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LSBGnet: Detection for LSBGs and UDGs using deep learning.

Detecting and characterizing low-surface brightness galaxies (LSBGs) and ultra-diffuse galaxies (UDGs) is known to be challenging due to their faint surface brightness, posing a significant hurdle for traditional detection methods. Recently, artificial neural networks proven to have a powerful learning ability, which can learn the features of the object from the image and complete classification or parameter regression tasks. Thus, artificial neural networks have been increasingly applied in astronomy field to handle the rising volume and complexity of photometric image. Object detection algorithms, one of the branches of computer vision, have greater capabilities than traditional classification and regression algorithms. Thus, it can accomplish large-scale galaxy detection tasks. In this work, we propose LSBGnet framework, a deep neural network specifically designed for automatic detection of LSBGs and UDGs. First, we use the images from Sloan Digital Sky Survey (SDSS) to train and test the model. The performance of the LSBGnet-SDSS model is outstanding in this work, and the recall and precision of LSBGnet model is more than 97% on the test set. Then, we select Dark Energy Survey (DES) sample to test the performance of the LSBGnet and the model achieved more than 97.5% recall and precision. Those result show that our LSBGnet model can accurately detect LSBGs from photometric images. Given the excellent performance of LSBGnet, we decided to use it for large-scale detection for UDG, a subset of LSBG, on KIDS DR5 (Kilo Degree Survey Data Release 5). We built the LSBGnet-KiDS model using the LSBGnet framework with iterative detection method. We utilize the LSBGnet-KiDS model to detect for UDGs from all photometric images of KiDS DR5 and obtained 966 UDG candidates. In this process, we successfully completed a large-scale detection for UDGs without using known UDG samples. When faced with a large-scale specific object detection task and the number of samples is not enough to build a model, we can utilize this method handle it. It also provides an effective approach to detection for specific objects for the upcoming surveys.

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