Computer System for Vehicle Speed Determination

Roman Lishchuk[1[0000-0002-2051-5365]], Pavlo Kulakov[1[0000-0002-0167-2218]], Volodymyr Kucheruk[1[0000-0002-6422-7779]], Andriy Semenov[2[0000-0001-9580-6602]], Serhii Kontseba[1[0000-0003-4161-5581]], Wiktoria Mankovska[1[0000-0003-0552-5482]], Anastasiia Neskorodieva[3[0000-0002-8591-085X]] and Svitlana Skurtol[1[0000-0003-4517-2466]]

[1] Uman National University of Horticulture, 1 Institutska Str., Uman, 20305, Ukraine
[2] Vinnytsia National Technical University, 95 Khmelnytske shosse Str., Vinnytsia, 21021, Ukraine
[3] Vasyl' Stus Donetsk National University, 21 600-richchia, Vinnytsia, 21021, Ukraine
roma0lir@gmail.com, kulakovpi@gmail.com, vladimir.kucheruk@gmail.com, semenov.a.o@vntu.edu.ua, kontseba@meta.ua, viktoriyasergiivna@gmail.com, neskorodieva.a@gmail.com, skurtol@i.ua
Correspondent e-mail: kulakovpi@gmail.com

Abstract. The article proposes a computer system for determining the car speed based on a Raspberry Pi 4 single-board computer, which uses the Raspberry Pi camera module and the OpenCV image recognition library. For the operation of the computer system, it is enough to use any camera with a matrix resolution of 0.3 megapixels. Using the small resolution of the matrix increases the computing power of the system. During image processing, the two-dimensional Gaussian function was used to calculate the transformation of each pixel in the image and Otsu's method of binarization, which is based on clustering, to automatically calculate the thresholded image. This system allows to detect a car and determine its speed in a predetermined rectangular area. Unlike existing systems, the operation of the proposed system is not affected by objects in the general field of the camera view, because only objects in the defined area are analyzed.

Keywords: Computer Vision, OpenCV, Otsu's method, speed detection, Raspberry Pi, computer system.

References

1. Buch, N., Velastin, S. A., & Orwell, J. (2011). A Review of Computer Vision Techniques for the Analysis of Urban Traffic. IEEE Trans. on Intelligent Transportation Systems, 12(3), 920-939. https://doi.org/10.1109/TITS.2011.2119372
2. Padmavathi, S. & Gunasekaran, K. (2014). Night Time Vehicle Detection for Real Time Traffic Monitoring Systems: A Review. Int. J. Computer Technology & Applications, 5(2), 451-456
3. Satzoda, R. K. & Trivedi, M. M. (2016). Looking at Vehicles in the Night: Detection and Dynamics of Rear Lights. IEEE Trans. on Intelligent Transportation Systems, P. 99, 1-11. https://doi.org/10.1109/TITS.2016.2614545

4. Genyuan Cheng, Yubin Guo, Xiaochun Cheng, Dongliang Wang, Jiandong Zhao,“Real-Time Detection of vehicle speed based on video image”, 2020 12th International Conference on Measuring Technology and Mechatronics Automation (ICMTMA).
5. Pillai, S. S. & Radhakrishnan, B. (2016). Night Time Vehicle Detection Using Tail Lights: A Survey. Int. J. of Engineering Research and General Science, 4(2), 551-556.
6. Chen, Y. (2009). Nighttime Vehicle Light Detection on a Moving Vehicle Using Image Segmentation and Analysis Techniques. WSEAS Trans. On Computers, 8(3), 506-515.
7. Chen, Y., Wu, B., Huang, H., & Fan, C. (2011). A Real-Time Vision System for Nighttime Vehicle Detection and Traffic Surveillance. IEEE Trans. On Industrial Electronics, 58(5), 2030-2044. https://doi.org/10.1109/TIE.2010.2055771
8. Jurić, D. & Lončarić, S. (2014). A Method for On-Road Night-Time Vehicle Headlight Detection and Tracking. Proceedings of the International Conference on Connected Vehicles and Expo, Vienna, Austria, 655-660.
9. Kim, H. (2013). Detecting Moving Objects Using Background Modeling and Local Binary Patterns. Information an International Interdisciplinary Journal, 16(3B), 2305-2310.
10. Kim, H. (2013). Image Processing Based Multiple Vehicle Monitoring System. Information an International Interdisciplinary Journal, 16(2B), 1491-1496.
11. Yap W, Paudel M, Yap FF, Vahdati N, Shiryayev O. A Robust Methodology for Dynamic Proximity Sensing of Vehicles Overtaking Micromobility Devices in a Noisy Environment. *Applied Sciences*. 2024; 14(9):3602. https://doi.org/10.3390/app14093602
12. Yuan, Yuan, Zhitong Xiong and Qi Wang. 2016. An incremental framework for video-based traffic sign detection, tracking, and recognition. IEEE Transactions on Intelligent Transportation Systems. 18(7): 1918-1929.
13. Z. Min and R. Li, "Design of Target Tracking Intelligent Vehicle Based on Machine Vision," *2024 5th International Seminar on Artificial Intelligence, Networking and Information Technology (AINIT)*, Nanjing, China, 2024, pp. 22-25, doi: 10.1109/AINIT61980.2024.10581602.
14. Luo, Y., Ci, Y., Jiang, S. *et al.* A novel lightweight real-time traffic sign detection method based on an embedded device and YOLOv8. *J Real-Time Image Proc* 21, 24 (2024). https://doi.org/10.1007/s11554-023-01403-7
15. Rother, C. (2002). A New Approach to Vanishing Point Detection in Architectural Environments. Image and Vision Computing, 20(9-10), 647-655. https://doi.org/10.1016/S0262-8856(02)00054-9
16. Bouwmans, T., El Baf, F., & Vachon, B. (2008). Background Modeling Using Mixture of Gaussians for Foreground Detection - A Survey. Recent Patents on Computer Science, 3(1), 219-237. https://doi.org/10.2174/2213275910801030219
17. Kucheruk, V., Palamarchuk, Y., & Kulakov, P. (2014). The statistical models of machinery milking duration by group milking machines. Eastern-European Journal of Enterprise Technologies, 4(4), 13-17. doi:10.15587/1729-4061.2014.26287
18. Kucheruk, V., Palamarchuk, Y., Kulakov, P., & Gnes, T. (2014). The statistical model of mechanical milking duration of farmyard milking installation. Eastern-European Journal of Enterprise Technologies, 2(4), 31-37. doi:10.15587/1729-4061.2014.23120
19. Kucheruk, V. Measurement of the Number Servings of Milk and Control of Water Content in Milk on Stall Milking Machines / V. Kucheruk, P. Kulakov, N. Storozhuk // Proceedings of the International Conference SCIT 2016, May 20-21, 2016, Warsaw, Poland. Recent Advances in Systems, Control and Information Technology. Part V, Volume 543 of the series Advances in Intelligent Systems and Computing, pp 435-447. - 01 December 2016. - DOI: 10.1007/978-3-319-48923-0_46

20. Raspberry Pi Foundation / Raspberry Pi Foundation website. - Access mode: https://www.raspberrypi.com/products/raspberry-pi-4-model-b/
21. Raspberry Pi Foundation / Raspberry Pi Foundation website. - Access mode: https://www.raspberrypi.com/products/camera-module-3/