UNIVERSITY OF NIS FACULTY OF MECHANICAL ENGINEERING

THE EIGHTH INTERNATIONAL CONFERENCE
TRANSPORT AND LOGISTICS

til 2021

THE APPLICATION OF CAMERAS ON THE HEAVY DUTY VEHICLES WITH AIM TO INCREASE THE DRIVER VISUAL FIELD

Nadica STOJANOVIĆ[1]
Ivan GRUJIĆ[1]
Jasna GLIŠOVIĆ[1]
Bojana BOŠKOVIĆ[2]
Saša VASILJEVIĆ[2]

[1)] *University of Kragujevac, Faculty of Engineering, Sestre Janjic 6, 34000 Kragujevac, Serbia*
[2)] *Academy of professional studies Šumadija, Department in Kragujevac, Serbia*

Abstract

Today, the big attention is giving to the traffic safety. By technology progression, as well as it application on the vehicles, the traffic accidents were reduced significantly. The drivers of the heavy duty vehicles, because of dimensions, in great number of situations cannot see other traffic participants, whether it was a vulnerable group or a car. So because of this reasons, cameras and sensors have found application at vehicles, and which in each moment are providing information to the driver if near him is other traffic participant. In this paper, will be shown the visual field of the driver of the heavy duty vehicle by application of mirrors and cameras in RAMSIS software package. It comes to the conclusion that on the vehicle is better to use cameras instead mirrors, because on this way the visual field as well as the traffic safety are increasing.

Key words*: cameras, sensors, traffic safety, visual field, RAMSIS.*

1 INTRODUCTION

Trucks usually have mirrors mounted on them, however, on some trucks can be found and cameras, all with purpose to reduce the blind spots around the vehicle, and to increase the visual field of the driver. The greatest influence on the blind spots has the size of the vehicle which is driven [1], while the design of the vehicle, doesn't have great influence. However, in the case of the heavy duty vehicles, N3 category, lower cab can provide beater visibility to the driver, which is very important, especially when this kind of vehicle is driven in urban areas [2].

The greatest problem, that is the reduction of the visual field appears during the drive in the curve , on which the greatest influence are having the design of the vehicle, as well as the parts which are mounted on the vehicle [3]. Cameras are having several advantages. First of all, cameras are providing beater visibility to the driver around the vehicle [4], and besides this, are influencing on the air resistance reduction [5]. Besides this, cameras can be mounted and in blind spots, with purpose to prevent the traffic accidents with the vulnerable traffic participants group [6], and besides this, usually are used in combination with sensors and alarms, in order to warn the driver about existence off accidental situation [7, 8].

So, cameras are providing safe ride to the driver, even when his concentration is very low, that is, when the driver is distracted. The applied of systems which are detecting the vehicle in the blind spot and are warning the driver, are working with the precision of 87% [9].

Fig. 1 *Working place of truck driver [10]*

The demands related to the visual field of the driver, and which are set for one vehicle, are defined as 2D areas which are projected on the road plane. The area covered by mirrors, is shown on the Figure 2, which is defined by UNECE Regulation 46, and that [11]:

- Class II - Main rear-view device on the driver's side and the passenger's side;
- Class IV Wide-angle view device on the driver's side and the passenger's side;
- Class V close-proximity view device, and
- Class VI front-view device.

Earlier, the visual field of the driver was determined by lights, which were mounted at the hight of the drivers eyes [14], while thanks to the technology progression, today are used a specialized software tool for visual field determination [15]. The specialized software's are providing the representation of the three-dimensional visual field in each mirror [5, 16].

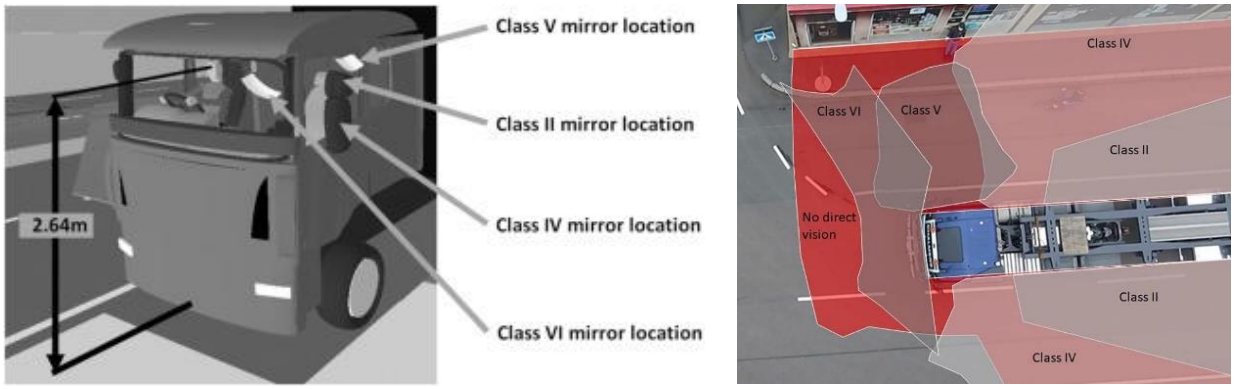


Fig. 2 Mirrors classification according to the Regulation 46 [12, 13]

The aim of the paper is the representation the visual field of the driver, when convex mirrors are applied, and when cameras are applied, with a review of previous researches, why is beater to use cameras instead the mirrors.

2 3D MODEL

With aim to determine the visual field of the driver, it is necessary to create a three-dimensional model of the heavy duty vehicle, which was created in real size, Figure 3. The applied software for the creation of the three-dimensional model of heavy duty vehicle is CATIA, while the analysis of the driver visual field was also conducted in CATIA, in the software add-on RAMSIS. In order to determine the visual field of the driver, it is necessary in the assembly to import human, and besides that to choose: the gender, to which population he belongs, years and anthropometric characteristics. RAMSIS in its library already has a specific human population with anthropometric characteristics which can be used in the further analysis. However, it provides the possibility of human population creating, where anthropometric characteristics can be defined. For the analysis conducted in this paper, it was used human model which already exists in library of the RAMSIS. On the Figure 4 are given the main anthropometric characteristics of the applied human model, for the analysis of the visual field of the driver.

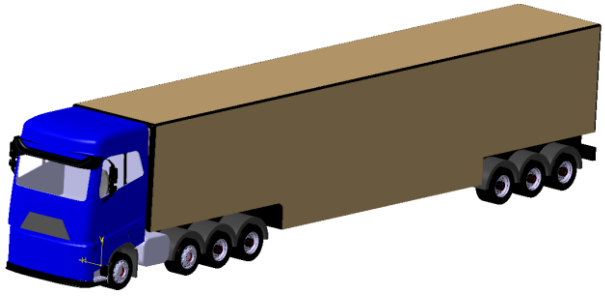
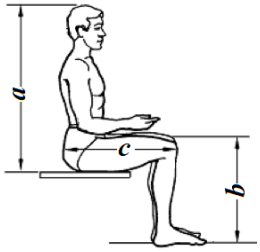


Fig. 3 *3D model of heavy duty vehicle - category N3*

RAMSIS allows the representation of the visual field of the driver, when mirrors are used, either flat or convex, or when cameras are used. Either mirrors or cameras are applied at the heavy duty vehicle, it is possible their adjustment, so can cover the area defined by Regulation 46. How in continues of the paper will be compared the visual field of the driver when mirrors are used and when cameras are used, on the Figure 5 is shown the shape of the mirrors, as well as which mirrors will be observed. While the camera will be in the centre of greater mirror, and which in horizontal plane covers 70° of the surface, while in vertical plane covers 50°.



Body height, mm	1771
Siting height (a), mm	221
Knee height sitting (b), mm	563
Buttock knee length (c), mm	616
Gender	Male

Fig. 4 *Human anthropometric characteristics [17, 18]*

Mirror parameters, are next. The width of the mirror is 230 mm and height is 360 mm, Figure 5.a, and the surface of the mirror is convex, and the radius of the mirror is 1500 mm. By Figure 5, is shown, which mirrors (marked mirrors, Figure 5.b) will be further considered in the paper.

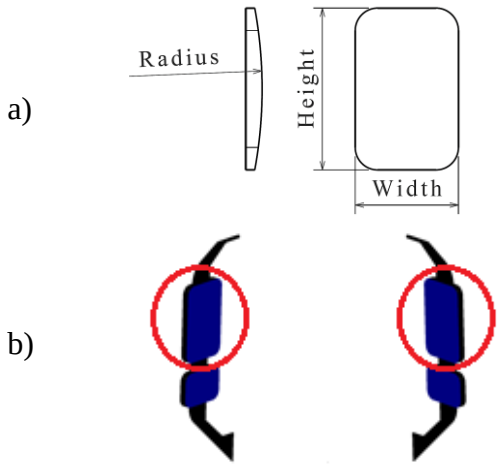


Fig. 5 *a) Considered dimensions of mirrors, b) The applied side mirrors of analysed vehicle*

3 THE REPRESENTATION OF THE VISUAL FIELD AND DISCUSSION

Today, on the trucks are using a convex mirrors. By application of convex mirrors, different from the mirrors,

where the surface is flat, the area of the visual field is significantly greater. However, even with the application of convex mirrors, still are existing blind spots, and because of this is tends to the application of newest technology, and all with purpose to increase the safety of the driver and of other traffic participants. In this paper were considered only the class IV mirrors, Figures 6 and 7. The class IV mirrors are adjusted according to the driver which controls presented vehicle, as well as according to the Regulation 46. On Figures 8 and 9, is shown the space around the truck, when instead mirrors, are used cameras. It can be noticed, that by cameras usage, much greater area around the vehicle is covered. Mutual, for the mirrors and cameras which are used on the vehicle, if the driver which currently drives hasn't adjusted them, and how is defined with Regulation 46, the driver will not notice in time what happens on the road (behind and in front of him), which further can led to the traffic accident [16]. However, what is different when the cameras are used in respect to the mirrors, cameras are not necessary to be adjusted by each next driver according to himself, this is when more drivers are driving the same truck, which is not the case with the mirrors.

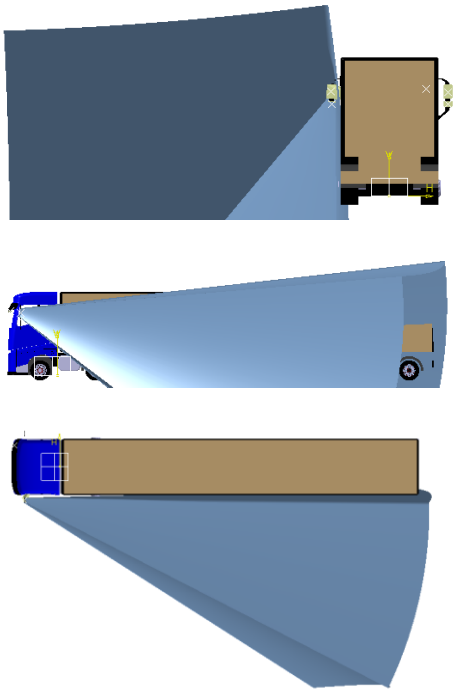


Fig. 6 *Visual field in left mirror*

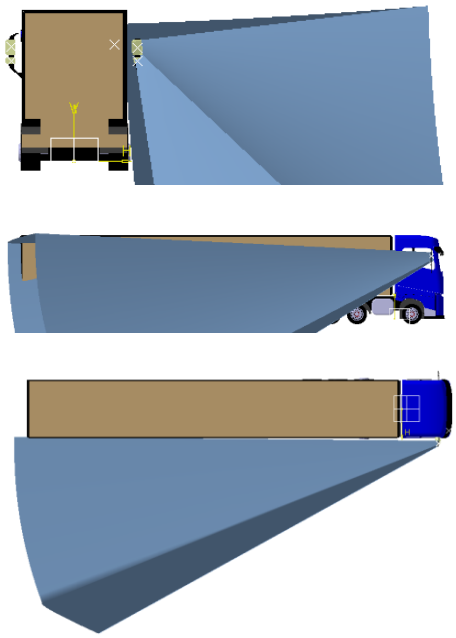


Fig. 7 *Visual field in right mirror*

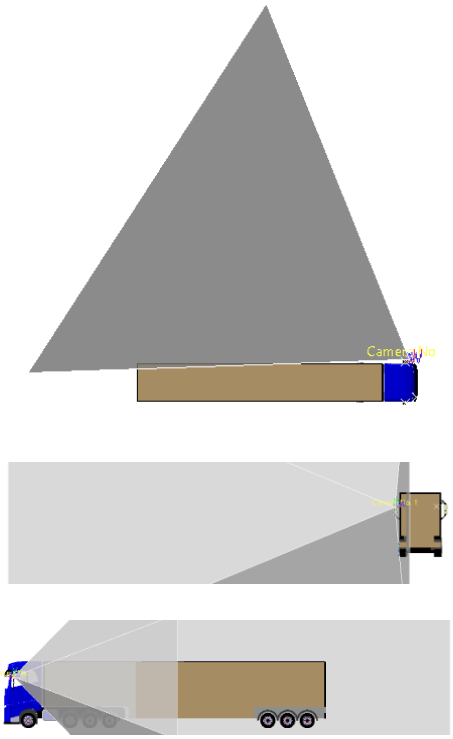


Fig. 8 *Visual field from left camera*

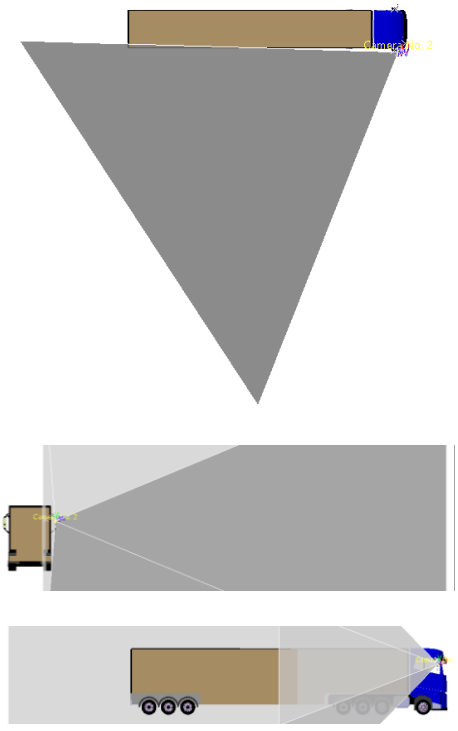


Fig. *9 Visual field from right camera*

Which at the same time represent and advantage when cameras are used, because a less time is necessary to the driver to prepare the vehicle for the trip.

On more advantage of the cameras in respect to the mirrors, is the reduction of air resistance, which was investigated in the earlier researches [5]. Cameras are never used alone, but besides cameras, are using and other systems, which are serving, to additionally simplify the control of the vehicle [7, 8, 10].

4 CONCLUSION

By technology progression, and it application in everyday people activities, work is greatly facilitated, and besides that, the level of safety increases. In the case of the traffic, it is very important to provide an easy vehicle control to the driver, because many information's which are arriving to the driver in each moment, and a little inattention can cause a traffic accident. By replacing the traditional mirrors with cameras, significantly improves the visual field of the driver, but only in the case if is adjusted according to driver and according to the Regulation 46.in future researches, should consider the replacement of all mirrors with cameras, and it should take into consideration, the cost effectiveness of cameras usage.

ACKNOWLEDGMENT

This paper was realized within the framework of the project "The research of vehicle safety as part of a cybernetic system: Driver-Vehicle-Environment", ref. no. TR35041, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

REFERENCES

1. Summerskill S., Marshall, R., 2016, *Understanding direct and indirect driver vision from heavy goods vehicles.*
2. Summerskill, S., Marshall, R., 2015, *The development of a truck concept to allow improved direct vision of vulnerable road users by drivers*, Procedia Manufacturing, 3, pp. 3717-3724,.
3. Gattis, J.L., Low, S.T., 1998, *Intersection angle geometry and the driver's field of view*, Transportation Research Record, 1612(1), pp. 10-16.
4. Fitch, G.M., Blanco, M., Camden, M.C., Olson, R.L., McClafferty, J., Morgan, J.F., Wharton, A.E., Howard, H.E., Trimble, T., Hanowski, R. J., 2011, *Field Demonstration of Heavy Vehicle Camera/Video Imaging Systems: Final Report*, U.S. Department of Transportation, National Highway, Blacksburg.
5. Stojanovic N., Grujic I., Glisovic J., Abdullah O. I., VasiljevicS., 2019, *Application of new technologies to improve the visual field of heavy duty vehicles' drivers*, in 5th International Conference "NEW TECHNOLOGIES, DEVELOPMENT AND APPLICATION" NT-2019, Sarajevo.
6. Ra, M., Jung, H.G., Suhr, J.K. Kim, W.-Y., 2018, *Part-based vehicle detection in side-rectilinear images for blind-spot detection*, Expert Systems with Applications, 101, pp. 116-128.
7. Bosch, Available: https://www.bosch-mobility-solutions.com/en/solutions/assistance-systems/blind-spot-detection-cv/, accessed 31.07.2021.
8. Continental, Available: https://www.continental-automotive.com/en-gl/Trucks-Buses/Vehicle-Chassis-Body/safety-topics/Functions/Right-Turn-Assist, accesed 01.08.2021.
9. Singh, S., Meng, R., Nelakuditi, S., Tong, Y., Wang, S., 2014, *Sideeye: Mobile assistant for blind spot monitoring*, in 2014 international conference on computing, networking and communications (ICNC), Honolulu.
10. Ttnews, Available: https://www.ttnews.com/articles/fleets-eye-camera-systems-replace-mirrors, accessed 31.07.2021.
11. Regulation No 46 of the Economic Commission for Europe of the United Nations (UNECE) — Uniform provisions concerning the approval of devices for indirect vision and of motor vehicles with regard to the installation of these devices.
12. Summerskill, S., Marshall, R., Cook, S., Lenard, J., Richardson, J., 2016, *The use of volumetric projections in Digital Human Modelling software for the identification of Large Goods Vehicle blind spots*, Applied Ergonomics, 53(A), pp. 267-280.
13. Schindler, R., Piccinini, G.B., 2021, *Truck drivers' behavior in encounters with vulnerable road users at intersections: Results from a test-track experiment*, Accident Analysis and Prevention, 159, p. 106289.
14. Kabir, S.N., Song, M., Chung, S.-O., Chung, S.-O., Kim, S.-C., Ha, J.-K., 2015, *Visibility evaluation for agricultural tractor operators according to ISO 5006 and 5721-1 standards*, Journal of Biosystems Engineering, 40(1), pp. 19-27.
15. Ball, J. K., Danaher, D.A., Ziernick, R.M., 2007, *A method for determining and presenting driver visibility in commercial vehicles*, SAE International, 2007-01-4232.
16. Stojanović, N., Grujić, I., Dorić, J., Vasiljević, S., Bošković, B., 2019, The influence of mirrors position on the driver visual field," in The 7th International Conference Transport and Logistics, Niš.
17. Dined, Available: https://dined.io.tudelft.nl/en/database/tool, Accessed 29.07.2021.
18. CH Design, Available: http://ch-design.weebly.com/chair-project/ergonomics-for-chair, Accessed 29.07.2021.

Contact address:
Nadica Stojanović
University of Kragujevac
Faculty of Engineering University of Kragujevac
34000 Kragujevac
Sestre Janjić 6
E-mail: nadica.stojanovic@kg.ac.rs