Sea-sky-line detection based on local Otsu segmentation and Hough transform

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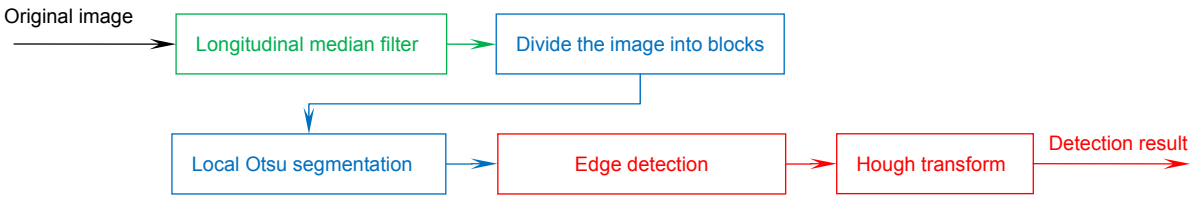

Flowchart of sea-sky-line detection based on local Otsu segmentation and Hough transform

Overview: Unmanned surface vehicle (USV) has a great potential to play an important role in the near future, such as sea environmental monitoring and maritime rescue. USV obtains information about surrounding sea surface environment by processing the visible light maritime image from the camera mounted on the USV. Sea-sky-line detection is useful in the visible light maritime image processing. It can provide important reference for the target detection and image calibration. Existing sea-sky-line detection methods are mainly used in infrared maritime images with simple scenes and less interference. In contrast, there are few studies on sea-sky-line detection in complex visible light maritime images. There are two main methods for the detection of sea-sky-line, namely the method based on line extraction from edge pixels and the method based on image segmentation. However, the former method is susceptible to the gradient change of sea waves and sea-sky-line, while the latter is limited by the accuracy of image segmentation. Due to the interference such as sea waves, ships and light, it is difficult to accurately detect the sea-sky-line of the visible light maritime image. To improve the detection accuracy and robustness, a sea-sky-line detection method based on local Otsu segmentation and Hough transform is proposed. Firstly, high-frequency noise such as light spot in the gray image is rapidly suppressed by longitudinal median filter. Then, according to the image features, local Otsu segmentation is performed to obtain binary images where edge pixels are extracted. Finally, Hough transform is used to fit edge pixels to complete the sea-sky-line detection. In the proposed method, image block processing compensates for the inhomogeneity of illumination and limits the interference scope of ships to some image blocks, which makes the local Otsu segmentation more accurate than the global Otsu segmentation. In addition, compared with the edge detection of the sea-sky-line based on the gradient, the edge detection of the sea-sky-line based on image segmentation can better adapt to the change of the image gradient and suppress the interference of the wave edge. Hough transform can ensure the accurate fitting of the sea-sky-line from the edge pixel if the number of edge pixels extracted of the sea-sky-line is more than half of the image width. Experimental results show that the interference of sea waves, ships and light can be effectively suppressed by the proposed method, which is relatively accurate, robust and real-time. The sea-sky-line detection accuracy of the proposed method is 93.0%, which is significantly higher than that of three representative sea-sky-line detection methods.

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