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# 基于K-means算法的温室移动机器人导航路径识别

# Navigating path recognition for greenhouse mobile robot based on K-means algorithm

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中文摘要:

针对温室移动机器人机器视觉导航路径识别实时性差、受光照干扰影响严重等问题，首先，将HSI颜色空间3个分量进行分离，选取与光照信息无关且可以有效抑制噪声影响的色调分量H进行后续图像处理，以削弱光照对机器人视觉导航的不良影响；针对温室环境图像特有的颜色特征信息，引入K-means算法对图像进行聚类分割，将垄间道路信息与绿色作物信息各自聚类，再通过形态学腐蚀方法去除聚类后图像中存在的冗余、干扰信息，以获得完整的道路信息，与常用阈值分割方法相比，可降低因分割信息不明确而导致后续Hough变换进行直线拟合时需占据大量内存且计算量较大的问题，进而提高移动机器人路径识别的快速性，并适应温室作业机器人自主导航的高实时性要求。试验结果表明，该文方法在复杂背景与变光照条件下的温室作业环境中可大幅降低光照对机器人导航的影响，对于光照不均具有良好的鲁棒性，道路信息提取率可达95%。同时，其平均单幅图像处理时耗降低53.26%，可显著提高路径识别速度。该研究可为解决温室移动机器人机器视觉导航路径识别的鲁棒性及实时性问题提供参考。

英文摘要:

Abstract: In a greenhouse with an unstructured environment, for the images collected by monocular vision, conventional path recognition algorithms are difficult to guarantee their robustness due to illumination variation, background reflection, shadow noise, etc. In addition, the increase of the amount of calculation of algorithms caused by the complicated background information of the greenhouse environment affects the quickness and the real-timeness of the greenhouse mobile robot autonomous navigation, which leads to the difficulty of meeting the requirement for the operation efficiency of the greenhouse mobile robot and impedes the practical application of the mobile robot technology in agricultural production. For the above problems, considering the influence of illumination conditions and complex background information in the greenhouse environment on the quality of the image segmentation, this paper focuses on the research of the color space selection and the image segmentation algorithm for a monocular vision greenhouse mobile robot. In order to not only reduce the impact of light information on the path recognition so as to improve the robustness of the algorithm, but also to enhance the accuracy of the path information recognition by adopting a novel image segmentation algorithm and meanwhile, reducing the calculation of the subsequent Hough transform so as to increase the quickness of path identification. Firstly, to ensure the robustness of the navigation path recognition algorithm in the greenhouse environment, three components H, S, and I are respectively separated from HSI color space, and the H component which has nothing to do with light intensity and can effectively restrain the effect of noise is extracted from the subsequent image processing. Secondly, to improve the rapidity of the greenhouse navigation path recognition and meet the real-time requirements of autonomous navigation operations, for the color characteristic of the greenhouse environment, the clustering segmentation of the image is performed based on K-means algorithm to achieve the respective clusters of the path and the green crop information. Then, the redundant and the interference information existing in the clustered image is eliminated by a morphological corrosion so as to obtain the complete and clear path information. Compared with a conventional threshold segmentation method, the proposed method can solve the problem of a too large memory occupation and a too long calculation time caused by the unclear segmentation information for the subsequent Hough transform, thus can enhance the rapidity of the greenhouse path recognition and meet the real-time requirements of autonomous navigation and operation of the greenhouse robot. Finally, in order to verify the effectiveness of the proposed method, the method in this paper, and the conventional method of the gray processing in RGB color space and the threshold segmentation are respectively used to process the greenhouse image information for comparison. The experiment results show that for the greenhouse robot working in the environment with a complex background and variable light, the proposed method can significantly reduce the effect of the non-uniform illumination on the navigation path recognition, that is, has a good robustness to the non-uniform illumination. Furthermore, the processing time of a single image is reduced by 53.26%, so the rapidity of the path recognition can be significantly improved.