

基于区域匹配的 图片阴影检测与去除

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基本介绍

- ▶ 基于图片区域之间材质匹配，实现图像阴影检测与去除方法。
- ▶ 在阴影检测方面达到了无需训练，即可直接检测，并一定程度上保证相似区域一致性的效果；
- ▶ 在阴影去除方面，可以最小化去除阴影操作对阴影区域的其他无关等特征的影响。

区域匹配计算

- ▶ 计算两个区域 S_i, S_j 之间的差异性；
- ▶ 特征提取：梯度特征、纹理特征、区域间距离；
- ▶ 差异计算：

$$D_{i,j} = D_{gradient_{i,j}} + D_{texture_{i,j}} + D_{distance_{i,j}} \quad (1)$$

阴影检测

- ▶ 特征选取：YCbCr色彩空间的Y通道信息、HSI色彩空间信息；
- ▶ 基本思路：利用每个区域的特征与匹配区域间的制约关系进行阴影检测。

$$Rx, y = \frac{H_e(x, y)}{I_e(x, y)} \quad (2)$$

变量准备

- 使用 mean shift[4] 算法对图像进行分割，每个区域记为 S_i ，中心为 C_i ，总计 n 块区域；
- 根据 Eq(1)，计算 S_i, S_j 之间差异 $D_{i,j}$ 为每个区域计算出相似度最高的对应区域，记为 $Near_i$ 。同时记录区域 i 是否为阴影的信息 $label_i$ ，初始化为 1；
- 对全部 $R_i, 1 < i < n$ ，使用 kmeans 聚类计算出两个中心 C_{shadow}, C_{lit} ，分别代表是否为阴影区域的特征中心。假设特征 R 服从正态分布，计算出 C_{shadow}, C_{lit} 对应的标准差 Std_{shadow}, Std_{lit} 。因此对于每个 R_i ，可以计算出分别属于 C_{shadow}, C_{lit} 的置信度 F_{shadow}, F_{lit} ；
- 对每个区域 S_i ， $Refuse_i$ 代表是否因为其他区域而被禁止称为阴影区域，初始化为 0。

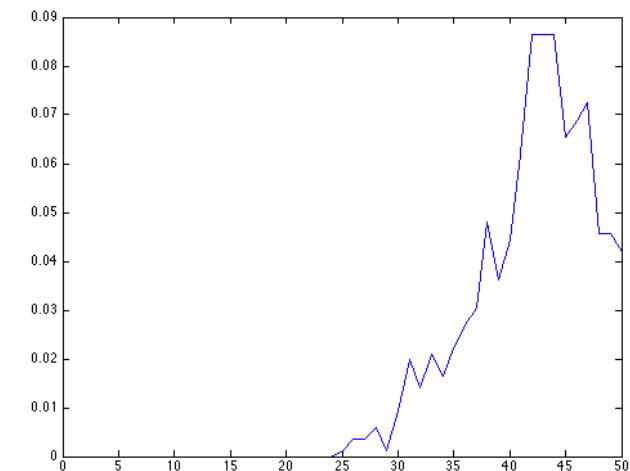
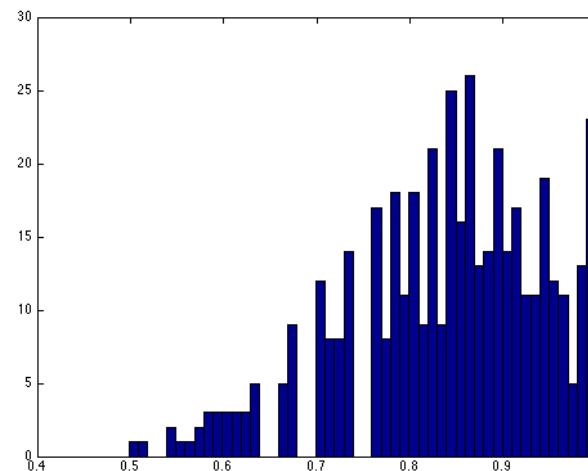
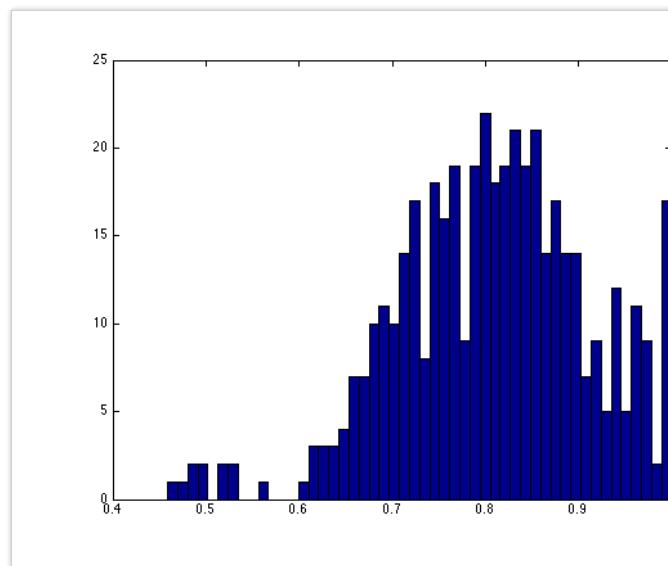
算法设计

- 1) 提取特征 Y_i, R_i , 准备相关变量;
- 2) 若 $Y_i < 60\% * \text{mean}(Y_{image})$, 则 $\text{label}_i = \text{shadow}$;
- 3) 选取 F_{shadow} 最大且 $\text{Refuse}_i = 0$ 的区域 S_i , 设置 $\text{label}_i = \text{shadow}$;
- 4) 记 S_i 最近区域 Near_i 为 S_j , 通过比较 R_i, R_j , 检查 S_i 与 S_j 是否为光亮相反区域, 如果是, 判断 $\text{Refuse}_j = 1$;
- 5) 反复迭代执行步骤 3)-4), 直到不再有更新发生;
- 6) 对于 $\text{label}_i = \text{shadow}$ 的 S_i , 通过比较 Y_i, Y_j, R_i, R_j , 如果判断 S_i 与 S_j 光亮类似, 且 $\text{Refuse}_j = 0$, 设置 $\text{label}_j = 0$ 。

阴影去除

- ▶ 在 HSV 色彩空间进行；
- ▶ 基本思路：对于阴影区域 S_i ，找到匹配的最相似区域 S_j ，满足 $label_j = 1$ 且 D_{ij} 最小。因此 S_j 为与 S_i 最相似的非阴影区域。使用 S_j 来对 S_i 进行调整，通过直方图匹配算法，去掉 S_i 上的阴影。

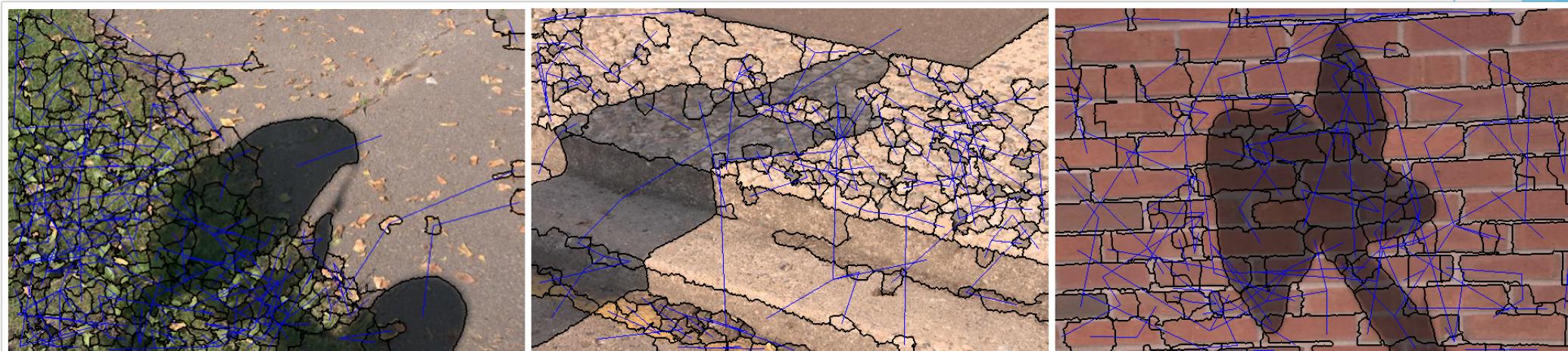
直方图匹配



算法设计

- 1) 计算出阴影检测结果 $label$, 同时将图像转换到 HSV 空间上;
- 2) 对每个阴影区域 S_i 重复 3)-5) 步骤;
- 3) 对区域 S_i , 找到 S_j 满足 $label_j = 1$ 且 $D_{i,j}$ 最小, 使用 S_j 亮化 S_i ;
- 4) 对于 HSV 色彩空间的每个通道 H, S, I , 计算 S_j 的直方图 $Hist_{H,j}, Hist_{S,j}, Hist_{I,j}$;
- 5) 以 $Hist_{H,j}, Hist_{S,j}, Hist_{I,j}$ 为直方图匹配的模板, 调整 S_i 的三个特征, 使得特征分布与模板靠近;
- 6) 将图片转换到 RGB 空间上;
- 7) 计算图片中的全部阴影区域与非阴影区域的交汇边界, 之后对全部边界进行高斯平滑。

区域匹配实验



阴影检测实验



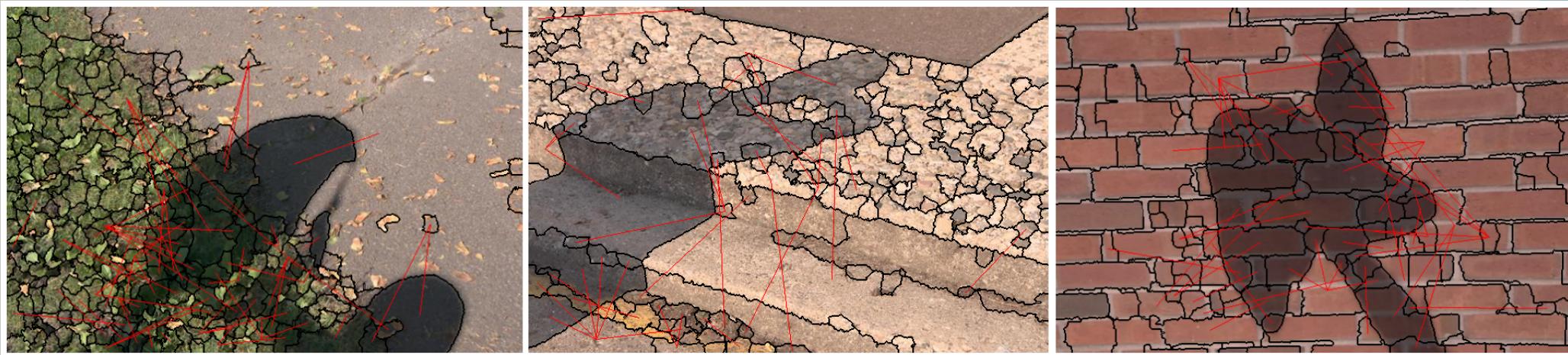
原图

检测结果

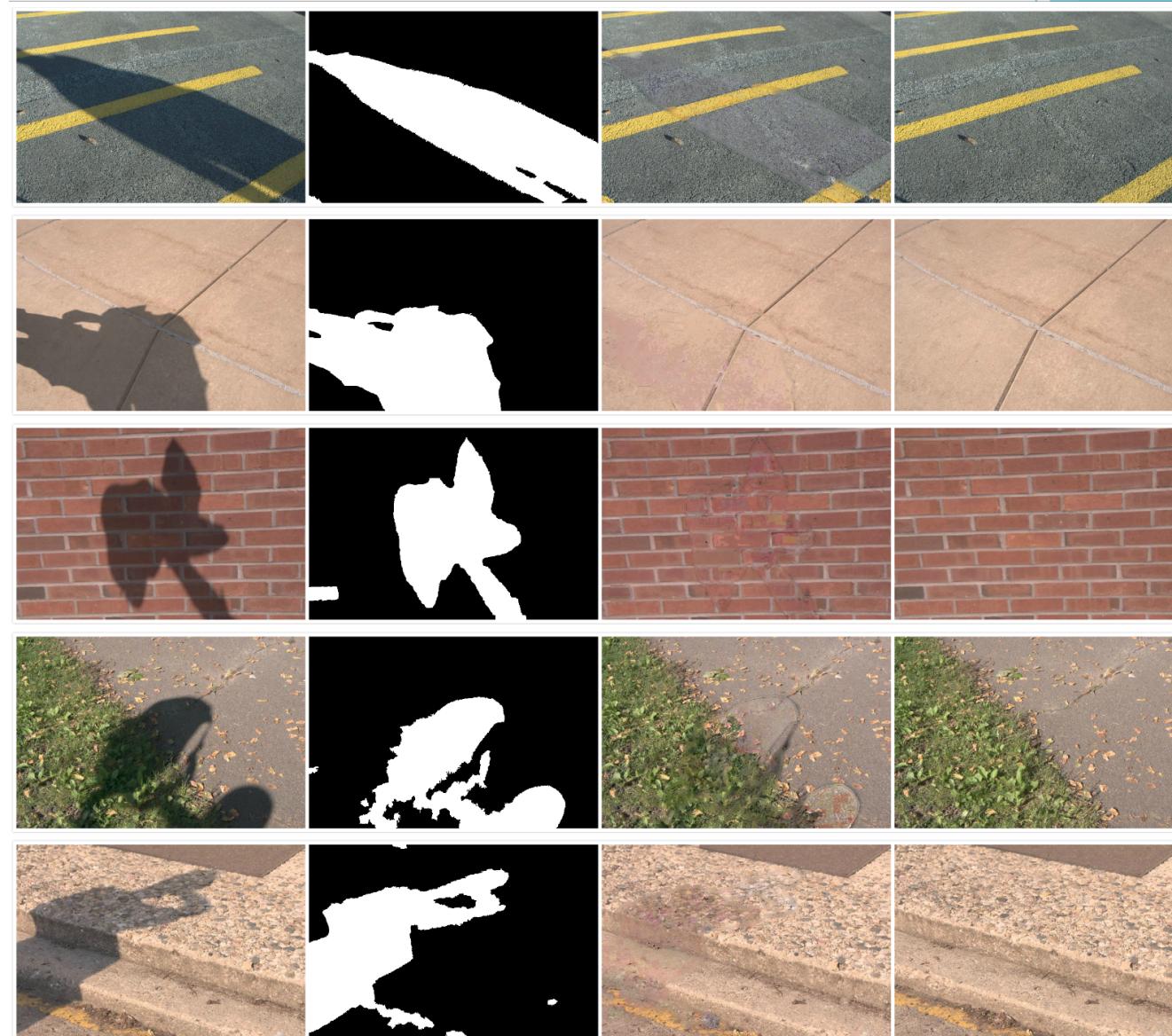
检测标签

去除结果

区域匹配实验（阴影去除）



阴影去除

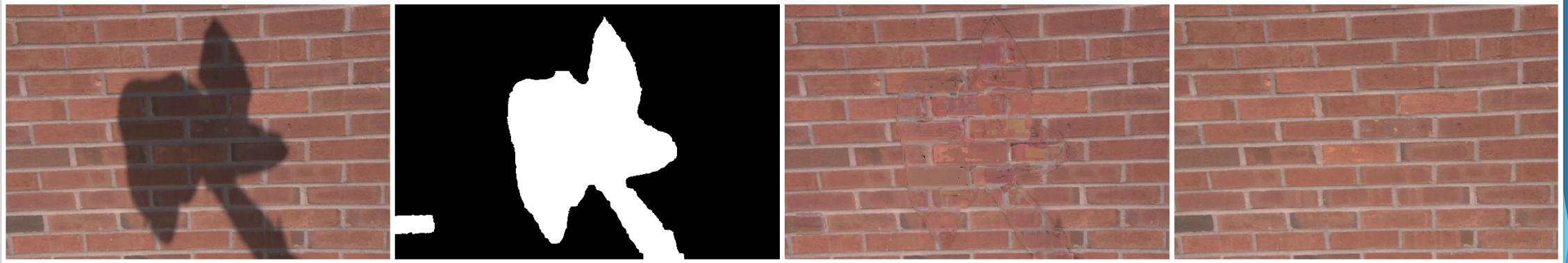


原图

检测结果

去除结果

去除标签



分析与改进

- ▶ 实验中发现算法的局限性在于，对于复杂图片，区域匹配的准确度很难保证，因此，会由于错误的匹配，带来错误的制约关系，或者会把区域恢复成错误的材质等等。同时，文章算法基于mean shift图像分割技术，在复杂图片中分割也很难准确。
- ▶ 进一步的改进希望主要在于对材质匹配区域的计算上。但是由于目前数据集有限，很难通过训练分类器等方法给出匹配区域，因此可以进一步考虑添加更多的阴影不变特征，在复杂图片中保证区域匹配的准确性。

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