则分别为 0.428 和 0.593;核相关滤波跟踪算法(KCF)的跟踪结果则为 0.562 和 0.684,这些结果表明,我们的跟踪方法在测试视频集上具有较好的整体性能,这是由于,多特征信息和低秩的重检测机制使得跟踪效果更加鲁棒.为了使结果有一定的可视性,图 7 给出了部分跟踪结果的示例序列.

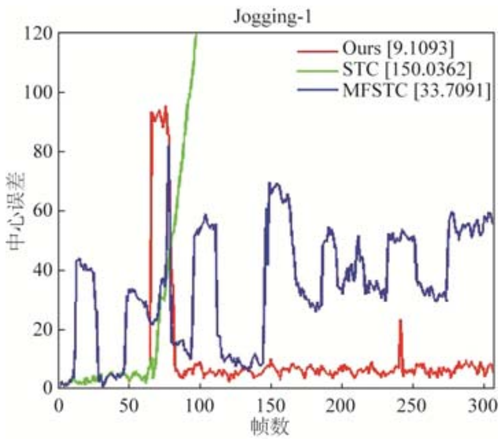

Fig.3 Center location error of Jogging
图 3 Jogging 视频中心位置误差曲线

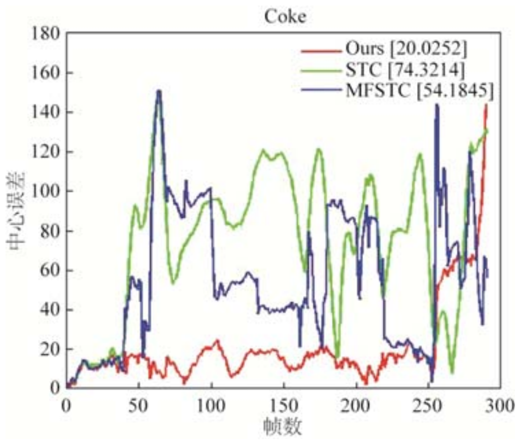

Fig.4 Center location error of Coke
图 4 Coke 视频中心位置误差曲线

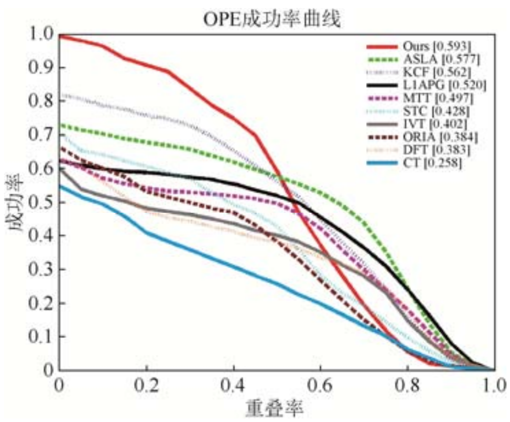

Fig.5 Overall success rate curves
图 5 总体成功率曲线

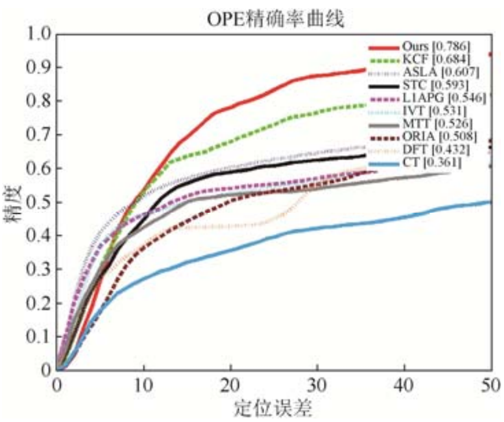

Fig.6 Overall precision rate curves
图 6 总体精确度曲线

为了全面地评估跟踪算法在不同难点上的性能,图 8 和图 9 给出各个跟踪器在各个难点属性上成功率和精确度的分析曲线.通过分析曲线我们可以看出,在 8 个难点属性里,本文提出的算法在以下 3 个属性上取得了跟踪精度第一:复杂背景、遮挡、平面外旋转,分别为 0.899、0.704、0.732,在其余除运动模糊和尺度变换两个属性外都排名前三.由于本文没有考虑尺度上的更新,使得在跟踪尺度变化上还有改进空间.综上,由所有的实验结果我们可以看出,本文算法在整个对比实验中有最好的整体跟踪性能,在单个的难度属性上也大部分取得了很好的效果,虽然在部分属性上未取得与相关算法相比的全面超越,但本文算法无论从精度、成功率和算法复杂度上都有不错的平衡,整体性能超过了参与比较的主流算法.

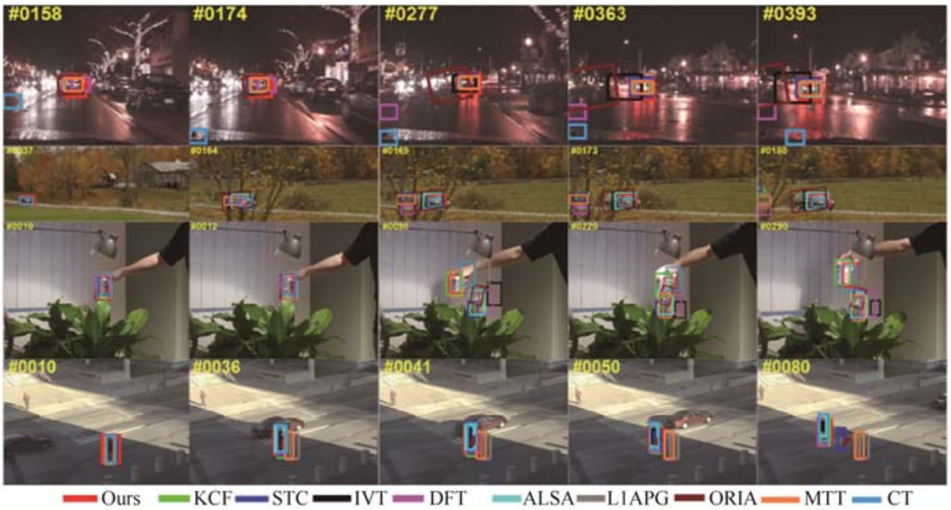

Fig.7 The tracking results illustration

图 7 部分跟踪结果显示

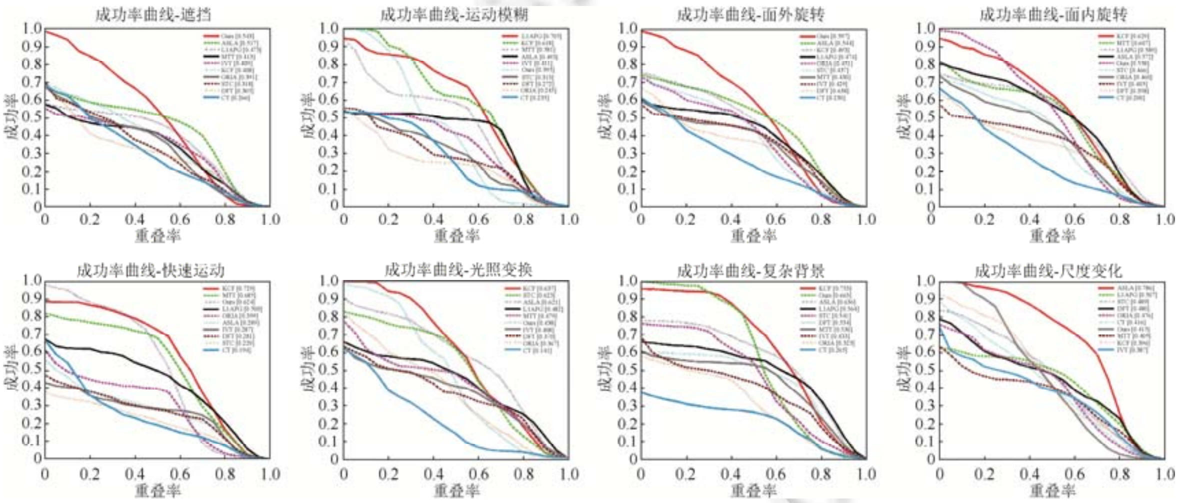

Fig.8 Tracking success curves on different attributes

图 8 在不同跟踪视频属性上的成功率曲线

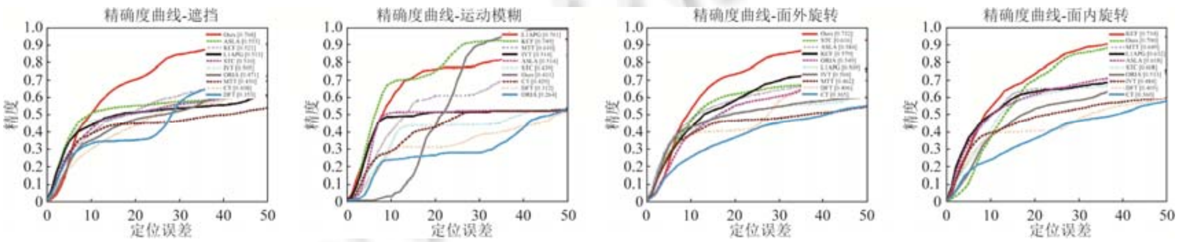

Fig.9 Tracking precision curves on different attributes

图 9 在不同跟踪视频属性上的精确率

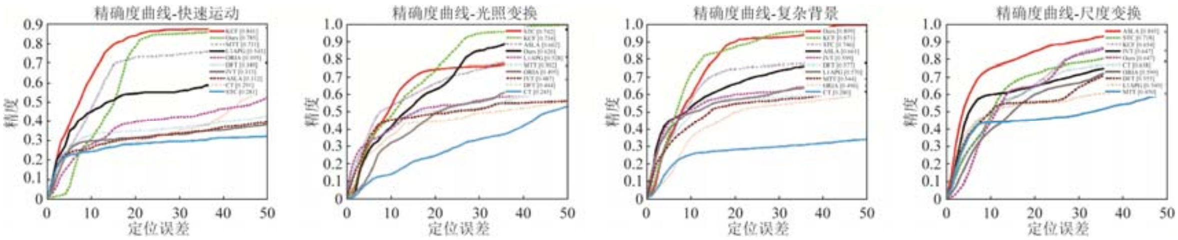

Fig.9 Tracking precision curves on different attributes (Continued)

图 9 在不同跟踪视频属性上的精确率(续)

4 结 论

本文提出了一种低秩重检测的多特征时空上下文的跟踪方法,通过利用多特征融合的技术改善了上下文的信息表达,完善了目标周围的结构信息,通过有效的低秩矩阵近似分解的方法构建了鲁棒的在线重检测器,该重检测器可以保持历史跟踪信息结构的一致性,在跟踪器跟踪失败后对目标周围进行目标的重定位,实现跟踪方法的长时有效跟踪.通过大量的实验评测可以得出,本文算法能够有效地处理遮挡等引起的跟踪失败的重定位问题,实验结果也表明,本文算法在跟踪精度、成功率和复杂度上取得了不错的性能,在总体性能上超过了当前一些先进的跟踪方法.需要指出的是,由于本文的多特征仅使用简单的颜色三通道,如果利用更加有判别性的特征提取算法,本文的跟踪算法将有进一步的提高.另外,目前基于深度学习的跟踪方法也日渐流行,利用卷积网络的特征也是提高跟踪效果的一个改进方向.

致 谢 我们向本文的编辑及审稿人表示感谢,感谢他们提出的深入而有建设性的修改意见.

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