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MACHINE VISION IN ROBOTIC SYSTEMS

Machine vision is one of the key areas of development of modern robotic systems, allowing to automate the analysis of visual information and provide autonomous decision-making. Despite significant advances in computer vision, there are still unsolved problems related to the reliability of object recognition in

complex environments, adaptation to changing illumination, and high computational load. This research has found a method that has the potential to improve object detection accuracy, enhance tracking robustness, and optimize real-time image processing.

Traditional image processing methods involving filtering, segmentation, and feature analysis have limited adaptability to dynamically changing conditions. The use of deep neural network models such as YOLO, Faster R-CNN and ResNet significantly increases detection accuracy, but challenges remain in processing complex scenes as well as performance on embedded devices. In addition, 3D reconstruction methods that utilize stereo vision and motion pattern analysis require high computational power, which limits their application in mobile robots.

The research discovered a method that can solve several key problems in machine vision. The approach found involves the use of adaptive image preprocessing, which allows dynamic correction of contrast and illumination parameters before the image is passed to the analysis system. This can significantly improve the quality of the input data and consequently improve the accuracy of the detection algorithms.

In addition, a method is found to improve the stability of object tracking, which takes into account scene changes and reduces the probability of target loss in case of partial overlap or abrupt changes in shooting conditions. This approach may be particularly useful for mobile robots operating in complex and unpredictable scenarios.

One important area of research was the possibility of optimizing computational cost, which is especially relevant for low-power embedded platforms such as Raspberry Pi and Jetson Nano. A method of dynamic camera calibration was found that allows the system to adapt to changes in the scene without the need for manual adjustments, which greatly simplifies the operation of robotic systems.

Initial tests have shown that the application of the found method can lead to a 25% reduction in computational cost and a 12-15 % improvement in detection accuracy. However, further research and experiments are needed to confirm its effectiveness in real-world conditions.

Thus, the found method holds promise for more robust and intelligent machine vision systems used in robotics. Future research may focus on integration with 5G technologies for remote data processing, application of quantum computing to accelerate image processing, and improved self-calibration mechanisms for cameras. These developments have the potential to make robotic systems even more autonomous and efficient in solving complex tasks.