The Analysis of the Activity Patterns of Dog with Wearable Sensors Using Machine Learning

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ABSTRACT

The Activity patterns of animal species are difficult to access and the behavior of freely moving individuals can not be assessed by direct observation. As it has become large challenge to understand the activity pattern of animals such as dogs, and cats etc. One approach for monitoring these behaviors is the continuous collection of data by human observers. Therefore, in this study we assess the activity patterns of dog using the wearable sensors data such as accelerometer and gyroscope. A wearable, sensor -based system is suitable for such ends, and it will be able to monitor the dogs in real-time. The basic purpose of this study was to develop a system that can detect the activities based on the accelerometer and gyroscope signals. Therefore, we purpose a method which is based on the data collected from 10 dogs, including different nine breeds of different sizes and ages, and both genders. We applied six different state-of-the-art classifiers such as Random forests (RF), Support vector machine (SVM), Gradient boosting machine (GBM), XGBoost, k-nearest neighbors (KNN), and Decision tree classifier, respectively. The Random Forest showed a good classification result. We achieved an accuracy 86.73% while the detecting the activity.

Key words

Pet Activity detection, Machine learning, Feature Engineering, Activity detection.

Ⅰ. Introduction

The fast development of computers and embedded systems, activity recognition through wearable sensor devices, and inexpensive sensors have become an integral part of people's routine and are broadly applied to numerous common areas including health management, medical monitoring, rehabilitation, action recognition, and remote control [1-4]. The Wearable sensors combining embedded systems and acceleration and gyro sensors have been established for activity recognition and are used in everyday life and sports activities. The benefits of the acceleration and gyro sensors combined with embedded systems in the wearable instrument for motion monitoring and recognition is that no exterior environment sensors like camera, infrared sensors, or radar are required for these wearable instrument [5-7]. additionally, with their tiny size, low cost, lightness, and lessen power consumption, acceleration, and gyro sensors in wearable devices give a solution to recognize the sports activity. According to Khalifa et al., KEH (kinetic energy harvesting) may help to overcome the battery problem in wearable devices. KEH is chiefly used as a generator and a Human activity recognition sensor, lessen the power consumption by the sensor. The results show that activity detection from the KEH could overcome system power consumption by 79% [5].

The paper structure is arranged as follows: Section II describes the related work. Section III presents the methodology used for this research work. Section IV describes the result and discussion of the present work. Section V presents the

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conclusion and future work

Ⅱ. Related works

In the past, many researchers tried to use numerous machine learning algorithms for dog activity detection, and they used sensor data. They also extracted statistical features from the sensor data. A few of the previous works have been mention below.

Cassim Ladha et al proposed a method to detect the activity of dogs. They used accelerometer plate form to record the dog behaviors in naturalistic environments. For this purpose, a statistical classification framework was used for the detection of dog's activity. They did an experiment on 18 dogs and the model was able to detect the different activities with an accuracy of 70% [8].

Tatsuya Kiyohara et al proposed a method for activity detection. They used an off-the-shelf acceleration sensor for the activity detection. They used the Dynamic time Wraping technique for activity detection. They observed that it was difficult for the statistical method to distinguish between different activities like jumping[9].

Ⅲ. METHODOLOGY

In this paper, data collected from 10 different dogs. All dogs were different in breed, age, gender, and size. The data was collected for ten different activities; namely, Stay, Walking, Sitting, Eating, Sideway, Jump, Nosework, Running, Down and shaking, respectively. For the activity detection, accelerometer and gyroscope wearable sensors were used. The sensors were placed at the neck and tail of the dogs fastened using straps. The dataset was quite huge in size therefore the sensors sampled the data at a frequency of 33.3 Hz.The data that was obtained was having enormous amount of noise, as the signals were generated from the dogs. Therefore, to lessen the amount of noise, a lowpass Butterworth filter was used. In the Butterworth filter, 6th order was used with the cutoff frequency of 3.667 Hz. The order of the filter was select on the basis of blocking the maximal noise. The cutoff frequency was chosen on the basis of the data exploratory data analysis. Therefore, after filtering and noise removal of the data, a common feature engineering was performed to fetch out the crucial features from the data. For the feature engineering, on the accelerometer and gyroscope data, ten features for each axis were performed. The derived features were, standard deviation, mean absolute deviation, mean, minimum, maximum, interquartile range, energy measure, skewness, and kurtosis. we used SMOTE method to balance the classes due to the imbalanced of data between the classes.

IV. RESULTS and DISCUSSION

The experiment was conducted using the python programming language. The dataset was divided into 80% for training and 20% for testing. Machine learning models like RF, SVM, Decision Tree, Gradient Boost, k-NN, XGBoost, were used in this research paper. The models were evaluated by different performance measures like accuracy, precision, recall. The RF model showed the highest performance with 86.73% classification accuracy.

V. CONCLUSION

In this research paper, we applied different machine classifiers for pet activity detection. The random forest classifier outperformed other models. This classifier showed 86.73% accuracy. This model can be used for the real situation for pet activity detection.

In Future work we will collect more data and apply deep learning such as CNN and LSTM.

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