameter tests carried out are lambda, complexity, and maximum iteration tests. The data used in this study were 90 data which were divided into 2 classes, namely stunting toddlers and normal toddlers. The SVM algorithm is a linear classification method, so it uses the kernel to deal with nonlinear data. The final results of this research produce the highest average accuracy of 86% λ = 10, C = 1, itermax = 200 and also use polynomial kernels. Comparison of the results of the classification of child stunting with the help of midwives shows that the system produces good accuracy
Keywords— Personal Health Record, Acceptance, Medical Record

I. BACKGROUND

Stunting describes chronic undernutrition during the growth and development period from the beginning of life. This situation is represented by a z-score for height for age (TB/U) less than -2 standard deviations (SD) based on WHO growth standards (WHO, 2010) [1]. Globally, around 1 in 4 toddlers is stunted (UNICEF, 2013) [2]. In Indonesia, based on the results of basic health research (Riskesdas) in 2013, there were 37.2% of toddlers who were stunted [3]. It is known from the total percentage, 19.2% of children are short and 18.0% are very short. The prevalence of stunting has increased compared to the 2010 Riskesdas results, which was 35.6%. The toddler period is a period that is very sensitive to the environment, so stunting is needed to describe chronic malnutrition during a period of growth and development from the beginning of life. This situation is represented by a z-score for height for age (TB/U) less than -2 standard deviations (SD) based on WHO growth standards (WHO, 2010) [1]. Globally, around 1 in 4 toddlers is stunted (UNICEF, 2013) [2].

The current method used to detect stunting in toddlers is to use KMS. The way to do this is to weigh the under-fives every month, the weighing results are recorded in the KMS, and between the points of weight from last month's weighing results and the results of this month's weighing are connected with a line. The series of child growth lines forms a child growth chart. This procedure is of course less effective. In addition, midwives can differ from one another in determining stunting status in toddlers.

Several studies on stunting have been carried out. These studies include research from Kukuh Eka Kusuma [4]. Observational study with a case-control design on toddlers aged 2-3 years in the East Semarang district. Sampling was done by consecutive sampling, 36 subjects in each group. Stunting was categorized based on the z-score for height for age (TB/A). Data on subject and respondent identity, birth length, parents' education, parents' occupation, family income and number of family members were obtained through interviews with a questionnaire. Data on children's height and parents' height were measured using a microtoise. Bivariate analysis using Chi-Square by looking at Odds Ratio (OR) and multivariate with multiple logistic regression. Results: The results of multivariate analysis showed that the risk factor for stunting in toddlers aged 2-3 years was low family economic status (P = 0.032; OR = 4.13), while birth length, parents' height, and parents' education were not stunting risk factor.

The second research is research from Khoiru Ni'mah [5]. The purpose of this study was to determine the factors associated with the incidence of stunting in toddlers. This research is an analytic observational study with a case-control design conducted in the working area of the Tanah Kali Kedinding Health Center, Surabaya. Samples were taken as many as 34 toddlers for each group of cases and controls with simple random sampling technique. The results of the study were that there was a relationship between toddler birth length, history of exclusive breastfeeding, family income, mother's education and mother's nutritional knowledge on the incidence of stunting in toddlers.

Subsequent research is research from Ningki Hermaduanti (2008) [6] who conducted research on SMS-Based Decision Support Systems to determine Nutritional Status with the K-Nearest Neighbor Method. By using this application, users can find out their nutritional status with fast, easy and cheap alternatives. . This study shows the accuracy value of the system is equal to 90.41%. The next research is research on the Towards Healthy Card from Adi Wicaksana (2011) [7], who designed the East Java Provincial Health Card (KMS) using a Weighted Spline Model. The background to this research is that the KMS currently used in Indonesia does not reflect the growth pattern of toddlers, especially in East Java. Based on the toddler growth curve in East Java Province, there is a change in pattern at a certain age limit and also an error variance that is not constant. KMS designed using a weighted spline regression approach has a lower evaluator standard than the KMS currently used in Indonesia. Previously, in 2002 in Malawi, an Integrated Nutrition and Food Security Surveillance (INFSS) development system utilized SMS technology by building an SMS gateway called RapidSMS. RapidSMS has succeeded in reducing costs very significantly when compared to paper-based surveillance [8].

From the description above, it can be seen that most of the research conducted was limited to the analysis of stunting. Research related to application development is mostly about the Card Towards Healthy Toddlers. Research related to the development of stunting detection software is still rarely carried out by some researchers.

The purpose of the research conducted is the Implementation of the Support Vector Machine Method for Early Detection of Stunting Based on Anthropometric Features The SVM method consists of a training process as system learning and testing to obtain classification results. The parameter tests carried out are lambda, complexity, and maximum iteration tests. The data used in this study were 90 data which were divided into 2 classes, namely stunting toddlers and normal toddlers. The SVM algorithm is a linear classification method, so it uses the kernel to deal with nonlinear data. The final results of this research produce the highest average accuracy of 86% $\lambda = 10$, $C = 1$, itermax = 200 and also use polynomial kernels. Comparison of the results of the classification of child stunting with the help of midwives shows that the system produces good accuracy.

II. METHOD

This section of the chapter discusses the design of the system for the Application of the Support Vector Machine (SVM) Method in the Classification of Stunting in Children. The data used in this research was obtained by means of library research, reading books or journals related to the problem being analyzed. The secondary data used in this study was in the form of child anthropometry data from WHO. The system design process consists of system description, data preprocessing, process design, Support Vector Machine (SVM) manual calculations, interface design, and test design. The system design process will be shown in the system design drawings in Figure 1.

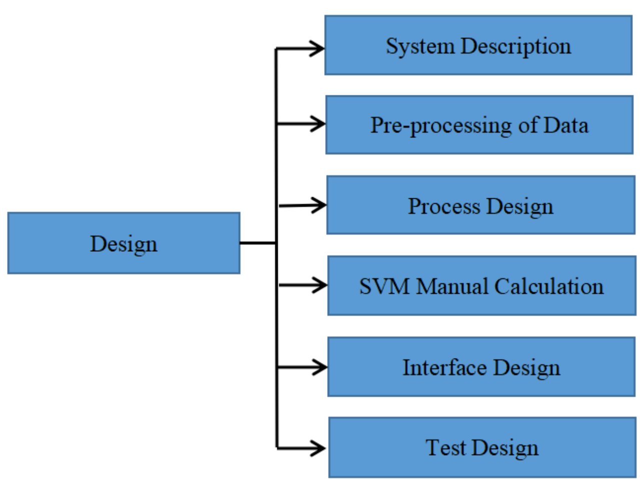


Fig. 1 System Design

System Description

System Description The system that will be created in this thesis aims to classify stunted toddlers and normal toddlers by implementing the Support Vector Machine (SVM) method. So that what is used consists of two classes, namely the stunting toddler class and the normal toddler class. The features used consisted of age, weight, height and head circumference, which were taken from anthropometric data. The classification process will use a polynomial kernel, because the data used is nonlinear. Then the training data will be processed using Sequential Training SVM. In solving multiclass problems, the concept used to determine classes in training data is One-Against-All.

Preprocessing Data

At this stage, data selection will be carried out from all features. The data consists of 2 classes, namely stunting toddlers and normal toddlers, and consists of 4 features, namely: age, weight, body length and head circumference. Each feature has a value taken from anthropometric data to simplify the calculation process on the system.

Table 1. Distribution of Normal and Stunted Toddler Features

No.	Feature	Classification
1	BB/Normal age, TB/Normal age	Normal
2	Less weight/age, less TB/age	Stunting

Process Design

The stunting toddler classification process is carried out by entering data on age, weight and height. The process will perform calculations based on the data entered by the user, namely data on age, weight and height, on the Input Data menu. After the data is inputted and pressing the Detection Button, the classification process will be carried out by performing calculations using the Support Vector Machine (SVM) method. After going through the calculation process, the results of the classification of stunting in toddlers will be obtained. The process of the stunting classification system for toddlers will be shown in the flowchart in Figure 1. The built system will later read the features in the training data. Based on the data entered by the user, the system will process it using the Super Vector Machine (SVM) method to produce a stunting classification that matches the features in the training data.

Support Vector Machine (SVM) Flow Chart

This sub-chapter describes the design of a problem-solving flow using the Support Vector Machine (SVM) method. In this sub-chapter, each process will be explained in detail.

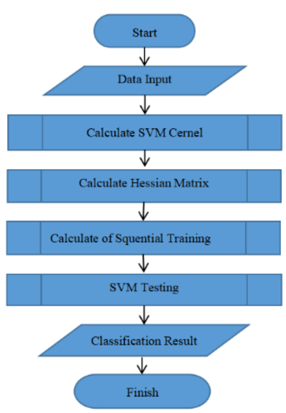


Fig. 2 Support Vector Machine Process Flow

The Support Vector Machine Algorithm Flowchart begins by entering the toddler anthropometric data set, performing the Kernel Polynomial calculation process, carrying out the Hessian Matrix calculation process, carrying out the Epsilon calculation process and carrying out the Learning Rate calculation process. In detail can be explained as follows.

a. Polynomial Kernel Calculation Process

The kernel used in this study uses Polynomial. The formula for the Kernel Pplynomial calculation is shown in equation 1:

$$K(x,y) = (x.y)^d \quad (1)$$

Where K(x,y) is the kernel value for each row of data, x is the initialization value of the symptoms and y is the initialization value of the symptoms to be compared against x

b. Hessian Matrix Calculation Process
The next process is calculating the hessian matrix, the calculation process uses the formula

$$D_{ij}=y_i y_j(K(x,y)+ƛ^2) \quad (2)$$

Where Dij = hessian matrix value in data row, yiyj = level class, K(xixj) = polynomial kernel result, and ƛ = lambda value

c. Epsilon Value Calculation
Calculation of the epsilon value using the formula

$$E_i = \sum_{j=1}^{n} \alpha_j D_{ij} \quad (3)$$

Dimana E_i =The epsilon value in the data row, α= nilai alpha, D_{ij}= Hessian matrix values

d. Learning Rate Calculation Process
The next calculation is to find the learning rate value using the formula

$$\gamma = \frac{0.001}{\max_i D_{ij}} \quad (4)$$

Where γ=learning rate value, Maxi D =the maximum value of the Hessian matrix

e. Delta Alpha Update Calculation Process
The next calculation is to find the alpha delta update using the formula
δα1=2min{max[(1- Ei),-αi], C-αi } (5)
δα1 = alpha delta value, Ei = epsilon value, αi = alpha value, and C = complexity value

f. Epsilon Value Update Calculation Process
The next calculation is to find the latest epsilon update value using the formula

$$E_i = \sum_{j=1}^{n} \alpha_j D_{ij} \quad (6)$$

g. Delta Alpha Update Calculation Process
The next calculation is to find the alpha delta update using the formula (f).
α1= α1+δα1 (7)
Where α1is the first alpha value and δα1 is indigo delta alpha.

h. The process of calculating positive and negative kernel values
The next calculation is to look for positive and negative kernel values. The way to get a positive kernel is to choose the largest positive value in the hessian matrix, while in a negative kernel, choose the largest negative value in the hessian matrix.

i. The process of calculating positive and negative weight values
The next calculation is to find the positive weight using

$$x^+ = \alpha_1 * 1 * K(x_i, x^+) \quad (8)$$

Meanwhile, to find the negative weight using the formula

$$w.x^- = \alpha_1 * 1 * K(x_i, x^-) \quad (9)$$

Where shows a positive weight value, shows a negative weight value, is the alpha value, K(,) is a positive kernel, andK(,) is a negative kernel.

User Interface Development

Database development for management of toddler medical records, so toddler medical records from born to five years old may well documented, including status of stunting development. Examples of forms for management of toddler medical records can be seen in figure 3.

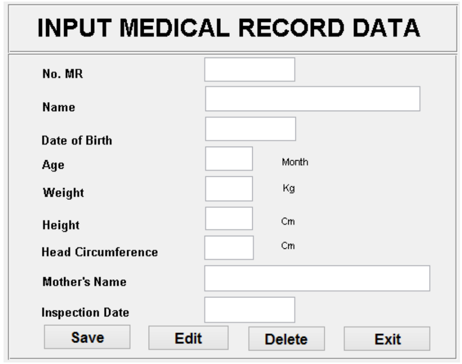


Fig. 3 Form Design for Toddler Medical Record Data Input

Detection of Stunting Status Toddler

Development of detection methods stunting status by using intelligent systems. The method used is detection of stunting based on age, body weight, body length and head circumference using Support Vector Machine [6].

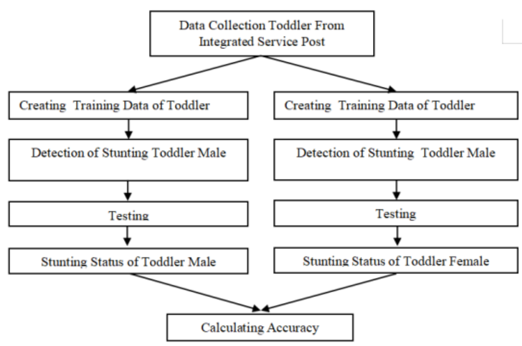


Fig. 4 Steps of Research

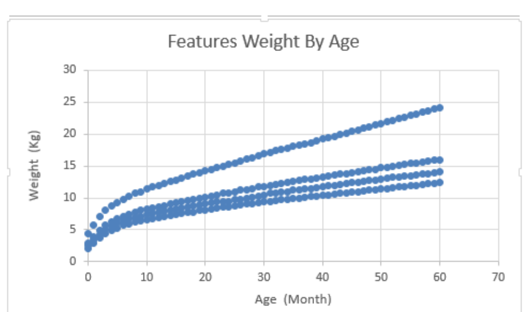
The Steps of stunting detection can be described as shown below:

a. Capturing Data From Posyandu (Integrated Health Care Center)

Data from Posyandu (Integrated Health Care Center) include medical records toddlers and anthropometric data includes: age, body weight, body length and head circumference.

b. Feature extraction

Feature extraction is a process to obtain accurate information in order to do identification process [8] - [9] (Duda, 2000). Features used for detection of stunting include: age, weight features, body length and head circumference according World Health Organisation (WHO) of children under five male and female. Features that are selected will be used for classification of stunting include: Stunting Toddler and Normal Toddler.



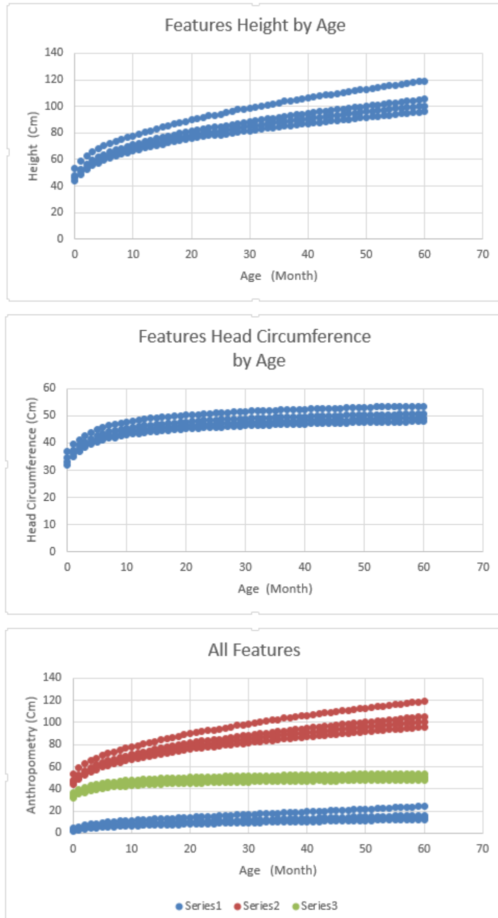


Fig. 5 Graph of Features Used

Stunting Monitoring Using Support Vector Machine (SVM)

Monitoring process of stunting do with classification process. Classification process consists of two parts, namely classification for toddler boys and girls. One method of classification is Support Vector Machine (SVM) [7]. Monitoring of stunting based on age and weight, age and body length, age and head circumference and by all. Outcome of this process is index value of biggest decisions function that states class of test data. If class resulting from classification process same with class of test data, then clasification is correct. The results of classification process are status of normal and stunting todller. Development of stunting detection applications using programming language Matlab [9]. Applications developed aims to facilitate midwives to record medical records toddler, watching the stunting status of toddler automatically, and display charts the development of anthropometric include weight, body length and head circumference. Graph of development of stunting of toddler is shown in Figure 5.

Fig. 6 Main Menu for Girls

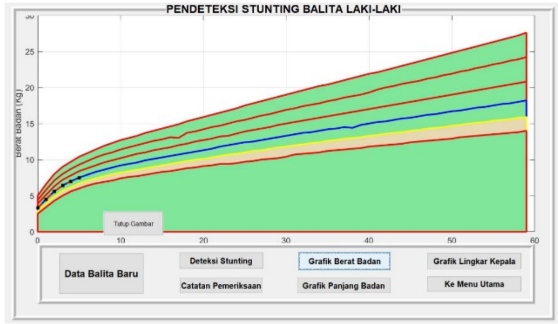


Fig. 7 Graph Monitoring Developments Weight Loss Girls Toddler

Calculating Accuracy Monitoring Stunting

Results of classification will be made comparison with Groundtruth (midwife) using *Receiver Operating Characteristic* (ROC), so that will be obtained four values, each of which is a true positive, false negative, false positive, and true negative. Truepositive (TP) indicates the stunting status of identified appropriately in accordance with the class. False positive (FP) is a stunting status that should be identified correctly in its class in classification process turned out to be wrong in identifying. True negatif (TN) is a stunting status that are not members of class identified right is not a member of that class. False negatif (FN) shows stunting status should not be a member of class identified as members of class. Based on all four grades were obtained true positive rate (TPR), which is known as sensitivity. Sensitivity formula is as follows:

$$TPR = \frac{TP}{TP+FN} \quad (10)$$

The false positive rate (FPR) or specificity is a value that indicates the level of error in identification that obtained using following equation:

$$FPR = \frac{FP}{FP+TN} \quad (11)$$

While the value that indicates the accuracy of identification (accuracy) is obtained from the following equation:

$$Accuracy = \frac{TP+TN}{TP+FP+TN+FN} x100\% \quad (12)$$

III. RESULTS AND DISCUSSION

The training data used in system developed is 240 data. The training data 0 to 12 is normal toddler, and 121 to 240 data is stunting toddler. While features used to detect nutritional status were age, body weight, body length and head circumference. Experiments carried out through four times the test by using 50 data testing. The first testing is testing for detection method of nutrition based on age and weight. Second is based on age and body length. The third trials are testing based on age and head circumference. While the fourth trial is testing the nutritional status based on age, body weight, body length and head circumference at once. This scenario is used to observe effect of feature selection in this case age, body weight, body length and head circumference on performance of infant nutritional detection methods are developed. Results of the first test showed an accuracy rate of 85.1%. Results of second testing showed an accuracy rate of 86 %%. Results of thirth testing showed an accuracy rate of 90.6%. Results of fourth testing showed an accuracy rate of 82.3%. This indicates that the method used by using the training data can be detected very accurately. Results of tests that have been done can be shown in Table 2.

Table 2. Results of Testing

Amount of Data	Accuracy			
	Testing 1 (Weight/Age)	Testing 2 (Height/Age)	Testing 3 (Head Circumference/Age)	Testing 4 (W,H,HC/Age)
60	85.1%	86%	90.6%	82.3%

IV. CONCLUSIONS AND SUGGESTIONS

Based on test results, it can be concluded that the software to detect stunting status of children (Height/Age) with methods Support Vector Machine (SVM) can be used as a model for detecting stunting of children. This is demonstrated by average value of 86% accuracy.

ACKNOWLEDGEMENT

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