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MEASUREMENT SYSTEM OF MYOTUBE MORPHOLOGICAL PARAMETERS FOR SPACE LIFE EXPERIMENT MISSION ABOUT MUSCLE ATROPHY IN ASTRONAUTS

Abstract

In long-term space life, muscle atrophy in astronauts has still confused us, which may be caused by microgravity, space radiation or other unknown factors. Therefore, a space life experiment will be carried out by Shanghai Engineering Center for Microsatellites (SECM) to explore the underlying molecular mechanisms of space muscle atrophy via cultured muscle stem cells and the differentiated myotubes. In this model, detecting morphological parameters of myotubes is widely used for evaluating the severity of muscle astropy. However, it is hard to perform the measurement precisely with bright-field microscopy images, which is the most common way to monitor the muscle differentiation process and the extend of muscle astrophy. In these images, many myotubes are minute and similar to the backgrounds. Moreover, many myotubes are overlapping with each other and it is difficult to distinguish one myotube from others. To our knowledge, existing myotube morphological measurement is carried out manually by scientists via software, such as Image-Pro Plus. It highly depends on the experience of operators, which can not be implemented in the space environment. In this paper, we present an automatic myotube morphological parameter measurement system, which can measure the area, the width and the length of myotubes. Due to the complexity of myotube images, the deep learning method is adapted to achieve the high accuracy instance-aware segmentation. We adopt U-net deep learning framework to segment myotube images and then extract contours of myotubes to measure the morphological parameters based on curvature analysis. Using a few of manually-annotated fluorescent images for pre-training and 400 manually-annotated microscopy images for training, the neural network can generate high accuracy myotube segmentation masks that allow us to analyze the morphology of myotubes. The number of pixels in each segmentation mask is regarded as the myotube area. And then, we detect the cytoskeleton based on the curvatures of each segmentation mask contour to compute the myotube width and length. Comparing with the manual measurement, our approach is more objective and saves a lot of time.