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Application for Early Detection of Childhood Development Using Intelligent System

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Abstract

Child development is a process of increasing abilities and more complex body structures and functions as a result of maturation of cells. Monitoring of child development needs to be done from in the womb to adulthood. But currently the activity of mothers in monitoring their child's development has decreased, due to busyness and laziness. The research objective is to develop an intelligent application for early detection of child development, from zero to six years old using an intelligent system. This application is intended for parents and the health medical team who work at the Public Health Center, to provide information about children's development, identify deviations in children's development and can provide early stimulation suggestions for what to give to children. This research includes two main things. The first is the development of software for managing toddler medical record data. The second is the development of software to detect child development using an intelligent system. The method used is an Artificial Neural Network, Backpropagation. With the developed application, early growth and development deviations can be identified easily, so that efforts to prevent, stimulate and cure as well as restore them can be carried out as early as possible. The accuracy of the developed application is 98.3%.

Keywords: backpropagation, child development, smart apps, toddlers

1. Introduction

Growth and development are two distinct but inseparable events. Growth is a change in body size and is something that can be measured such as height, weight, head circumference which can be read in growth books. While the development is more aimed at the maturity function of the organs of the body. For example, feet for jumping (rough movements), fingers for writing, buttoning clothes (smooth movements), understanding (how children learn from their environment to understand body parts, colors), speech (children are able to express what is intended) and socialization (Syafitri, D. & Wardhani, 2012).

In accordance with the process of growth and development, monitoring needs to be done from the start, namely when in the womb until adulthood. With good monitoring, irregularities can be detected early, so that the corrective actions taken will get more satisfactory results. With the existence of early detection and intervention programs for developmental deviations

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implemented in the community through the Integrated Service program, the Toddler Family Development program (TFD), programs at the Community Health Center, it is necessary to think about a management system for the next facility as a means of further referral, including the last reference place that can handle holistically and completely (Staal et al., 2011).

Several studies on child development have been carried out. Research conducted by Suryanto found that the implementation of SDIDTK for babies was only documented at 13.28% and this documentation was felt to be less effective because it only focused on babies (zero to 12 months) (Sejati, Ardhitya & Sofiana, 2015) Whereas in each posyandu there are other toddlers (aged 12 months and over to 72 months), where toddlers (zero to 72 months) are the main target in SDIDTK measurement. Other research related to early detection of growth deviations in children has been carried out by Chesney, Chesney has conducted research on the causes of growth and development disorders in children due to several factors including: lack of attention from parents, incomplete immunization at an early age, food poisoning (Chesney, 2013). This became the basis for research conducted by Russ by creating an online hearing loss detection system, called the Victorian Infant Hearing Screening Program (Russ et al., 2004). This system was tested on 82 children where the children were assisted by their parents to answer the questionnaires given by the system. This questionnaire uses the Auditory Brainstem Response (ABR) instrument to compare the growth and development of normal children with children who have hearing problems. The ABR instrument is used to measure a child's response to their hearing ability. This test is used to test the acceleration of hearing from the ear to the brainstem.

Other research on child growth and development has been carried out to screen the growth and development of toddlers and pre-school children based on multimedia with reference to the developmental pre-screening questionnaire (PSQ) to help health workers, cadres and especially parents to have a correct and quick understanding in diagnosing developmental delays in toddlers (Widodo & Boedijanto, 2014). Thus, if irregularities are found, stimulation can be given quickly, precisely and accurately. Subsequent research on developmental disorders in toddlers has been carried out, this research uses a web-based early detection of child growth and development, to recognize child development disorders (Syafitri, D. & Wardhani, 2012).

From the description above, it can be seen that most of the research conducted is limited to the analysis of child development. Research related to the development of growth detection software is still rarely carried out by some researchers. This study aims to develop an application for early detection of development in children aged zero to six years. This research includes two main things. The first is the development of software for managing toddler medical record data. The second is the development of software to detect child development using an intelligent system. The method used is the Backpropagation Neural Network (Hermawan, 2006), n.d.; Agustin & Prahasto, 2012). To detect early development of children, the application calculates the normal number of children's development by 75%. If the child's growth and development have a number of less than 75%, then the application responds that the child data entered includes the category of children who have child development disorders, and the application will immediately provide

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early stimulation to the user in the form of information that needs to be carried out by the parents.

2. Method

Regular monitoring of development can detect early developmental delays in children. Monitoring of child development can be done using the Child-Development Pre-Screening Questionnaire (KPSP). The application for early detection of child development was developed, based on the Child-Development Pre-Screening Questionnaire using the Backpropagation method (Siahaan, 2014). Examination is an assessment of children's development in 4 development sectors, namely: gross motor, fine motor, speech or language and socialization or self-reliance Developmental pre-screening questionnaire for children divided into several age categories, namely: 1 month old baby, 3-month-old baby, 6-month-old baby, 9-month-old baby, 12-month-old baby, 24-month-old baby, babies aged 36 months, babies aged 60 months, and babies aged 72 months. Therefore, the detection of child development is also differentiated according to age. So that in smart applications, this consists of nine smart applications. The stages in the research can be explained as follows:

2.1. Data collection.

The stages in data collection are the stages for analysing, designing, and building artificial neural network systems. The data collected in this study is secondary data. The data used is toddler data from screening results using the Developmental Pre-Screening Questionnaire (DPSQ) at the Prosperous Integrated Service Center, Ponowaren Village, Tawangsari, Sukoharjo, Central Java, Indonesia. Totaling 100 toddlers. The secondary data used in this study has been validated by the Midwife at the Integrated Service Center.

2.2. Early Detection of Childhood Development Using the Backpropagation Method

The early detection application for developing children aged zero to 6 years (72 months) consists of 9 applications, namely smart applications for the process of detecting child development based on toddler age. The stages in early detection of child development using the Backpropagation Method (Kiki & Kusumadewi, 2004; Rogachev et al., 2021) can be explained as follows:

2.2.1. Data Input

The first stage in the child development detection process is to input data by determining the input variables. The input variables in the study were adjusted for the detection of child development based on age, because each age category has different variables. An example for a 1-month-old child has 4 variables, namely: the baby can stare at the mother, the baby can make the sound o...o..., the baby can smile, the baby can move its arms and legs. The Input Data Variables for a 1-month-old toddler are shown in Table 1. Then the data will be processed into training data (training) and test data (testing). The division of the data carried out is training data 70%, 80% and test data 30% and 20%. This input data will be entered into the system and then stored in the database.

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Table 1. Input Data Variables for 1-month-old Toddler

Variable	Value Unit	Information
X0	Strongly Disagree (0) Disagree (0.25) Enough (0.50) Agree (0.75) Strongly Agree (1)	Baby can stare at mom
X1	Strongly Disagree (0) Disagree (0.25) Enough (0.50) Agree (0.75) Strongly Agree (1)	Babies can make sounds o…o…
X2	Strongly Disagree (0) Disagree (0.25) Enough (0.50) Agree (0.75) Strongly Agree (1)	Babies can smile
X3	Strongly Disagree (0) Disagree (0.25) Enough (0.50) Agree (0.75) Strongly Agree (1)	Babies can move their arms and legs

2.2.2. Data Transformation

At the data transformation stage, it is the stage for changing the symptom data values into the form of a scale of numbers 0 and 1 so that they can be used for calculating the training and testing stages in Backpropagation (Buscema, 1998; Stergiou & Siganos, 1996). The number 1 indicates a child with normal development, and the number 0 indicates a child with abnormal development. Results of transformation of child development detection data are shown in Table 2.

Table 2. Results of Transformation of Child Development Detection Data

No	Variable				Class
	X0	X1	X2	X3	
1	0.5	1	1	1	Normal
2	0.5	1	0.5	0.75	Normal
3	0.5	1	1	0.75	Normal
4	1	0.5	0.5	0.5	Normal
5	0.5	0.5	1	0.75	Normal
6	0.25	0	0.5	0	Apnormal
7	0.25	0	0	0.75	Apnormal
8	0.75	0	0	0	Apnormal
9	1	0	0	0	Apnormal
10	0	1	0.5	0	Apnormal

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2.2.3. Training

At this stage the system training process will be carried out using existing training data so that it can carry out training in accordance with Backpropagation training (Kun, 2012; Suliman & Zhang, 2015). After the training process is carried out, the final weight will be obtained. This final weight will be used for testing. Training data is data used to train the Artificial Neural Network application that has been built. While the test data (testing) is used to carry out the testing process on applications that have carried out the training process. The distribution of data in this study is 70:30 and 80:20. For the needs at the training stage set the maximum epoch, target error and learning rate. Initialization Maximum epoch = 1000, learning rate (α) = 0.01 and Target error 0.001.

2.2.4. Testing

At this stage testing will be carried out on the system using the data provided. This stage aims to determine whether the resulting output is in accordance with the actual data.

2.2.5. Child Development Detection

Detection of child development using the backpropagation method, the process starts from the training stage to testing. The backpropagation architecture is shown in Figure 1 (Vazirani et al., 2010).

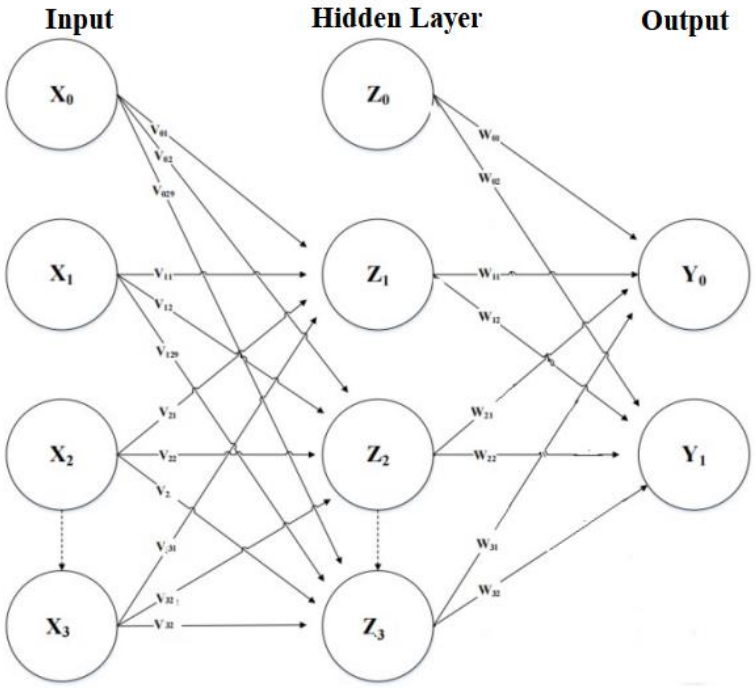

Figure 1. Backpropagation Architecture for Child Development Detection

Figure 1 shows the backpropagation architecture for detecting development in children aged one month, which consists of 4 input variables, namely X_0 – X_3 which are symptoms of

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developmental deviations in children. The network consists of 4 units (neurons), namely $Z_0 - Z_3$ in the hidden layer and there are 2 output units, namely Y_0 Y_1 in the output layer. Then the weights connecting $X_0 - X_3$ with the hidden layer are V_{11}, V_{21}, ……. and V_{33}. V_{ij} is the weight that connects the ith input neuron to the jth neuron in the hidden layer. V_{01}, V_{02}…… V_{03}, are the bias weights that will connect the first to the second neuron in the hidden layer. As for the weights Z_1, Z_1, Z_2 and Z_3 with neurons in the output layer Y_0 is W_{j0}, Y_1 is W_{j1}, the bias weights that connect the hidden layer to the output layer are W_{00} for output Y_0, W_{01} for output Y_1. The activation function used between the input layer and the output layer is the binary sigmoid activation function(Asaad & Ali, 2019).

The stages used in the backpropagation method to detect child development consist of 2 stages, namely: the stages for training (training) and the stages for testing (testing). Stages of training (training) consists of 2 (two) phases. Phase I is the forward propagation phase (feedforward propagation). In phase 1 the input pattern (X_0, X_1, X_2 and X_3) is calculated forward from the input layer to the output layer using the binary sigmoid activation function. The second phase is the backpropagation phase. While the testing phase only uses Phase 1, namely the feedforward propagation phase (Aguinaga et al., 2017).

2.2.6. Interface Design

At the interface design stage or interface design is used to connect between users to applications that have been built so that users can interact with applications easily. The design of the interface in this study includes: the front page, the training process, the testing process and individual tests using Graphical User Interface (GUI).

3. Result

3.1. Front Page Display

The front-page display is the first page which consists of 3 menu options for the application to be built by the researcher. The following is the front-page display which can be seen in Figure 2 below:

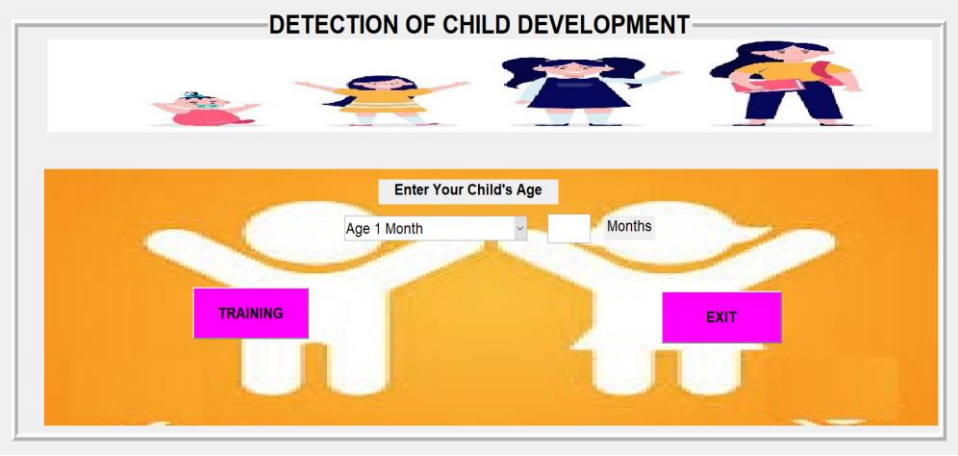

Figure 2. Front Page Display

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3.2. Display the Training Menu

The training display is a display for carrying out the training process and a display for entering values from the maximum variable epoch, target error, learning rate and number of hidden layer neurons. The training display design can be seen in Figure 3 below:

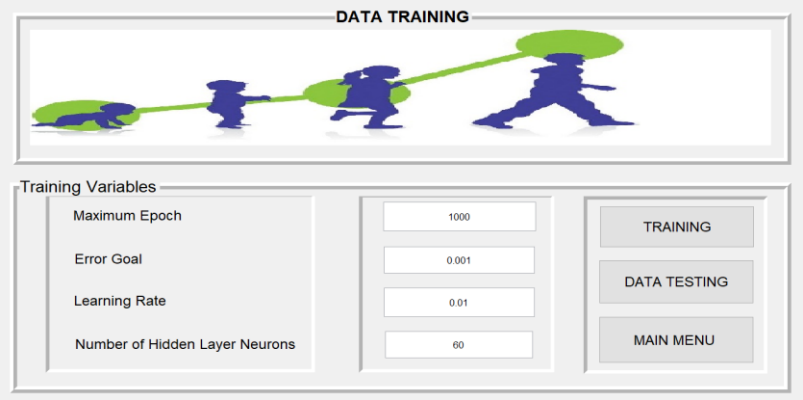

Figure 3. Display of Training Menu

The results of the training process are shown in Figure 4, below.

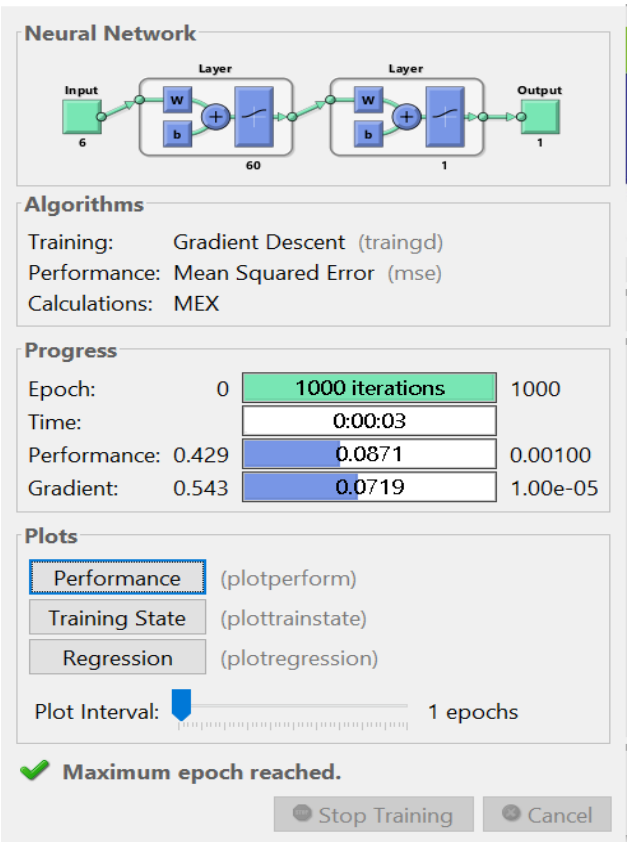

Figure 4. Results of the Training Process

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3.3. Data Testing

The training data used is 100 data. The parameter test results shown below are the results of testing based on learning rate (α=0.01), this test uses data with a ratio of 70:30 (70 training data and 30 test data), 80:20 (80 training data and 20 test data). This test uses 1000 epochs and a target error of 0.001.

Table 3. Data Test Results

No	Training Data	Hidden Layer	Learning Rate	Result
1	70:30	29	0.01	75%
2	70:30	29	0.1	98.3%
3	80:20	29	0.01	42%
4	80:20	29	0.1	77.5%

Table 3 above shows the results of testing carried out 4 times. The first experiment using 70 training data and 30 testing data with a learning rate of 0.01 obtained an accuracy of 75%. The second experiment using 70 training data and 30 testing data with a learning rate of 0.1 obtained an accuracy of 98.3%. The third experiment using 80 training data and 20 testing data with a learning rate of 0.01 obtained an accuracy of 42%. While the last experiment using 80 training data and 20 testing data with a learning rate of 0.1 obtained an accuracy of 77.5%.

4. Discussion

Backpropagation method has been successfully implemented for diagnosing deviations in toddler development. The parameters used in this study are learning rates 0.01 and 0.1. The maximum epoch is 1000. The target error is 0.001, the number of hidden layer neurons is 29. The best parameter is learning rate (α) = 0.1, and the number of hidden neurons is 29 in a comparison of training data and test data of 70:30 with an accuracy of 98.3%. The amount of training data, the learning rate value, the number of hidden neurons will affect the accuracy results.

To increase the accuracy of the method used, it can be done by increasing the amount of training data, changing the learning rate, for example 0.2. For further research, researchers will detect deviations in child development using the backpropagation method with momentum. The Momentum Backpropagation Algorithm and Standard Backpropagation are basically the same, the only difference lies in the final stage, namely weight adjustment. Adding momentum parameters in updating weights can often speed up the training process. This is because momentum forces the process of changing weights to keep moving so that they are not trapped in local minimums (Abdul Hamid et al., 2011). Momentum in a neural network is the change in weight based on the gradient direction of the last pattern and the previous pattern. The addition of momentum parameters to the Artificial Neural Network aims to accelerate the learning process towards convergence. Experimental results have also shown that this method can make the network reach convergence quickly and stably.

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