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Sébastien Villon[c,a], David Mouillot[c] , Marc Chaumont[b,a], Emily Darling[d], Gérard Subsol[a], Thomas Claverie[c,e] ,Sébastien Villéger[c]

sebastien.villon@lirmm.fr

a LIRMM, University of Montpellier/CNRS, France
b University of Nîmes, France
c MARBEC, IRD/Ifremer/University of Montpellier/CNRS, France
d WCS World Life Conservation Society, New-York, U.S.A.
e CUFR Mayotte, France

One of the current challenges of marine ecology is to monitor biodiversity accurately and efficiently at large spatial scale and at high frequency. Therefore, underwater surveys based on video are increasingly used as an alternative to reef fish count by divers. However, analyzing videos imped the process of fast quantification because it remains time-consuming. There is thus an urgent need for automatic identification of coral reef fish species in underwater images. We designed a convolutional neural network and trained it using a learning database containing more than 90,000 fish images of 20 different common species on Mayotte coral reef. In experiments based on more than 4,400 test images from different acquisition campaigns, this algorithm reached 94% of accurate recognition. In particular, the algorithm was able to recognize a fish even when it was partially hidden behind corals or other fish. We also tested the effectiveness of our algorithm by comparing it to human specialists in terms of speed and correct identification. The algorithm outperforms human experts by more than 5% (95.7% against 89.3%) and it was around 100 times faster than human (processing an image in 0.06 seconds).