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Non-intrusive Hand Control of Drone Using an Inexpensive and Streamlined Convolutional Neural Network Approach

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Abstract : The purpose of this work is to develop a method for classifying hand signals and using the output in a drone control algorithm. To achieve this, methods based on Convolutional Neural Networks (CNN) were applied. CNN's are a subset of deep learning, which allows grid-like inputs to be processed and passed through a neural network to be trained for classification. This type of neural network allows for classification via imaging, which is less intrusive than previous methods using biosensors, such as EMG sensors. Classification CNN's operate purely from the pixel values in an image; therefore they can be used without additional exteroceptive sensors. A development bench was constructed using a desktop computer connected to a high-definition webcam mounted on a scissor arm. This allowed the camera to be pointed downwards at the desk to provide a constant solid background for the dataset and a clear detection area for the user. A MATLAB script was created to automate dataset image capture at the development bench and save the images to the desktop. This allowed the user to create their own dataset of 12,000 images within three hours. These images were evenly distributed among seven classes. The defined classes include forward, backward, left, right, idle, and land. The drone has a popular flip function which was also included as an additional class. To simplify control, the corresponding hand signals chosen were the numerical hand signs for one through five for movements, a fist for land, and the universal “ok” sign for the flip command. Transfer learning with PyTorch (Python) was performed using a pre-trained 18-layer residual learning network (ResNet-18) to retrain the network for custom classification. An algorithm was created to interpret the classification and send encoded messages to a Ryze Tello drone over its 2.4 GHz Wi-Fi connection. The drone’s movements were performed in half-meter distance increments at a constant speed. When combined with the drone control algorithm, the classification performed as desired with negligible latency when compared to the delay in the drone’s movement commands.

Keywords : classification, computer vision, convolutional neural networks, drone control
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