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基于**Retinex**图像增强的不同光照条件下的成熟荔枝识别

Recognition of ripe litchi in different illumination conditions based on Retinex image enhancement

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中文摘要:

为了满足自然环境下荔枝采摘机器人视觉定位系统的有效性和实时性的要求，针对不同光照条件的荔枝彩色图像，采用基于双边滤波的Retinex图像增强算法凸显图像的荔枝果实和果梗，对增强处理后的图像在HSI颜色空间中进行H分量旋转的处理，再对旋转处理后的H分量进行Otsu自动阈值分割去除荔枝图像果实和果梗外的复杂背景，然后通过将双三次插值算法和传统的模糊C均值（Fuzzy C-Mean）算法融合，对去背景后的荔枝图像在YCbCr颜色空间中进行Cr分量模糊聚类分割，实现荔枝果实和果梗的识别。荔枝图像的分割试验结果表明：该算法对晴天顺光、逆光、遮阴、阴天顺光等光照条件的荔枝图像能够有效地分割，对阴天弱光照、果实被遮阴条件下的荔枝也能较好的识别，并保持荔枝果实和果梗区域的完整性，4种光照条件荔枝图像分割正确率分别为96%、90%、89.3%和88.9%，成熟荔枝识别的正确率达到了90.9%，该研究为荔果采摘机器人的室外作业的实时性和有效性提供指导。

英文摘要:

Abstract: To realize the goal of precise positioning of a picking robot in a natural environment of fruit and vegetables, some problems remain to be solved. The variability of illumination in natural environment is one of the main factors and causes low recognition accuracy and long recognition algorithm running time. In order to meet the effectiveness real-time requirements of the litchi picking robot visual positioning system in a natural environment, the recognition of ripe litchi in a natural environment was studied. According the litchi color images in different illumination conditions, to analyze the color features of litchi images a bilateral filtering Retinex image enhancement algorithm was used to highli the litchi fruit and stem, which was needed to reduce the influence of illumination on litchi image processing and to highlight the recognized target. The color component characteristics in different color spaces of litchi images under different illumination conditions were analyzed to determine the H component rotation in HSI color space to the litch image after image enhancement processing, which can reduce the influence of uneven illumination under the foundation of maintaining a relative relationship between colors of th original image. According to the bimodal characteristics of the H component grayscale histogram after rotation processing, the Otsu automatic threshold segmentation method for component image threshold segmentation was chosen to remove the complex background except for the litchi fruit and stem. The fuzzy c-means (FCM) clustering algorithm was th selected to segment the fruit and stem of the litchi image, and due to the characteristics of the artificially given clustering number and low arithmetic speed of the traditional fuzzy means clustering algorithm, the fuzzy clustering algorithm was improved. Through the fusion of the bicubic interpolation algorithm and the FCM algorithm, the improved fuzzy c-r clustering algorithm was used in the fuzzy cluster segment of the Cr component in YCbCr color space, in which the recognition of the litchi fruit and stem was realized. One Hundr ten litchi images in different illumination conditions were randomly selected and used for the litchi fruit and stem segmentation experiments based on the research algorithm. The experimental results are that 100 mature litchi images were segmented correctly to fruit and stem, and in the other segmentation results, interference noise such as branches, the sk and land existed. The recognition accuracy rate of ripe litchi can reach 90.9%. The experiment results show that this algorithm has good stability for litchi image segmentation in different illumination conditions, such as sunshine and front lighting, shade, backlighting, and clouds , mainly for the litchi recognition under the condition of weak light in cloudy days and the shaded fruit, which can well maintain the integrity of the litchi fruit and stem. The research results can provide the theoretical basis and technical support to the effectiveness and real-time for fruit and vegetable picking robot vision positioning systems, and lay the foundation for visual precise positioning.

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