光学 精密工程
OPTICS AND PRECISION ENGINEERING
Ei 核心期刊
主管：中国科学院
主办：中国科学院长春光学精密机械与物理研究所
中国仪器仪表学会
主编：曹健林



光学精密工程 2013, 21(9) 2364-2370 ISSN: 1004-924X CN: 22-1198/TH



信息科学

# 采用改进Mean Shift算法的移动机器人行人跟踪

王丽佳1，2，贾松敏1 *，王爽1，李秀智1

1.北京工业大学 电子信息与控制工程学院，北京 100124；
2.河北工业职业技术学院 信息工程与自动化系，河北 石家庄 05000

摘要： 为了提高移动机器人目标跟踪系统在复杂环境中的跟踪性能，提出在双层定位机制下采用基于自适应核函数的Mean Shift算法实现目标跟踪。利用射频识别器件（RFID）检测携带标签的目标，实现外层粗定位并确定感兴趣区域（ROI）；在内层则根据对视差图的ROI的处理结果确定初始搜索窗口，然后应用基于自适应核函数的Mean Shift算法在从立体相机获得的左图中应用基于自适应核函数的Mean Shift算法实现对目标的精确定位。自适应核函数由目标的区域特征与Epanechnikov函数相融合构成，克服了目标边缘处背景像素对目标颜色概率分布的影响。与传统的Mean Shift算法相比，所提方法在同色背景干扰下仍能准确跟踪目标。另外，RFID限定了图像搜索范围，节省了运算开支，图像处理的平均时间为62.11 ms/frame，满足实时跟踪的要求。实验结果表明，该方法可实现移动机器人在同色背景干扰、遮挡、目标快速移动等情况下的目标跟踪。

关键词： 移动机器人 行人跟踪 双层定位机制 自适应核函数 Mean Shift算法 射频识别技术

# Person tracking of a mobile robot using improved Mean Shift

WANG Li-jia1,2, JIA Song-min1 *, WANG Shuang1, LI Xiu-zhi1

1.College of Electronic Information and Control Engineering, Beijing Universtiy of Technology, Beijing 100124, China;
2.Department of Information Engineering and Automation, Hebei College of Industry and Technology, Shijiazhuang 050000, China

Abstract: To improve the performance of person tracking for a mobile robot in complex environments, an adaptive kernel function based Mean Shift algorithm was proposed by using a coarse to fine localization mechanism. In the outer layer, a Radio Frequency Identification Device (RFID) was adopted to detect the person with an ID tag to determine the Region of Interest (ROI) coarsely. In the inner layer, the ROI of a disparity image was processed to estimate an initial searching window. Then, the adaptive kernel based Mean Shift algorithm was applied to location of the person precisely in the left image from a stereo camera. The adaptive kernel function was combined with the regional feature of person and the Epanechnikov function, which can reduce the effect of the background pixel on the target’s color probability distribution. Compared with the traditional Mean Shift algorithm, the presented algorithm can track the target successfully when the background has the same color. Furthermore, the searching area is narrowed by the RFID, so that the computational cost is reduced. The average computing time is 62.11 ms/frame, which satisfies the requirements of real-time target tracking. The experimental results indicate that the proposed tracking method can complete the target tracking in a background with the same color, short-term occlusion, fast moving, and a sudden turn for a mobile robot.

Keywords: Mobile Robot Person tracking Coarse to fine localization mechanism Adaptive kernel function Mean Shift algorithm Radio Frequency Identification Device(RFID)

收稿日期 2013-03-12 修回日期 2013-05-03 网络版发布日期 2013-09-30

基金项目:

江苏省普通高校研究生科研创新计划基金资助项目;江苏省普通高校研究生科研创新计划基金资助项目;国家教育部留学回国人员科研启动基金;北京市自然科学基金重点项目

通讯作者: 王丽佳

作者简介: 王丽佳(1981-)，女，河北承德人，博士研究生，讲师，2008年于郑州大学获得硕士学位，主要从事智能机器人导航、机器视觉等方面的研究。
作者Email: wanglijia_19811103@163.com

参考文献：

[1]张娟, 潘建寿, 吴亚鹏, 等. 基于双目视觉的运动目标跟踪与测量[J]. 计算机工程与应用, 2009，45(25): 191-194. ZHANG J, PAN J SH, WU Y P, et al.. Tracking and measurement of moving object in binocular stereo vision [J]. Computer Engineering and Applications, 2009, 45(25): 191-194. (in Chinese) [2]TAKEMURA H, ZENTARO N, MIZOGUCHI H. Development of vision based person following module for mobile robots in/out door environment [C]. Proceedings of the 2009 IEEE International Conference on Robotics and Biomimetics, Guilin, China, December 19-23, 2009: 1675-1680. [3]沈志华, 赵英凯, 王晓荣, 等. 全自主机器人双目视觉运动检测研究[J]. 计算机测量与控制, 2006, 14(1): 26-27. SHEN ZH H, ZHAO Y K, WANG X R, et al.. Research on ios-vision system of autonomous mobile robot for motion detection [J]. Computer Measuement & Control, 2006, 14(1): 26-27. (in Chinese) [4]刘士荣, 孙凯, 张波涛, 等. 基于改进Camshift算法的移动机器人运动目标跟踪[J]. 华中科技大学学报：自然科学版, 2011,39 (S2): 223-226. LIU SH R, SUN K, ZHANG B T, et al.. Mobile robot moving object tracking based on modified Camshift algorithm [J]. J. Huazhong Univ. of Sci. & Tech.：Natural Science Edition, 2011, 39(S2): 223-226. (in Chinese) [5]薛陈, 朱明,陈爱华. 鲁棒的基于改进Mean-shift的目标跟踪[J]. 光学 精密工程, 2010,18(1):234-239. XUE CH, ZHU M, CHEN AI H. Robust object tracking based on improved Mean-shift algorithm [J]. Opt. Precision Eng., 2010, 18 (1):234-239. （in Chinese) [6]董蓉, 李勃, 陈启美. 基于SIFT特征的目标多自由度Mean Shift 跟踪算法[J]. 控制与决策, 2012, 27(3):

399-407. DONG R, LI B, CHEN Q M. Multi-degree-of-freedom mean-shift tracking algorithm based on SIFT feature [J]. Control and Decision, 2012, 27(3): 399-407. (in Chinese) [7]颜佳, 吴敏渊, 陈淑珍, 等. 跟踪窗口自适应的Mean Shift跟踪[J]. 光学 精密工程, 2009, 17(10): 2606-2611. YAN J, WU M Y, CHEN SH ZH, et al.. Mean Shift tracking with adaptive tracking window [J]. Opt. Precision Eng., 2009, 17(10): 2606-2611. (in Chinese) [8]刘宁夏, 丁显廷, 孙明竹, 等. 基于Camshift与活动轮廓模型的细胞追踪方法 [C]. Proceeding of the 31st Chinese Control Conference, Hefei, China, July 25-27, 2012: 3656-3661. [9]LIU N X, DING X T, SUN M ZHU, et al.. Cells tracking based on Camshift and active contour model [C]. Proceeding of the 31st Chinese Control Conference, Hefei, China, July 25-27, 2012: 3656-3661. (in Chinese) [10]AMIR H M, ARASH A L. Applying mean shift, motion information and Kalman filtering approaches to object tracking [J]. ISA Transactions, 2012, 51: 485-497. [11]JIA S M, LIN W G, WANG K ZH, et al.. Network distributed multi-functional robotic system supporting the elderly and disabled people [J]. Journal of Intelligent and Robotic Systems, 2006, 45: 53-76. [12]OUADAH N, CADENAT V, LERASLE F, et al.. Multi-sensor-based control strategy for initiating and maintaining interaction between a robot and a human [J]. Advanced Robotics, 2011, 25: 1249-1270. [13]COMANICIU D, MEER P. Mean shift: a robust approach toward feature space analysis [J]. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2002, 24(5): 603-619. [14]贾松敏, 王丽佳, 王爽, 等. 改进的步态光流图与视角相结合的身份识别 [J]. 光学 精密工程, 2012，20(11): 2500-2507. JIA S M, WANG L J, WANG SH, et al.. Person identification combining modified gait flow image and view [J]. Opt. Precision Eng., 2012, 20(11): 2500-2507. (in Chinese)

本刊中的类似文章

1．董立珉 刘源 徐国栋 李鹏飞.卫星系统网络节点的智能化设计[J]. 光学精密工程, 2013,21(4): 1086-1095

2．褚金奎, 陈文静, 王洪青, 戎成功.基于偏振光传感器的移动机器人导航实验[J]. 光学精密工程, 2011,19(10): 2419-2426

3．孙中森[1,2];孙俊喜[1,3];宋建中[1];乔 双[1,4].一种抗遮挡的运动目标跟踪算法[J]. 光学精密工程, 2007,15(2): 267-271