从图 6 和表 5 中观察到,应用 3 种算法输出的图像比原始图像都具有更低的功耗.当限定图像的平均结构相似系数(MSSIM)为 0.95 时:对于图像 1,应用 WRA 算法图像功耗降低 10.2%,应用 RRA 算法图像功耗降低 9.6%,应用 MRA 算法图像功耗降低 10.4%;对于图像 2,应用 WRA 算法图像功耗降低 11.2%,应用 RRA 算法图像功耗降低 9.5%,应用 MRA 算法图像功耗降低 11.7%;对于图像 3,应用 WRA 算法图像功耗降低 9.5%,应用 RRA 算法图像功耗降低 8.1%,应用 MRA 算法图像功耗降低 9.6%.对于 3 幅图像,本文提出的 MRA 算法平均降低 10.6%的功耗,有一定的功耗优化效果.

对于第 2 组中的 3 幅图像,在保持同样的结构相似度的限制条件下,MRA 算法降低的功耗分别比 WRA 算法高出 0.2%,0.5%和 0.1%,平均值为 0.27%.说明本文提出的算法与 MRA 算法对降低图像的功耗效果基本一致,并无明显的优势.这是由于对于第 2 组的图像无明显的显著区域,图像整体各部分无明显的差别,因此本文算法无法提取图像的特征区域,因而各区域在视觉关注度方面无明显区分.所以在对此类图像时,本文算法将图像当作一个整体来对待,因而其功耗优化效果与 WRA 算法基本无差别.但在实际应用场景中,此类图像出现的概率较小,因而在大概率应用场景中,图像通常有一定的显著区域,因而本文提出的方法具有一定的优势,接下来通过统计分析进行说明.

为了验证提出方法的通用性,我们进行了多样例统计分析,随机从 Google 图像库中选取 200 张图像来验证.对每一张图像,采取相同的处理步骤:首先记录其原图像的功耗信息,而后记录使用 MRA 算法处理后的功耗数据,最后对这 200 张处理后的功耗降低率进行统计.图 7 为 200 张图像应用 MRA 方法后的功耗优化比例分布图.

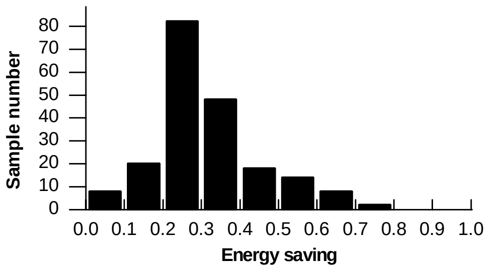

Fig.7 Power optimized proportional distribution of test samples

图 7 测试样本功耗优化比例分布图

在保证图像的 $MSSIM \geqslant 0.95$ 时,从图中可以观察到:41%的实验样本实现降低功耗为 20%~30%,24%的实验样本实现降低功耗为 30%~40%,只有很少的实验样本的功耗降低非常不明显.这是由于这些图像的兴趣域基本占据整个图像,同时,该类图像的各颜色信息表示特定的物理含义,所以基本无法对该类图像的各像素值进行调整,因而无法进行功耗优化.所有实验样本平均降低功耗为 18.6%,这证明了提出方法的有效性和通用性.在进行多样例统计分析中我们发现:当图像的主色彩是白色或者蓝色时,功耗的降低比例是非常明显的.这是由于在 AMOLED 功耗模型中,蓝色颜色分量消耗屏幕功耗较高,红色分量和绿色分量消耗的屏幕功耗相对蓝色较小;而对白色色彩可以显著地降低各颜色分量,因而功耗优化效果较为明显.而对图像的主色彩是灰色时,功耗的降低比例不是非常明显.这是由于该类色彩其各颜色分量的像素值已相对小,在调整各颜色分量像素值时,调整的幅度较小,因而功耗优化略差.同时,对显著区域明显且该显著域的区域大小相对有限时,我们的方法对该类图像的功耗优化效果较好.

5 总 结

本文针对 AMOLED 的自发光特性,提出基于多区域内容感知的图像低功耗优化方法.方法的核心是:通过多区域内容感知算法对显示内容的重要区域进行提取,在保留图像重要区域特征的前提下,根据各区域的视觉关注度进行多区域像素调节,从而在实现保证图像整体视觉效果的同时,最大限度降低图像显示功耗.通过实验验证表明:提出的方法可以平均节约 18.6%的显示功耗,同时保持较高的图像视觉质量.文中提出的方法可以较

好地降低图像显示功耗,同时,该方法也可以用于视频及其他多媒体应用场景.

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