

## Analyzing Dog Health Status through Its Own Behavioral Activities

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## Analyzing Dog Health Status through Its Own Behavioral Activities

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### ● 요약 ●

In this paper, we suggest an activity and health monitoring system to observe the status of the dogs in real time. We also propose a *k-days* algorithm which helps monitoring pet health status using classified activity data from a machine learning approach. One of the best machine learning algorithm is used for the classification activity of dogs. Dog health status is acquired by comparing current activity calculation with passed *k-days* activities average. It is considered as a good, warning and bad health status for differences between current and *k-days* summarized moving average (SMA) > 30, SMA between 30 and 50, and SMA < 50, respectively.

**키워드:** Smart Costume, IoT technologies, *k-days*, SVM, Smart feeding machine.

### I. Introduction

Dogs are the most popular house pets in the world today, and since many dog owners treat their dogs as family member. A dog's health is often intrinsically linked to its owner's own health. Regular feeding and behaviors monitoring are crucial issues in dog's maintenance. To improve and extend a dog's life, proper monitoring depends on analyzing the information gathered from daily physical dog activities.

Prior to our current research, similar dog monitoring studies have been conducted measuring various health indicators. In these studies health analysis of regular dog activities has shown clinical significance in detecting many mobility related disorders, and lifestyle risk factors for certain diseases. Identifying potential health outcomes for dogs, activity monitoring has been used to objectively determine responses to medical therapy and to

estimate the energy expenditure of dogs [1]. In response to the data derived from prior research, the pet industry firms have expressed plans to develop a smart automatic feeding system which integrates auto-feeding functions with dog behavior analysis, as an IoT technology.

Currently, there is no readily available products in the pet care market sector which automatically estimates the health of animals nor reflects that animal's changing health status. To fill this void, in our present research, we develop an unique device that electronically analyze dog feeding and behavioral data in indoor conditions and gives instant feedback to its' user for optimal pet care. One of the goals of this experiment is to better understand the problem of diagnosing dogs health status

using its own historical data without entering breed of dogs. Another goal is to electronically determine the healthiest living environment of dogs, by utilizing the *k-days* analysis system. This *k-days* study fixes every kind of dogs without entering height and weight. Additionally, data is collected with an accelerometer sensor that is fixed in a smart costume device.

## II. Health monitoring system

### 2.1. Overview of the working system

The fundamental structure of the system contains three components which are: a smart costume, a smart feeding machine, and a monitoring application as shown in Figure 1. To make a difference from other feeding systems, we decided specifically to develop artificial intelligent (AI) systems. This AI system can help analyzing daily physical activity behavior and diagnosing health status.

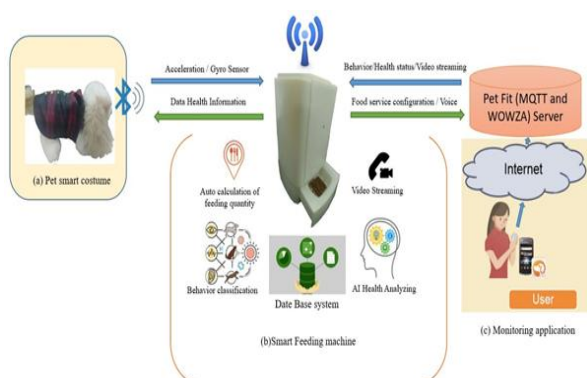


Figure 1. System overview

The results of this analysis and diagnosis can be seen from monitoring applications. Furthermore, the smart costume can be represented as a movement algorithm detection measuring multidimensional data. In the following sections we will review how this process is obtained sequentially.

### 2.2 How to calculate k-days

The wearable smart costume sensor data is saved behavior data to the database by the smart analyzing system. From this, the algorithm identifies the behaviors which were created using the angular detection of yaw, roll and SVM classification estimation of dog behaviors [2]. A common way to identify health status in the system is to feed with its features to an

anomaly detector. Anomaly detection has been used in fields such as intrusion detection and fraud detection [3]. So, our anomaly model-based health algorithm (AMHA) technique, can realize to find optimal *k-days*. The first, behavior data is collected in several days with a healthy dog. After that feeding machine task is to find count of active and inactive behaviors proportions. if behaviors proportion is achieved to unchanged relation during several days, these past days will choose as an optimal *k-days*. Having chosen the optimal *k-days*, if achieved behaviors stable relations will change, the health condition would go negative estimation that "warning" or "bad" point. Thus, choosing the optimal *k-days* by analyzing system, it begins to calculate statistical summary. Statistical analysis is defined as  $N =$  chosen *k-days* of each activity by hourly;  $RS =$  resting,  $WL =$  walking,  $ST =$  standing and  $RN =$  running amounts of last days. Moreover, other activities are defined as percentage resting activity (PRSA), percentage standing activity (PSA), percentage walking activity (PWA), percentage running activity (PRA) and summarize moving of average (SMA). The equations for each are shown below formulas.

$$PRSA = \frac{RS}{N} * 100 \% \quad (1)$$

$$PSA = \frac{ST}{N} * 100 \% \quad (2)$$

$$PWA = \frac{WL}{N} * 100 \% \quad (3)$$

$$PRA = \frac{RN}{N} * 100 \% \quad (4)$$

$$SMA = \frac{1}{n} \sum_{i=0}^n a_i = \frac{1}{4} (PRSA + PSA + PWA + PRA) \quad (5)$$

$n =$  is the total number of items

The percentage difference is calculated using above the formula 5: After having obtained issue, estimating the distance of SMA less than 30 estimating distance Figure 2 is given a "good," range between from 30 to 50 is a "warning," and reach of upper than 50 is a "bad" state is temporary analyzing of dog condition. Our feeding machine needs several days to calculate SMA algorithm results. After that, the work presented for monitoring; smart feeding machine is sent to server this information for illustrating smart phone analysis application.

## III. Performance Evaluation

For diagnosing health status of the dog experiment, a convenience sample of Bernese Mountain healthy adult dog was chosen. The Bernese mountain dog recruited for this part

Table 1 Calculation of the *k*-days (7 days was chosen) comparing with actual last day

Comparing with <i>k</i> -days	Result numbers calculated by percentage					Health status
	Running	Walking	Standing	Resting	summarize	
1 day	97.8	99	93.8	100	97.8	'good'
2 days	99.7	96.4	102.2	99.9	99.5	'good'
3 days	91.7	94.3	108.6	99.5	98.5	'good'
4 days	108	100	106	90	101	'good'
5 days	114.6	102	108	98.8	105.85	'good'
6 days	99.4	101	89	101	97.6	'good'
7 days	98.4	98	91	101	97.1	'good'

of the experiment was a healthy female adult dog. Using the AMHA technique, the optimal graph to measure the health condition of the dog has been achieved for 7 days. There was a real correlation between four activations, but during the experiment, we observed that more resting activity spending time. than the other three activations. Thus, data from all trials for the dog were included in the subsequent analysis. After applying testing dataset, belong to four activities of simple algorithm was selected for implementation, showed the sensitivity of 97.8% summarizing in first day. This number comes from using the mean (Arithmetic) formula:

$$N = \frac{\sum x}{n} \tag{6}$$

n, x = means [4] the sum median of all the data points divided by the number of 7 days of data points for each activity and add to (1), (2), (3), (4), (5) formulas. When evaluating variations, the percentage of difference between total four activities in 1 day counts from 97.8% to 100% (mean 97.8%, 99%, 93,8% and 100% for 97.8 respectively) for summarizing result. The 97.8 percentage of a result number is made up 9.7 points estimating which less than SMA > 30 is "good". On the other case, accuracy of 105.85 % summarizing a positive value of 10 also less than 30 is "good" result is shown in Table 1. At the commencement of this our simple algorithm was determined health status is "good" relating to the health status belong to simple health analysis. Because in 7 days, the *k*-days analysis was performed positive heaths status. If our dog were more non activation during the experiment health point would be negative apprehension.

#### IV. Conclusions

The experimental results show to ensure that the *k*-days approach is suitable for accuracy measuring health. When utilizing accelerometers as a research toll care must be taken to specify the method of attachment. Implementation of this accelerometer-based health monitoring algorithm reports that our dog is still healthy analyzing by own historical dataset during several days. The use of accelerometers and these simple health algorithms may be preferable to the alternative way of estimating health by statistically, due to their suitability for extended durations and in both indoor and outdoor environments. The reason of this, humans have a lower comprehend of dogs' health management. This research that may support health predicting clinically and further expand and justify the results may present an incentive to promote dog adoption for appropriate individuals.

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