



第十四届全国大学生软件创新大赛

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落笔云烟

Magpie's Pen

项目测试文档

Version: V2.2.0



花生队

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目录

| | | |
|----------|-------------|----------|
| 1 | 测试计划 | 1 |
| 1.1 | 测试策略与目标 | 1 |
| 1.2 | 测试范围 | 2 |
| 1.3 | 测试环境 | 3 |
| 2 | 单元测试 | 4 |
| 2.1 | 单字识别与分割功能 | 4 |
| 2.1.1 | 测试用例与结果分析 | 4 |
| 2.1.2 | 测试结果综合分析及建议 | 4 |
| 2.1.3 | 测试经验总结 | 4 |
| 2.2 | 文字骨架分析模块 | 5 |
| 2.2.1 | 测试用例与结果分析 | 5 |
| 2.2.2 | 测试结果综合分析及建议 | 5 |
| 2.2.3 | 测试经验总结 | 5 |
| 3 | 功能测试 | 6 |
| 3.1 | 书写整体评测 | 6 |
| 3.1.1 | 测试用例与结果分析 | 6 |
| 3.1.2 | 测试结果综合分析及建议 | 6 |
| 3.1.3 | 测试经验总结 | 6 |
| 4 | 系统测试 | 8 |
| 4.1 | 模型性能测试 | 8 |
| 4.1.1 | 测试用例与结果分析 | 8 |
| 4.1.2 | 测试结果综合分析及建议 | 10 |
| 4.1.3 | 测试经验总结 | 10 |

文档修订历史

| 序号 | 修订原因 | 版本号 | 作者 | 修订日期 | 备注 |
|----|----------|---------|----|------------|--------|
| 1 | 创建引言模块 | V1.0.0 | A | 2020.11.13 | |
| 2 | 更新引言模块 | V1.0.1 | D | 2020.11.15 | |
| 3 | 创建测试计划模块 | V1.1.0 | D | 2020.11.20 | |
| 4 | 更新测试计划模块 | V1.1.1 | D | 2020.12.20 | |
| 5 | 创建单元测试模块 | V2.0.0 | D | 2021.1.20 | |
| 6 | 更新单元测试模块 | V2.0.1 | D | 2021.2.1 | |
| 7 | 创建功能测试模块 | V2.1.0. | D | 2021.2.18 | |
| 8 | 更新功能测试模块 | V2.1.1 | D | 2021.3.15 | 添加测试用例 |
| 9 | 更新功能测试模块 | V2.1.2 | D | 2021.3.27 | 更新具体步骤 |
| 10 | 文档核对 | V2.2.0 | B | 2021.4.2 | |
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1 测试计划

1.1 测试策略与目标

测试策略:

| 测试层面 | 测试对象 | 测试重点 | 测试难点 | 测试方法 | 备注 |
|------|-----------------------------|--|------------------------------|-----------|------------------|
| 数据层 | 对数据库操作 | 数据库操作是否快速准确, 数据库操作本身是否符合事务特征。数据库是否有被注入风险 | 数据库的注入风险要覆盖数据库与控制器的所有接口、所有情形 | 动态测试 | 对常见针对数据库攻击类型进行测试 |
| | 后台控制器中的数据 | 数据是否符合范围要求, 进制是否正确, 是否会造成数据异常 | 数据操作要考虑尽可能多的异常情况 | 静态测试 黑盒测试 | |
| | 逻辑层的静态数据 | 静态数据要符合范围性质要求 | 分析静态数据要结合控制逻辑 | 静态测试 | |
| | 内部接口 | 内部接口是否符合接口规范, 接口异常处理 | 接口异常处理 | 动态测试 | |
| | 中间件 MediumWare (Laravel) | Flask 中间件接口是否满足功能要求 | 框架封装、与框架耦合性太强 | 黑盒测试 | |
| 逻辑层 | 内部接口 | 所有必填参数情况+所有选填参数情 | 部分(登录)接口状态不对 | 动态测试 | |

| | | | | | |
|-----|---------|-------------------|--------------|-----------|------------|
| | | 况测试、稳定性测试 | 测试者开放 | | |
| | 后台控制函数 | | | | |
| | 异常处理 | 可能的控制逻辑异常进行测试 | 异常类型复杂 | 动态测试 | |
| | 安全性 | 控住逻辑的完整性、用户信息的加密等 | 存在的安全隐患可能很复杂 | 静态测试 动态测试 | 注意安全性和隐私保护 |
| 用户层 | 前端界面 | 前端界面信息完整性、美观协调 | 界面细节比较多 | 动态测试 | |
| | 功能操作 | 操作符合用户习惯、步骤简洁 | 了解特定用户习惯 | 动态测试 | |
| | 异常提示 | 各种异常的肯情况前端提示结果 | | 动态测试 | |
| | 跨浏览器兼容性 | 在不同的浏览器所有功能正常使用 | | 动态测试 | |

目标：软件发布时的质量等级为 RC2

1.2 测试范围

测试范围示意表：

| 类别 | 测试广度 | 测试深度 |
|----|-------|-------------------|
| 前端 | 链接测试 | 覆盖每一个前端链接 |
| | 内容测试 | 检查内容是否符合隐私安全和美观协调 |
| | 浏览器测试 | 在不同的浏览器中运行，测试兼容性 |
| | 可用性测试 | 测试每一个使用单元，检查可用性 |
| 后台 | 安全测试 | 后台逻辑无漏洞、接口规范无隐患 |

| | | |
|-----|-------|-----------------------|
| 数据库 | 功能测试 | 功能是否可用、是否易用、是否达到开发时需求 |
| | 系统测试 | 整体系统架构是否兼容，模块功能之间不冲突 |
| | 并发测试 | 高数量请求下各部分系统的稳定性 |
| | 安全性测试 | 接口传输加密、敏感数据存储形式加密 |
| | 稳定性测试 | 在高并发状态下数据库的稳定性和准确性 |

1.3 测试环境

硬件环境:

| 硬件环境 | 处理器 | Memory | Storage | 基准频率 | RAID |
|-----------------------------------|-----|--------|---------|------|------|
| 硬件设备 1 (HUAWEI) | | 6GB | 128GB | | 1 |
| 硬件设备 2 (OPPO reno5 pro+) | | 12GB | 256GB | | 0 |

软件环境:

| | |
|------|---|
| 系统环境 | Android 10.0 |
| 应用环境 | 后端框架: Flask 数据库: mongodb 前端代理服务器: Nginx 任务调度: celery |

网络环境:

1. 100M 带宽
2. 下载均值 10.53 Mbps
3. 上载均值 1.80 Mbps

数据准备:

1. 中科大手写汉字数据集 CASIA-HWDB
2. 哈工大手写识别数据集 HIT-OR3C
3. 北邮脱机手写汉字数据集 HCL2000

测试工具:

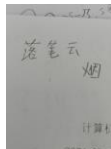
1. PHPUnit
2. Jmeter

2 单元测试

2.1 单字识别与分割功能

2.1.1 测试用例与结果分析

测试用例：

| | | | | |
|----------|---|---|------|----|
| 用例编号 | 001 | | | |
| 功能描述 | 识别出图像中手写的字，减少干扰因素的影响 | | | |
| 用例目的 | 测试识别分割功能是否正确运行 | | | |
| 前提条件 | 整体图像预处理生成的新图像文件 | | | |
| 特殊的规程说明 | 图像大小小于 20MB | | | |
| 用例间的依赖关系 | 无依赖关系 | | | |
| 具体步骤 | 输入 | 期望结果 | 实际结果 | 备注 |
| 1 |  | 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| | |

测试结果分析:

输入图像后，识别模型能准确地识别出图中文字以及其所在位置，所返回结果与预期一致。

2.1.2 测试结果综合分析及建议

综合多次实验结果，可以发现文字检测算法行为稳定，效果良好。在实际应用中，推荐对图像首先进行降噪处理，以提高算法准确性。

2.1.3 测试经验总结

在对单字识别与分割功能测试时，需要准备不同纸质与不同书写风格的输入，以此检测算法鲁棒性：对分割后的图像应再次输出，观察定位是否准确。

2.2 文字骨架分析模块

2.2.1 测试用例与结果分析

测试用例:

| | | | | |
|----------|---|--|---------|-----|
| 用例编号 | 002 | | | |
| 功能描述 | 识别出文字骨架，为用户书写评分 | | | |
| 用例目的 | 测试文字骨架识别模型是否正确运行 | | | |
| 前提条件 | ① 用户提供正确的文字图像 ② 单字图像分割完毕 | | | |
| 特殊的规程说明 | 无特殊说明 | | | |
| 用例间的依赖关系 | 无依赖关系 | | | |
| 具体步骤 | 输入 | 期望结果 | 实际结果 | 备注 |
| 1 |  |  | 与期望结果相同 | |
| 2 |  |  | 与期望结果相同 | |
| ... | ... | ... | ... | ... |

测试结果分析:

经多次测试，输入文字后，模型能够准确的分析出该文字的骨架，并在前端返回文字笔画，返回结果正确。

2.2.2 测试结果综合分析及建议

基于文字识别与分割的结果，文字骨架模型运行稳定，输出正确。

2.2.3 测试经验总结

该模型在实际使用中展现了强大的鲁棒性，针对特殊数据也能保证稳定运行。

3 功能测试

3.1 书写整体评测

3.1.1 测试用例与结果分析

测试用例:

| 用例编号 | 001 | | | |
|----------|---|--|---------|-----|
| 功能描述 | 对用户上传的文字图像, 进行文字识别分割后, 对每个字体书写进行评价 | | | |
| 用例目的 | 测试书写评测功能流程是否通畅 | | | |
| 前提条件 | 整体图像预处理生成的新图像文件 | | | |
| 特殊的规程说明 | 图像大小小于 20MB | | | |
| 用例间的依赖关系 | 无依赖关系 | | | |
| 具体步骤 | 输入 | 期望结果 | 实际结果 | 备注 |
| 1 |  |  | 与期望结果相同 | |
| ... | ... | ... | ... | ... |

测试结果分析:

整个测试结果良好: 落笔云烟应用在收到用户文字图像后, 依据设定流程, 对文字进行定位与分割, 接着对于分割好的文字, 正确的展示其骨架结构, 为评分提供依据。

3.1.2 测试结果综合分析及建议

从结果上看, 落笔云烟各部分功能配合良好, 鲁棒性强。不过在测试中也存在这一些问题, 如用户字体书写过近会导致文字切割不精确。接下来的工作是对分割精度进行更细化的优化。

3.1.3 测试经验总结

对于测试集的选择，应尽可能覆盖各种情况，比如控制文字间距；同时测试手写体文字与印刷体文字；以及有意使用无法识别的文字，以此判断应用在不同场合下的表现。

4 系统测试

4.1 模型性能测试

4.1.1 测试用例与结果分析

预期性能指标测试用例 1:

| 用例编号 | 001 | | | |
|----------|---|----------------------|---------------------------|---------------------------|
| 性能描述 | 验证汉字骨架识别模型性能 | | | |
| 用例目的 | 识别出汉字的骨架，考察识别的性能 | | | |
| 前提条件 | CPU: Intel Core i5 及以上 | | | |
| 特殊的规程说明 | OCR 识别出汉字 ID 与裁剪后汉字图片 | | | |
| 用例间的依赖关系 | 依赖于 OCR 的输出结果 | | | |
| 具体步骤 | 输入/动作 | 期望的性能 (平均值) | 实际的性能 (平均值) | 备注 |
| 1 | {汉字 id, 裁剪后汉字 图片, (云端处理) Ocr 坐标数 据} | 4s (CPU) 1s (GPU) | 3.2s (CPU) 0.82s (GPU) | 识别出汉字的 热力图与笔画 方向 |
| 2 | {汉字 id, 裁剪后汉字 图片, (AIUnit 处 理)Ocr 坐标 数据} | 4s (CPU) 1s (GPU) | 2.7s (CPU) 0.5s (GPU) | 更迅速识别出 汉字的热力图 与笔画方向 |

测试结果分析:

对照界面规范和界面表，根据创新性设计要求，检查所得各界面设计符合规范，功能实现与功能描述协调一致，便于操作且稳定，且推测时间性能满足期望要求。

预期性能指标测试用例 2:

| | | | | |
|---------|------------------------|--|--|--|
| 用例编号 | 002 | | | |
| 性能描述 | 基于惯性矩的字体结构检测评分算法 | | | |
| 用例目的 | 考察算法性能 | | | |
| 前提条件 | CPU: Intel Core i5 及以上 | | | |
| 特殊的规程说明 | 无 | | | |
| 用例间的依赖关 | 依赖于骨架识别模型的结果 | | | |

| 系 | | | | |
|------|------------------------------|----------------|----------------|----|
| 具体步骤 | 输入/动作 | 期望的性能 (平均值) | 实际的性能 (平均值) | 备注 |
| 1 | {裁剪后汉字 图片, 汉字骨架数 据} | 1s (CPU) | 0.74s (CPU) | 无 |

测试结果分析:

对照界面规范和界面表, 根据创新性设计要求, 检查所得各界面设计符合规范, 功能实现与功能描述协调一致, 便于操作且稳定, 且推测时间性能满足期望要求。

预期性能指标测试用例 3:

| 用例编号 | 003 | | | |
|----------|------------------------|----------------|----------------|---------------------------|
| 性能描述 | 汉字练习每日推荐模块 | | | |
| 用例目的 | 考察模型性能 | | | |
| 前提条件 | CPU: Intel Core i5 及以上 | | | |
| 特殊的规程说明 | 无 | | | |
| 用例间的依赖关系 | 依赖于汉字识别模块的结果 | | | |
| 具体步骤 | 输入/动作 | 期望的性能 (平均值) | 实际的性能 (平均值) | 备注 |
| 1 | {用户 token} | 1s (CPU) | 0.32s | 通过用户练习内容以及阅读文章内容解决用户冷启动问题 |

测试结果分析:

对照界面规范和界面表, 根据创新性设计要求, 检查所得各界面设计符合规范, 功能实现与功能描述协调一致, 便于操作且稳定, 且推测时间性能满足期望要求。

预期性能指标测试用例 4:

| 用例编号 | 004 | | | |
|----------|------------------------|----------------|----------------|--------|
| 性能描述 | 手写汉字对齐模型 | | | |
| 用例目的 | 考察模型的性能 | | | |
| 前提条件 | CPU: Intel Core i5 及以上 | | | |
| 特殊的规程说明 | 无 | | | |
| 用例间的依赖关系 | 依赖于汉字骨架识别模型的结果 | | | |
| 具体步骤 | 输入/动作 | 期望的性能 (平均值) | 实际的性能 (平均值) | 备注 |
| 1 | {汉字 id, | 1s | 0.58s | 可以正确识别 |

| | | | | |
|--|------------------------|--|--|-----------------------|
| | 裁剪后汉字 图片, 标准字图片} | | | 出汉字中心位 置并置热力权 重 |
|--|------------------------|--|--|-----------------------|

测试结果分析:

对照界面规范和界面表, 根据创新性设计要求, 检查所得各界面设计符合规范, 功能实现与功能描述协调一致, 便于操作且稳定, 且推测时间性能满足期望要求。

4.1.2 测试结果综合分析及建议

整体而言, 测试结果符合与其要求。其中以汉字骨架模型为核心的周围算法运行时间均较为迅速; 汉字骨架识别模型运行速度主要取决于云侧算力, 通过引入 AIUnit 端侧算力支持, 可以一定程度上缓解云端的 Ocr 压力。

4.1.3 测试经验总结

为了使得测试结果更科学、准确, 测试用例的选择应当从多个角度进行采样, 取其中代表性强的用例的测试作为结果, 进行分析。