CLEAR ROADS AHEAD

AI systems can be trained to identify animals crossing highways in near real time

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1

Five million large animals are killed on Brazilian highways every year, according to the Brazilian Center for Road Ecology

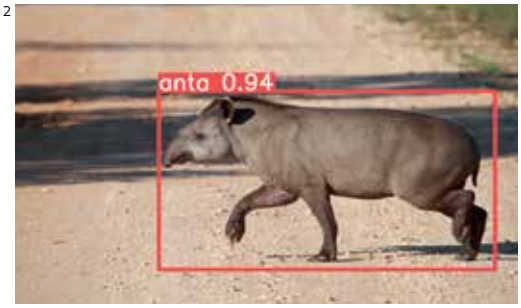
Computer systems that use artificial intelligence (AI) to detect moving objects can be adapted and trained to identify animals crossing Brazilian roads. These adapted AI systems could be installed in roadside devices to issue almost immediate alerts when animals are spotted on highways, in addition to automatically classifying which species are most frequently hit by vehicles.

These are the main findings of a study led by scientists from the São Carlos Institute of Mathematics and Computer Science at the University of São Paulo (ICMC-USP), who analyzed the performance of 14 systems on the basis of the You Only Look Once (YOLO) algorithm, which is used to identify and indicate the locations of specific objects in an image or video (in this case, animals). The study was published in the journal *Scientific Reports* in January.

None of the systems performed perfectly when tasked with analyzing images of five wild animal species they had been trained to recognize: the tapir, jaguarundi (wild cat), maned wolf, cougar, and giant anteater. Some, however, such as Scaled-YOLOv4, achieved an accuracy level of more than 85% in most situations. "Comparative studies are essential to determining the response time needed for these systems to work efficiently on the roads, a scenario that involves high-speed vehicles, and to evaluate the feasibility of their implementation," says computer scientist Rodolfo Meneguette, head of the research group.

The tests were carried out on tiny, simple Raspberry Pi 4 computers, which weigh approximately 50 grams. Because they are so small and inexpensive, this type of device could theoretically be installed on existing roadside devices with a Wi-Fi internet connection. The microcomputer would analyze and classify the images locally, transmitting only its verdict (whether or not there is an animal on the road) to a cloud-based system. The external structure would then trigger a warning almost immediately to drivers traveling on the same stretch of road.

PHOTOS 1 PAULO BAQUETA/GETTY IMAGES 2, 3 AND 4 BRA-DATASET



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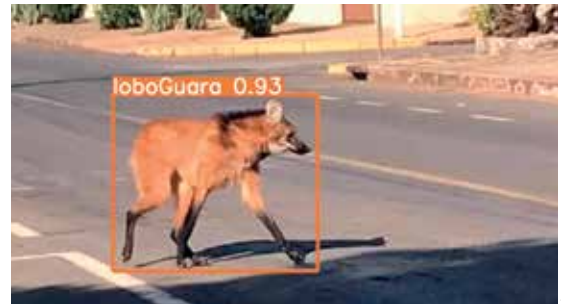

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Screenshots of the outputs of three systems designed to identify and classify wild animals in images

According to estimates by the Brazilian Center for Road Ecology (CBEE), linked to the Federal University of Lavras (UFLA) in Minas Gerais, approximately five million large animals are killed on Brazilian roads every year, including capybaras, jaguars, monkeys, and maned wolves.

To train the YOLO models to recognize these five specific animals, the researchers created a database called the BRA-Dataset, which contains 1,458 images of these species. The database was populated by free online images found via the Google Images search engine. In addition to these online images, the team used videos they recorded themselves at São Carlos Ecological Park to test how quickly the systems could recognize the animals.

The YOLO architecture combines image processing and AI to form convolutional neural networks, which are widely used in the field of computer vision. "This approach allows the machine, when receiving new images or videos, to compare the learned characteristics against predefined classes," explains computer scientist Gabriel Ferrante, lead author of the article, who defended his master's thesis on the topic at ICMC-USP in 2023, supervised by Meneguette.

The neural network divides a still or moving (video) image into smaller parts, sets of pixels (points) that are transformed into numerical data. Through mathematical and probabilistic calculations, these data are used to classify the type of object that appears in the image and its location with a given degree of certainty.

The images accompanying this article show the types of results provided by the YOLO system when looking for animals on roads. Boxes are drawn around the recognized species, which are classified as belonging to one of the five classes the system had learned to recognize. At the end of the process, the name of the animal recognized by the model is shown in the image, followed by a number between 0 and 1. The expression "anta 0.90," for example, means that the system is 90% certain that the object identified in the image belongs to the anteater class.

"We tested different models based on the YOLO architecture to try to see if one could be ideal for specific contexts," explains computer scientist Luís Nakamura of the Federal Institute of São Paulo (IFSP) Catanduva campus, coauthor of the article. Despite being trained, the systems were inaccurate at distinguishing animals in more challenging scenarios, such as when the animals were hidden by other objects, camouflaged in the landscape, or very far from the camera.

"To understand the pixel patterns in an image, convolutional neural networks scan parts of it in sequence," explains Ferrante. "If the environment interferes with the recognition of important visual characteristics, such as edges, textures, and colors, the software has difficulty classifying and defining the area of a possible object."

Systems designed to analyze images taken in daylight are not suitable for night surveillance or low-visibility conditions. In these cases, the use of infrared cameras that are capable of "seeing" in the dark could serve as an alternative. This approach, however, was not tested in the present study.

Data scientist Alexandre de Siqueira, who was not involved in the research, believes that future studies could expand the number of animal species included in the database used to train the systems. "If this technology were installed in static cameras, it could even be used to observe species migrating between different regions of the country, for example," says Siqueira, who worked at the Berkeley Institute for Data Science (BIDS) at the University of California between 2019 and 2022. "It is also important to test networks with models other than YOLO to assess which is the fastest or cheapest, depending on the purpose of the application." ■

The research project and scientific article consulted for this report are cited in the online version.