Developing Mobile Intelligent System For Cattle Disease Diagnosis and First Aid Action Suggestion

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***Abstract*— Animal husbandry is one of main concerns of agricultural development revitalization in Indonesia. The domestic products from this sector are yet to meet the domestics' demands of meat and dairy products. Therefore, instead of continuously dependent on imported products, efforts on animal husbandry revitalization to stimulate the production growth from this sector are critically needed. The aim of this paper is to present the work of developing mobile intelligent system for cattle diseases diagnosis and first aid action suggestion system. The core intelligent engine of the system is developed using fuzzy neural network. In the sense of ubiquity of smartphones, the user interface is developed as mobile application under Android operating system. System testing over real-world cattle diagnosis medical data set and expert verification showed that the systems could diagnose correctly with validity 100% and average accuracy 96.37%. The experimental results also showed that frame base knowledge representation outperformed rule base knowledge representation.**

Keywords— Mobile Intelligent Software;Cattle Deaseases; Diagnosis;Android;Fuzzy Neural Network

I. INTRODUCTION

Animal husbandry industry as one of main agricultural development sectors in Indonesia is still far from satisfactory. To meet the domestic demand of meat and dairy, Indonesia is still highly dependent on imported products. Based on report released by ministry of agriculture Republic of Indonesia in 2012 [1], the domestic dairy products only supply 30% of national dairy demand, while another 70% of demand is supplied by imported products from other countries. The similar case occurs for national beef demand, in which more than 30% of the demand is still supplied from imported products as reported in [3].

As a matter of fact, Indonesia as one of the largest agricultural-driven country supposed to be able to supply the national demand of animal husbandry products independently. It also has a great prospect as a critical success factor of national economy growth trigger. Therefore, it is necessary to revitalize the agricultural development in Indonesia, particularly the animal husbandry sector, where the national demand of products from this sector is very high.

One of animal husbandry revitalization efforts proposed in this study is the use of information technology (IT). In this study, an intelligent system for cattle diseases diagnosis and first aid actions recommender system is proposed. The rationale of this study is the fact that cattle diseases problem is one of main problems resulting in low productivity in animal husbandry sector. To date, cattle raisers that are the main players in this sector highly depend on veterinarians to cope with cattle diseases issues. Unfortunately, the number of veterinarians serving the cattle raisers is very limited. A report from general directorate of animal husbandry and animal health, ministry of agriculture Republic of Indonesia [2,3] shows that overall Indonesia still lacks approximately 20000 veterinarians until 2020 to adequately serve animal husbandry sector demands. In particular, 6000 of veterinarians are critically needed in rural area and isles. Meanwhile, there are not more than 1000 veterinarians graduated annually from all universities in Indonesia. Consequently, this fact left cattle diseases issues remain unsolved.

Fuzzy Neural Network was developed to cover the weaknesses of Fuzzy System and Neural Network. Fuzzy system has drawbacks in terms of learning ability which is owned by Neural Network, while the Neural Network has the disadvantage in terms of knowledge representation and explanation abilities possessed by Fuzzy System. Therefore, Fuzzy Neural Network combines the advantages of Fuzzy System and Neural Network that not only excel in learning capability, but also the ability of explanation and knowledge representation [13].

Several studies using Fuzzy Neural Network to the problem of diagnosis of the disease have been done. Hayashi [17] using fuzzy to process input data and a case study for medical diagnosis and the result was pretty good compared to without fuzzification process first. Kahramanli & Allahverdi [16] to diagnose diabetes and heart disease by using the hybrid algorithm and Fuzzy Neural Network

Chowdhury and Saha [15] developed a system to diagnose the critical condition of the patient on the basis of fuzzy neural network. From these studies shows that the fuzzy neural network is suitable to diagnose some diseases.

Purwanto [8] had previously conducted a study entitled "Application of Artificial Neural Network Algorithm In Intelligent System For Detection And Treatment Cow Disease". in the study was found to be flawed in that, the use of attributes in the dataset that seem rigid or stiff as an instance of the attribute is still a crisp. In reality, the attributes that are used in disease detection not only of value "Yes" or "No", but more a ordinal that has levels that, as exemplified by Uzoka [14]. Listiana [7] similar with Purwanto but she used rough sets algorithm approach. From the study can be seen that this algorithm has a limitation for a large amount of training data where the time taken to generate the rule is too long.

The expected outcome of developing the intelligent system proposed in this study is to decrease the high dependency of cattle raisers on veterinarians to cope with cattle diseases related issues. The easy-to-use mobile intelligent system developed in this study is expected to help cattle raisers to diagnosis as early as possible the cattle diseases and finally to help giving recommendations for cattle raisers to take actions for tackling the disease. Thus, at the end the risk of cattle death could be minimised.

II. Dataset Instances and Method

The data instance used in the experiment in this study consists of 250 medical records for three different cattle diseases i.e. Mastitis, foot and mouth disease, and Septicemia Epizootic [5, 6, 7, and 8]. Under these data instance, the experiment was carried out with the method explained in the following explanation.

Generally, the method used in this study consists in two main phases. The first phase aims is developing core intelligent engine and the second phase an intelligent mobile system is developed.

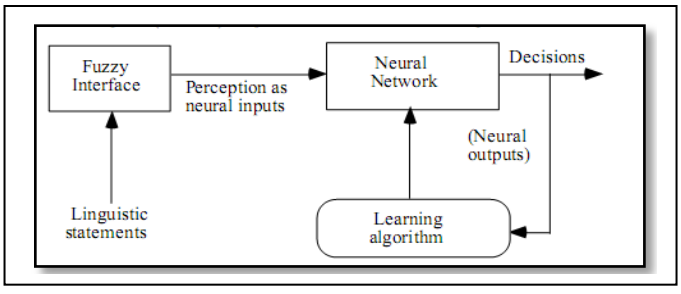

Fig. 1. Fuzzy Neural Network System

In the first phase fuzzy neural network (FNN) [4] is adapted. Basically, the FNN is described by Fig. 1. In essence, the core distinction between FNN and the general artificial neural network is the existence of Fuzzy Interface. In which, instead of using crisp membership function i.e. 0 and 1, the value between 0 and 1 is assigned to membership function. To make it clear, Figure 2 can be considered as an example. Taking the body temperature of cattle as an example of input, in FNN a temperature of 36.5 degree Celsius could be considered as both low and normal temperature to some extent. Contrarily, in general neural network, it should be categorized as either low or normal but not both of them. The membership functions of Fig. 2. is defined in equation (1), (2), and (3).

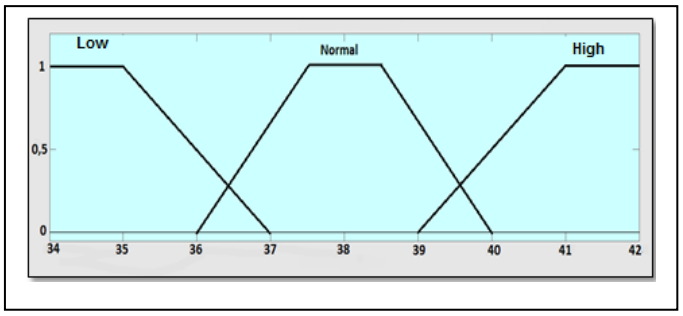

Fig. 2. Fuzzy Membership function

$$\mu Low(x) = \begin{cases} 1; & x \leq 35 \\ (37 - x)/2; & 35 \leq x \leq 37 \\ 0; & x \geq 37 \end{cases}$$

(1)

$$\mu Normal(x) = \begin{cases} 1; & x \leq 36 \; or \; x \geq 40 \\ (x - 36)/1.5; & 36 \leq x \leq 37.5 \\ 1; & 37.5 \leq x \leq 38.5 \\ (40 - x)/1.5; & 38.5 \leq x \leq 40 \end{cases}$$

(2)

$$\mu High(x) = \begin{cases} 0; & x \leq 39 \\ (x - 39)/2; & 39 \leq x \leq 41 \\ 1; & x \geq 41 \end{cases}$$

(3)

The central component of FNN is the neural network (NN) itself. In greater granularity, the architecture of neural network is depicted by Figure 3. As shown by Fig.3., there are three layers i.e. input, hidden, and output layers. The input layer is the set of 17 symptoms shown by cattle under diagnosis. Detail of these symptoms can be found in [7, 8]. The number of node in hidden layer is determined by experimental basis (refer to [9] for detail). Moreover, the output layer is the decision variables, which is the result of diagnosis. Clearly, it determines whether the input symptoms indicate that the cattle under diagnosis are whether suffering from Mastitis, foot and mouth disease, or Septicemia Epizootic.

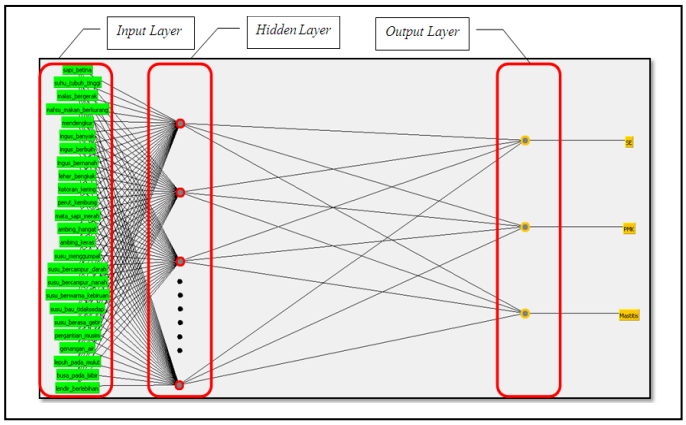

Fig. 3. Fuzzy Neural Network System

Another important component of FNN is the learning algorithm. In the experiment of this study, the back propagation algorithm with gradient descent learning function was implemented. There are three parameters that must be set up during the experiments i.e. epoch, goal and learning rate. Detail explanation of this algorithm can be found in [10] and the parameter setting in this experiment is elaborated in [5].

In the second phase, the mobile intelligent system is developed. As mobile application, the system is developed in Android operating system. The popularity and pervasive usage of Android as mobile operating system is the rationale of choosing Android in this study. In nutshell, there are two main parts of mobile intelligence system development proposed in this work i.e. the development of knowledge base and the development of user interfaces. The knowledge base is derived from core intelligent system developed in prior phase.

Because of limited computing resources in mobile application environment, the sensible choices of techniques for representing the knowledge are critical. In this study, two knowledge representation i.e. rule base and frame base are implemented and evaluated. In rule base, the knowledge is represented as set of implications rules (see [11] for detail). Whilst in frame base knowledge is represented as set of objects. Each object is modeled as a frame with some slots representing its attributes (see [12] for detail).

III. Experiment, Results, and Discussion

In this work, the development of intelligent mobile system has been successfully implemented in Android operating system. The user interfaces including the main user interface, symptoms input user interface, and diagnosis result as well as first aid recommender system user interface are clearly depicted by Fig.4.

Fig. 4. Mobile Application User Interface

To evaluate the performance of the developed system, two experiments were carried out in this study. The first experiment was conducted to evaluate the performance of FNN while in the second experiment the performance of system was evaluated under two different knowledge representations.

$$MSE = \frac{\sum_{t=1}^{N} |Yactual - Ypredict|^2}{N} \quad (4)$$

In the first experiment, as explained in the previous section the decision on number of hidden layer nodes and the learning rate is experimental basis. In this study, 230 out of 250 data record are used for training the algorithm. The experimental results showed that in terms of mean square errors (MSE) the best number of hidden layer is 10 and the best learning rate is 0.9 with MSE 0.87%. MSE is defined by equation (4), where t is an individual instance and N is the total number of instances; Yactual is the value of actual result and Ypredict is the value of prediction resulted from FNN. Table 1 summarizes our experimental result.

The final result of experiment over 230 training data with the best known parameter setting tuning (learning rate 0.9 and 10 hidden layer nodes) showed that the MSE is 0.58 %. It means that the system can predict correctly the cattle diseases for more than 99% of training data set. Finally, the experimental testing over the remaining 20 out of 250 data set also showed that the system can predict the cattle diseases with validity 100% and average accuracy 96.37%.

TABLE I. FNN Experimental Results

Number of Hidden layer Nodes	Learning Rate (Result in %)			
	0.1	*0.3*	*0.6*	*0.9*
4	36.21	13.16	4.42	3.23
5	12.98	11.33	4.79	5.99
6	13.98	4.87	6.56	1.72
7	10.55	4.91	9.35	1.15
8	8.88	6.83	2.19	6.36
9	11.79	5.75	1.91	9.06
10	11.68	4.80	2.62	**0.58**

TABLE II. WEIGHT BETWEEN HIDDEN LAYER AND OUTPUT LAYER

Hidden Layer	Output Layer		
	Node 1	Node 2	Node 3
Node 1	15.39	0.08	194.62
Node 2	180.94	0.83	308.58
Node 3	-3.18	354.09	-33.36
Node 4	-46.72	208.14	-0.09
Node 5	-0.37	0.29	-43.46
Node 6	-28.35	-25.41	203.59
Node 7	-37.03	-23.89	0.06
Node 8	-0.69	40.69	0.34
Node 9	0.03	163.09	-11.32
Node 10	0.51	-12.08	-0.04

TABLE III. BIAS BETWEEN INPUT LAYER, HIDDEN LAYER AND OUTPUT LAYER

Hidden Layer	Bias	Output Layer	Bias
Node 1	-414.34	Node 1	6.92
Node 2	-423.16	Node 2	-0.29
Node 3	-0.66	Node 3	0.05
Node 4	-0.42	-	-
Node 5	3.68	-	-
Node 6	3.54	-	-
Node 7	6.76	-	-
Node 8	1.03	-	-
Node 9	-154.49	-	-
Node 10	-20.43	-	-

Meanwhile, the experimental result on evaluating the performance of mobile application is done under two different knowledge, representations is shown by Fig. 5. In terms of validity, the experiment over 60 cases data set (20 cases for each disease) showed that frame base is superior over rule base. To be specific, as shown by Figure system under frame base could diagnose 100% correctly while under rule base only 51.6 %. Moreover, in terms of processing system, the experimental result also showed that frame base outperformed rule base. As shown by Fig. 6., in average under frame base the system required only 1 second while under rule base require 4.7 second to produce diagnosis results.

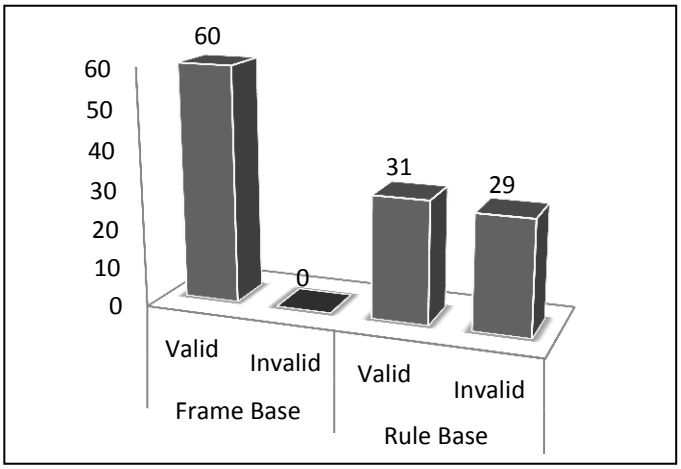

Fig. 5. System Performance (Validity) under two different Knowledge Representation

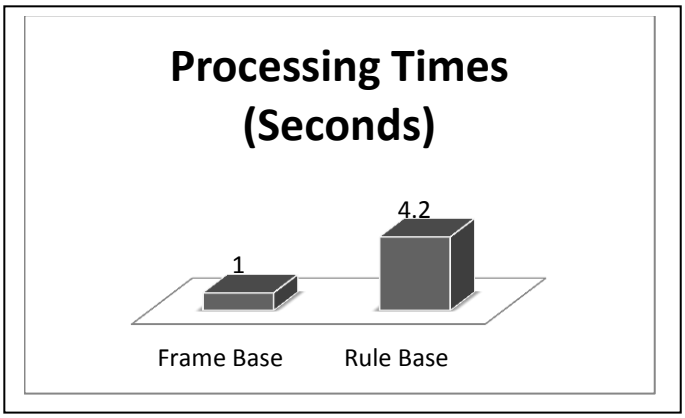

Fig. 6. System Performance (Processing Time) under two different Knowledge Representation

CONCLUSION

This paper has presented the development of mobile intelligent system for cattle diseases diagnosis and first aid action recommendation system. The core intelligent engine is implemented using Fuzzy Neural Network, while the real application is developed under Android operating system. System testing over real-world cattle diagnosis medical data set and expert verification showed that the systems could diagnose correctly with validity 100% and average accuracy 96.37%. The experimental results also showed that frame base knowledge representation outperformed rule base knowledge representation. In this initial work, the system is developed specifically to diagnose for only three cattle diseases. In the future work, it could be enhanced to deal with other cattle diseases with more sophisticated approaches and methods. Another important point of this work is that this work could encourage further work on investigation of Information Technology, particularly the area of Artificial Intelligence in order to revitalize the development in animal husbandry sector towards national independency in meat and dairy national demand supply.

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