论文与报告

移动机器人闭环检测的视觉字典树金字塔TF-IDF得分匹配方法

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摘要
针对移动机器人视觉闭环检测中, 基于视觉字典本的场景外观表征性能受制于有限单词个数以及算法效率低的不足, 本文对机器人视觉特征分层量化, 构建视觉字典树, 计算树节点的TF-IDF熵作为对应视觉单词的权重, 生成图像--单词逆向文档索引. 为消除视觉字典本的单尺度量化误差, 并克服基于字典树投影路径的平面匹配模式中不 区分不同层次节点的区分度对闭环检测的影响, 本文融合字典树低层单词的强表征性和高层单词的强鲁棒性, 提出由下而上逐层计算图像间相似性增量的金字塔得分匹 配方法. 将不同时刻相似性大于阈值的图像位置提取为候选闭环, 通过后验确认操作剔除误正闭环. 在移动机器人视觉闭环检测实验中, 本文算法提高了图像相似性计算 的效率和准确性, 提高了闭环检测的准确率和召回率.

关键词　　闭环检测　视觉字典树　TF-IDF得分准则　金字塔匹配
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Visual Vocabulary Tree with Pyramid TF-IDF Scoring Match Scheme for Loop Closure Detection

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Abstract
The performance of visual environment modeling in appearance-based robot loop closure detection by using conventional vocabulary is restricted by limited number of visual words and high computational cost. We construct a visual vocabulary tree by clustering the visual features hierarchically captured by a mobile robot. The TF-IDF entropy for each node is computed and is treated as the weight of each visual word, and the inverted index of image-word is exploited. To avoid the quantization error of single scale vocabulary and the neglect of the different discriminative power among different level words of tree-based match, we take advantage of the robustness of high level words and the discriminability of low level words to present a pyramid scoring match scheme. The candidates of loop closures are detected by using a similarity threshold. A posteriori management helps discard outliers by verifying that the two images of the loop closure satisfy some hypothesis constraints. The experiments of loop closure detection in mobile robotics demonstrate that our scheme improves similarity calculation significantly in both accuracy and efficiency and obtains a higher precision-recall ratio with a faster speed of loop closure detection compared to the traditional methods.

Key words　Loop closure detection　visual vocabulary tree　TF-IDF scoring scheme　pyramid match

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