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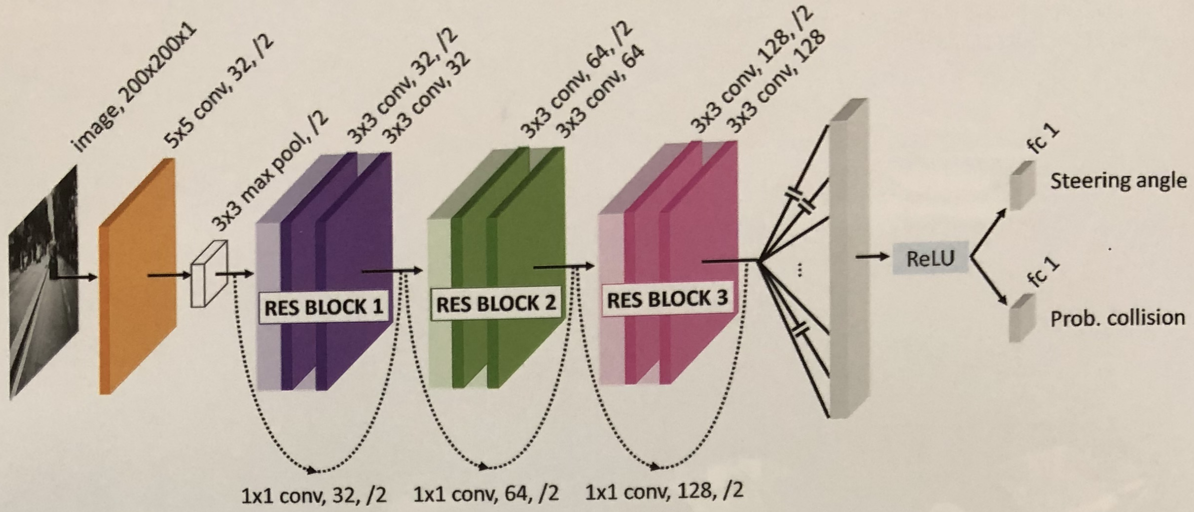
The DroNet collision avoidance neural network



UAV highway safety code

Airborne vehicles

Researchers at the University of Zurich and at the National Centre of Competence in Research (NCCR) Robotics have developed an algorithm to enable a UAV to fly through a city's streets while avoiding road vehicles and other objects (writes Rory Jackson).

"The DroNet algorithm takes a single image as an input," Antonio Loquercio from the university explained. "The resolution and detail requirements aren't very high – a greyscale image measuring 200 x 200 pixels is enough.

"This image then passes to a convolutional neural network. It's a very small network, very different from the types you see for image classification. It was designed to make inferences as fast as possible; it's much simpler than others in its field," he said.

The algorithm then converts input images into two high-level commands: a steering angle that determines the heading of the UAV, and a collision probability to determine its velocity. When this collision probability is high, the UAV slows down or stops; when it is low, the UAV speeds up.

"When the system recognises a significant open space in front of the UAV, the collision probability output is low," Loquercio said. "It's high though when something increasingly covers its field of view. We didn't engineer this ability directly with 3D information, recognition of depth or anything – we just pass an image to it."

> It's a very small network, very different from the types for image classification, and it's much simpler than others in its field

To develop the convolutional network, the team used the TensorFlow open-source software library (implemented in Python and C++) for the learning segment of development. Then it used the Robotic Operating System language to program the neural network to communicate with the Parrot Bebop 2 UAV used in testing and to compute the velocity and attitude commands.

The initial dataset used data from cars to enable the UAV to learn how to behave according to basic traffic rules such as staying on the road and avoiding vehicles, people and obstacles. The team also collected a custom dataset from bicycles consisting of outdoor collision sequences, to better help the UAV to anticipate potentially dangerous situations.

The approach to designing the algorithm was centred on producing as general and flexible an approach as possible, as previous approaches were deemed too demanding. For example, reinforcement learning-based and supervised learning algorithms require vast amounts of data, which can be expensive or hazardous to collect.

"Our neural network does not require a GPU or other expensive or power-hungry processor," Loquercio said. "We wanted to avoid such heavy hardware requirements and opt for something that can be executed simply and quickly.

"This approach can also be applied to UGVs that need to navigate in congested or obstacle-prone environments, including indoors."