ABSTRACT

The development of autonomous vehicles has become a major focus in the world of technology, especially in the aspect of precise lane detection in dynamic environmental conditions. This study aims to develop a lane detection system on a miniature autonomous vehicle using the Hough Transform algorithm optimized with a computer vision-based multi-color space detection strategy. This system is implemented on the Duckiebot DB21J module equipped with an IMX219 camera and processing by Jetson Nano. The methodology used includes literature study, system design, hardware and software implementation, and comprehensive testing in five different scenarios in two lighting conditions (305 lux and 181 lux). The results show that the system is able to detect lanes with an accuracy of 97.14% in bright conditions and 96.40% in standard conditions, exceeding the minimum target of 90% with a consistent detection rate of 99.26% and 99.16%. The system demonstrated excellent spatial precision with an angular error of 0.494°-0.57° and a positional error of 1.19-1.31 cm, and an average processing time of 213-230 ms. This study demonstrated the superiority of the developed method with an accuracy increase of 6.40%-12.14% compared to previous studies using CNN+Hough Transform, Hough+Gaussian Filter, and SVM Model. This system has the potential to be applied to educational robotics platforms and advanced research in vehicle automation.

Keywords: autonomous vehicle, lane detection, computer vision, Hough Transform, Jetson Nano, Duckiebot