An Instance Segmentation and Depth Perception based Obstacle Detection and Distance Measurement Method on Substation Patrol Robot

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Abstract

In order to guarantee the safe production and reliable operation of the power grid, regular inspections of substation equipment are essential. The new generation of information and communication technology represented by artificial intelligence has a significant impact on the traditional substation inspection methods, which has caused profound changes. Among them, the substation intelligent patrol robot is one of the representative products. In the research of substation intelligent patrol robots, navigation and obstacle avoidance technology are the most critical. The obstacle avoidance requires the robot to react to the changing surrounding environment in real time. It should automatically detect the obstacles to avoid the risk of collisions and falls, and continue to follow the planned global path after obstacle avoidance.

The existing obstacle detection and distance measurement methods of substation patrol robot mainly have the following defects: First, The robot needs to be equipped with two or more sensing devices in order to achieve obstacle detection and distance measurement, which makes the whole system structure complex and less reliable. Secondly, the obstacle detection based on traditional machine learning needs to extract features artificially; while the deep neural network for target detection can only give the rectangular bounding box of obstacles. Both of them are with limited precision and cannot complete the distance measurement task at the same time. Thirdly, the algorithm based on single and dual-purpose visual ranging method is complex, and the adaptability to complex illumination conditions is not high.

This paper proposes an obstacle detection and distance measurement method for substation patrol robot based on instance segmentation and depth perception. The pixel-level instance segmentation between road and obstacles are fulfilled by using Mask R-CNN network. To the best of our knowledge, it is the first time that Mask R-CNN is introduced and utilized in obstacle detection and distance measurement of substation patrol robot. In the first step, the pre-processed RGB image is used to train the deep neural network Mask R-CNN to perform pixel-level instance segmentation between obstacles and roads. In the second step, the obtained mask is combined with the depth data processed by using the Grubbs method to eliminate the abnormal data. Finally, we can measure the distance from the patrol robot to the obstacle through pixel-level matching. Compared with the old method, our proposed method has a simple framework with acceptable high recognition precision, good reliability, low cost and is valuable in practice.