

MT4ImgRec: A Metamorphic Testing Tool for Image Recognition Software

Dongyu Cao^①, Hongjing Guo^①, Chuanqi Tao^{①②}

① College of Computer Science and Technology, Nanjing University of Aeronautics and Astronautics, Nanjing, China

② Ministry Key Laboratory for Safety-Critical Software Development and Verification, Nanjing University of Aeronautics and Astronautics, Nanjing, China

Correspondence to: taochuanqi@nuaa.edu.cn

Abstract—Although data-driven image recognition software has widely emerged in various fields, they suffer from quality issues. Metamorphic testing has been successfully applied to AI software for alleviating test oracle problems. Nevertheless, metamorphic testing still relies on manual methods in most cases, which is time-consuming. To improve test efficiency, a testing tool called MT4ImgRec is designed to automatically perform metamorphic testing for image recognition software.

Keywords—metamorphic testing; image recognition testing; tool

I. INTRODUCTION

The major challenge in testing image recognition software lies in the lack of a test oracle, which checks the correctness of the test execution [1]. Metamorphic testing is an effective manner that generates new test cases using the MRs (Metamorphic Relations) and determines whether the test passes by verifying whether the MRs are met [2]. However, metamorphic testing is mostly performed manually. Thus, this paper implemented MT4ImgRec, a testing tool of image recognition software using metamorphic testing, which reduces the expenses in the test and enhances the test efficiency.

II. FUNCTION MODULES

MT4ImgRec consists of five modules. Figure 1 shows the interface of MT4ImgRec. The current version could be found in <https://github.com/Miracy/MT4ImgRec>.

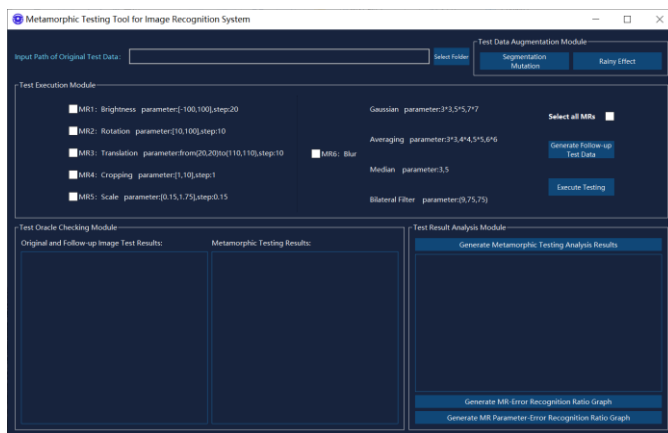


Figure 1. Interface of MT4ImgRec

A. Original Test Data Management Module

After receiving the path of the test case folder, the module checks the original test cases for format and validity one by one. If passing the inspection, its file information is recorded.

B. Test Data Augmentation Module

The test data augmentation module aims to amplify the

original test data by using segmentation mutation and adding the rainy effect. Segmentation mutation is realized by a YOLACT algorithm [3], which can quickly detect and divide the part of the target object of an image. Adding rainy effect is achieved by generating different densities of random noise, and elongating and rotating them.

C. Test Execution Module

For the original test data after amplification, the corresponding MRs are selected to automatically generate follow-up test data. MT4ImgRec implements six MRs for the image recognition software, including brightness, rotation, translation, cropping, scale, and blurring (averaging, gaussian, median, and bilateral). After generating follow-up test data, MT4ImgRec runs the program with a pair of test inputs (the original image and follow-up image) and records the output recognition result for each image.

D. Test Oracle Checking Module

The test oracle checking module judges the metamorphic test results by comparing the execution results of the original and follow-up test data. If two results are consistent, the metamorphic test result is displayed as passed, and the converse is not passed.

E. Test Result Analysis Module

The test result analysis module sorts and analyzes the test results. Different MRs and the number of test error cases of each parameter will be displayed. This tool also visualizes test results by using bar charts, including every MR-error recognition ratio and every parameter of MR-error recognition ratio.

III. CONCLUSION

MT4ImgRec is designed to test image recognition software using metamorphic testing, which can automate repetitive testing activities to enhance test efficiency. In the future, we will develop the testing tool for other intelligent software.

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