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Animal Repellent System for Smart Farming Using Artificial Intelligence and Deep Learning

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ABSTRACT

Agriculture automation has been on the rise leveraging, among others, Deep Neural Networks (DNN) and IoT for the development and deployment of many controlling, monitoring and tracking applications at a fine-grained level. In this rapidly evolving scenario, managing the relationship with the elements external to the agriculture ecosystem, such as wildlife, is a relevant open issue. One of the main concerns of today farmers is protecting crops from wild animals' attacks. There are different traditional approaches to address this problem which can be lethal (e.g., shooting, trapping) and non-lethal (e.g., scarecrow, chemical repellents, organic substances, mesh, or electric fences). Nevertheless, some of the traditional methods have environmental pollution effects on both humans and ungulates, while others are very expensive with high maintenance costs, with limited reliability and limited effectiveness. In this project, we develop a system, that combines AI Computer Vision using DCNN for detecting and recognizing animal species, and specific ultrasound emission (i.e., different for each species) for repelling them. The edge computing device activates the camera, then executes its DCNN software to identify the target, and if an animal is detected, it sends back a message to the Animal Repelling Module including the type of ultrasound to be generated according to the category of the animal.

Keywords: Animal Recognition, Repellent, Artificial Intelligence, Edge Computing, Animal Detection, Deep Learning, DCNN.

INTRODUCTION

Agriculture has seen many revolutions, whether the domestication of animals and plants a few thousand years ago, the systematic use of crop rotations and other improvements in farming practice a few hundred years ago, or the “green revolution” with systematic breeding and the widespread use of man-made fertilizers and pesticides a few decades ago. Agriculture is undergoing a fourth revolution triggered by the exponentially increasing use of information and communication technology (ICT) in agriculture.

Autonomous, robotic vehicles have been developed for farming purposes, such as mechanical weeding, application of fertilizer, or harvesting of fruits. The development of unmanned aerial vehicles with autonomous flight control, together with the development of lightweight and powerful hyperspectral snapshot cameras that can be used to calculate biomass development and fertilization status of crops, opens the field for sophisticated farm management advice. Moreover, decision-tree models are available now that allow farmers to differentiate between plant diseases based on optical information. Virtual fence technologies allow cattle herd management based on remote-sensing signals and sensors or actuators attached to the livestock. Taken together, these technical improvements constitute a technical revolution that will generate disruptive changes in agricultural practices. This trend holds for farming not only in developed countries but also in developing countries, where deployments in ICT (e.g., use of mobile phones, access to the Internet) are being adopted at a rapid pace and could become the game-changers in the future (e.g., in the form of seasonal drought forecasts, climate-smart agriculture).

LITERATURE SURVEY

The use of passive acoustic monitoring in wildlife ecology has increased dramatically in recent years as researchers take advantage of improvements in autonomous recording units and analytical methods. These technologies have allowed researchers to collect large quantities of acoustic data which must then be processed to extract meaningful information, e.g., target species detections. A persistent issue in acoustic monitoring is the challenge of efficiently automating the detection of species of interest, and deep learning has emerged as a powerful approach to accomplish this task. This article reports on the development and application of a deep convolutional neural network for the automated detection of 14 forest- adapted birds and mammals by classifying spectrogram images generated from short audio clips. This article proposes a multi-step workflow that integrates this neural network to efficiently process large volumes of audio data with a combination of automated detection and human review. This workflow reduces the necessary human effort by 99% compared to full manual review of the data. As an optional component of this workflow, this article proposed a graphical interface for the neural network that can be run through RStudio using the Shiny package, creating a portable and user-friendly way for field biologists and managers to efficiently process audio data and detect these target species close to the point of collection and with minimal delays using consumer-grade computers.[1]

The aim of this project is crop prediction helps the farmers to grow suitable crops depending on the soil parameters by the use of machine learning techniques and it also helps in prevention of the intruders like wild animals into the field.[2] Methodology: The implemented smart agriculture system is cost effective for maximizing agricultural farm water supplies, crop prediction, and wild animal prevention. Depending on the level of soil moisture, the proposed system can be used to turn the water sprinkler on / off, thereby making the process easier to use. The system proposed can be used to predict the crop based on the soil condition which helps the farmer grow the proper crops at proper time .

Through this system it can be inferred that use of IOT and Automation there by achieving significant progress in irrigation. The proposed system is thus a solution to the problems facing in current irrigation cycle. The proposed system also helps in the prevention of trespassing wild animals in the agricultural sector. Using ultrasonic sound, the buzzer irritates wild animals and makes them leave the area. Using the alarm tone flooding techniques which requires less energy In addition to that the device is eco-friendly, because there is no harm to the ecosystem and no disruption to humans.

The aim of this project is efficiently converting video of animals at any length into models capable of making accurate behavioural prediction using Long Short-term Memory (LSTM). A foundational step of any animal is the establishment of an accurate behavioural model. Building a model that is capable of defining and predicting an animal's behaviour is critical to advancing ethological theory and research, however many animal models fail to be sufficiently thorough or often do not exist at all. Great pools of data are available for improving these models through recorded video of animals posted on video hosting sites throughout the internet, however these sources are largely left unused due to their sheer quantity being too much for researchers to manually observe and annotate. This article proposed a pipeline approach for efficiently developing predictive behavioural models using a confluence of machine learning tools. Accuracy in prediction and its significance against a much longer standing time-series analysis statistical model. The results of testing proposed pipeline showed promise in that the LSTM network, trained on the JAABA annotated frames [6]

The language is the most common factor to divide humans and animals. Numerous classification techniques can be used for classification purposes, and the classification commonly can be done acoustically and visually. The classification systems are playing a considerable role, and bioacoustics monitoring was a significant field. Visual classification of animals is done by using either satellite images or established camera images. Nevertheless, due to some circumstances, image processing techniques cannot be applied. Then the acoustical classification techniques are taken place to encounter those problems.

This article presents a method for classifying animal vocalizations using four Siamese networks and dissimilarity spaces. Different clustering techniques taking both a supervised and unsupervised approach were used for dissimilarity space generation. A compact descriptor is obtained by projecting each pattern into the dissimilarity spaces generated by the clustering methods using different numbers of centroids and the outputs of the four Siamese networks. The classification step is performed using a set of SVMs trained from such descriptors and combined by sum rule to obtain a highly competitive ensemble as tested on two datasets of animal vocalizations. In addition, experimental results demonstrated the diversity between the proposed approach and other state-of-the-art approaches can be exploited in an ensemble to further improve classification performance. The fusions improved performance on both audio classification problems, outperforming the standalone approaches.

The aim of this project is the use of TESPAR S-matrices of Teager cepstral coefficients along with some additional features and Random Forest classification algorithm to discriminate between animal species based on their sounds. Methodology: Identification of animals by their sounds is important for biodiversity assessment, especially in detecting and locating animals. Many animals generate sounds either for communication or to accompany their living activities. One of the important tasks when analysing animal sounds is to measure the acoustically relevant features. This article explores the use of a combined Tiger— cepstral—TESPAR (Time Encoded Signal Processing and Recognition) analysis to discriminate between different animal species. Experiments using this approach together with classification techniques shows that TESPAR S-matrices of Tiger cepstral coefficients along with some additional features can be successfully used to discriminate between different animal species, even in the conditions of small training sets.

Agricultural production is an essential element in the development of human civilization. As the number of Taiwan Macaques increases, the original habitats cannot provide enough space and food for these macaques. So, there are many monkeys break in farm fields to obtain food and make significant agricultural damages. To prevent the croplosses, some protection and warning systems need to be deployed to detect and drive away these monkeys. This article presents a IoT-based system to recognize coming monkeys which can be used to warn the farmers and make some noises to drive out the monkeys. Also, the sensing information and images will be sent back to the server for further intelligent analysis. The system is very useful for farmers in Taiwan because the agricultural damages by monkeys become more and more serious. Also, MQTT-based IoT architecture make the system to be extended easily.

The placement of grazing animals in vineyards requires additional support to the animal husbandry activities. Such support must include the monitoring and the conditioning of animal's location behaviour, especially their feeding posture. With such a system, it is possible to allow sheep to graze in cultivated areas (e.g., vineyards, orchards) without endangering them. This article proposes the overall system architecture, from collars, the mobile nodes carried by sheep, up to the cloud platform with different tasks as data analyses, data processing or data storage. The potential of this platform is proven by an important use case of the Sheep IT project, namely the detection of moments where sheep present a posture that could put in risk the vines and grapes. A dataset composed of collar's sensor data was built stored taking advantage of the existing platform and each entry was manually classified. Different ML algorithms were then evaluated in order to assess the platform power. All algorithms showed similar accuracy but the results obtained using DT are especially relevant since, their easier interpretation, helped to the definition of posture control algorithm to be implemented on collars.

The technology plays a central role in our everyday life. There has been a surge in the demand of Internet of Things (IoT) in many sectors, which has drawn significant research attention from both the academia and the industry. In the agriculture sector alone, the deployment of IoT has led to smart farming, precision agriculture, just to mention a few. Crop damage caused by animal attacks is one of the major threats in reducing the crop yield. Due to the expansion of cultivated land into previous wildlife habitat, crop raiding is becoming one of the most conflicts antagonizing human wildlife relationships. This article an integrative approach in the field of Internet of Things for smart Agriculture based on low power devices and open-source systems. The article is to provide a repelling and monitoring system for crop protection against animal attacks and weather conditions. Pattern classification based on deep network outperforms conventional methods in many tasks. However, if the database for training exhibits internal representation that lacks substantial discernibility for different classes, the network is considered that learning is essentially failed. Such failure is evident when the accuracy drops sharply in the experiments performing classification task where the animal sounds are observed similar. To address and remedy the learning problem this article a novel approach was proposed for classifying animal sounds. First of all, 102 species databases composed of 8 anurans, 43 birds, and insects was established by collecting in real environment and web-site for experiment.

The proposed method was composed of feature extraction and classification. For feature extraction, mid-level features extracted by the three individual CNN's each trained for classifying species within a Class were combined. This feature was projected onto the subspace which was estimated by applying LDA for efficient classification and dimension reduction. After that, SVM was applied to the projected features for classification. In experiment, performance of the proposed method was compared in two types of CNN architecture approaches. The proposed method was shown to outperform others in overall accuracy.

SYSTEM IMPLEMENTATION

In this project, deep convolution neural network-based classification algorithm is devised to detect animals both in video and images. Proposed approach is a classification model based on different features and classifiers. The different features like color, gabor and LBP are extracted from the segmented animal images. Possibilities of fusing the features for improving the performance of the classification have also been explored. Classification of animals is accomplished using CNN and symbolic classifiers. Initially, features are extracted from images/frames using blink app pre-trained convolution neural network. Later the extracted features are fed into multi-class CNN classifier for the purpose of classification.CNN is constructed using sequence of layers like Convolutional, subsampling and fully connected Layer.

Overall procedure for animal detection is given below:

1. The image is fetched using the monitoring panel.
2. The fetched image is processed using the python coding.
3. The fetched image is checked for various features of objects that match with any animal of trained data set.
4. Then it detects and classifies the animal which has been captured by the monitoring panel.
5. Algorithm calculates the accuracy in percentage based on number of matched objects.
6. If the accuracy of detected animal is above 45% the alert signal will be sent to the registered user through the SMS Service Provider.

PERFORMANCE ANALYSIS

In this module we able to find the performance of our system using SENSITIVITY, SPECIFICITY AND ACCURACY of Data in the datasets are divided into two classes not animal (the negative class) and animal and type (the positive class). Sensitivity, specificity, and accuracy are calculated using the True positive (TP), true negative (TN), false negative (FN), and false positive (FP). TP is the number of positive cases that are classified as positive. The important points involved with the performance metrics are discussed based on the context of this project: True Positive (TP): There is a Animal and the algorithms detect Animal name. False Positive (FP): There is no Animal, but the algorithms detect as Animal and display Animal name. False Negative (FN): There is a Animal, but the algorithms do not detect Animal and name. True Negative (TN): There is no Animal, and nothing is being detected. Accuracy is a measure that tells whether a model/algorithm is being trained correctly and how it performs. In the context of this thesis, accuracy tells how well it is performing in detecting humans in underwater environment. Accuracy is calculated using the following formula.

Accuracy = (T P + T N)/ (T P + T N + F P + F N)

CONCLUSION

Agricultural farm security is widely needed technology nowadays. In order to accomplish this, a vision-based system is proposed and implemented using Python and OpenCV and developed an Animal Repellent System to blow out the animals. The implementation of the application required the design and development of a complex system for intelligent animal repulsion, which integrates newly developed software components and allows to recognize the presence and species of animals in real time and also to avoid crop damages caused by the animals. Based on the category of the animal detected, the edge computing device executes its DCNN Animal Recognition model to identify the target, and if an animal is detected, it sends back a message to the Animal Repelling Module including the type of ultrasound to be generated according to the category of the animal.

The proposed CNN was evaluated on the created animal database. The overall performances were obtained using different number of training images and test images. The obtained experimental results of the performed experiments show that the proposed CNN gives the best recognition rate for a greater number of input training images (accuracy of about 98 %). This project presented a real-time monitoring solution based on AI technology to address the problems of crop damages against animals. This technology used can help farmers and agronomists in their decision making and management process.

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