Chapter 9
Animal Activity Recognition From Sensor Data Using Ensemble Learning

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ABSTRACT

Animal activity recognition is an important task to monitor the behavior of animals to know their health condition and psychological state. To provide a solution for this need, this study is aimed to build an internet of things (IoT) system that predicts the activities of animals based on sensor data obtained from embedded devices attached to animals. This chapter especially considers the problem of prediction of goat activity using three types of sensors: accelerometer, gyroscope, and magnetometer. Five possible goat activities are of interest, including stationary, grazing, walking, trotting, and running. The utility of five ensemble learning methods was investigated, including random forest, extremely randomized trees, bagging trees, gradient boosting, and extreme gradient boosting. The results showed that all these methods achieved good performance (>94%) on the datasets. Therefore, this study can be successfully used by professionals such as farmers, vets, and animal behaviorists where animal tracking may be crucial.

INTRODUCTION

Activity recognition is a research subject that aims to understand what activities an agent does with the information obtained from an Internet of Things (IoT) environment and the agent. The research subject has been taken into consideration because of playing a significant role in producing personalized applications. There are two main types of activity recognition tasks related to living organisms: human activity recognition and animal activity recognition. This study focuses on animal activity recognition.

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Animal activity recognition (AAR) is the process of identifying the activity of an animal by analyzing video or sensor data. AAR is in the interest of pet owners, veterinarians, and the agricultural community since it acts as a useful indicator of animal health and welfare. According to researches, when they are not under human supervision, knowing what animals do gives us a lot of information about their health and psychology.

The aim of this study is to make predictions of goats' movements with machine learning algorithms. We consider the problem of prediction of goat activity from sensor data. We developed a pipeline of data pre-processing, segmentation, feature extraction, model construction, and activity classification especially designed for performing decision-making on IoT systems.

The main contributions of this chapter can be summarized as follows. It investigates the utility of ensemble learning algorithms to classify major movement modes of goats from sensor data. Our specific objective is to classify goat behavior into five major activity modes: stationary, grazing, walking, trotting, and running. Our study is also original in that it considers multiple sensor data: accelerometer, gyroscope, and magnetometer. A combination of this variety of IoT sensors gives us a robust insight into goat movements. This study also compares different ensemble learning algorithms to determine the best one for goat activity recognition, including Random Forest (RF), Extremely Randomized Trees (Extra Trees), Bagging Trees (BT), Gradient Boosting (GBoost), and Extreme Gradient Boosting (XGBoost). The experimental results showed that all these ensemble learning methods showed good performance (>94%) on the datasets.

BACKGROUND

In recent years, animal activity recognition has become more popular because of its usability in numerous fields such as health, security, and remote monitoring. Besides, an increased number of IoT-based systems is providing more people to contribute to this field. In the past years, many scientific publications (Arablouei et al., 2021; Alvarenga et al., 2016) suggest that when we get some insight into animal activity patterns, we are in a stronger position to understand an animal's health and wellbeing. Besides, it is desirable to take advantage of tracking the animal's daily routine as a sign of changes in internal or external factors. One approach to monitoring animals is building an IoT system that can gather data and extract information to track animal activities. If the outputs of such an IoT system are localized in areas such as vets and farming, it is quite possible to construct a hypothesis from the daily routine of animals. These hypotheses can be relevant in which environments animals are less stressed, future health problems, and so on. The previous studies on animal activity recognition are given in Table 1.

Generally, animal activity recognition techniques can be categorized under two main groups: sensor-based and vision-based. The *sensor-based technique* (Rahman et al., 2018; den Uijl et al., 2017) uses data gathered by a single or set of IoT sensors placed on an animal body. It has been a fast-growing field because of the benefits of inertial measurement units (IMUs): low-cost, small-size (few mm), light-weight (few grams), ease of programming, and providing reliable information about the body such as force and angular. The *computer vision-based techniques* (Guan et al., 2020; Dandil and Polattimur, 2020; George et al., 2018) use data gathered by a camera placed near the animal. However, there are many problems related to this approach: highly dependent on the light, requiring resolution, limiting the area, high cost, and breaching personal privacy potentially. For this reason, in this study, we carried out the experiments by using a sensor-based approach.