



Časopis Naučnog društva za pogonske mašine, traktore i održavanje  
Journal of Scientific Society of Power Machines, Tractors and Maintenance

# TRAKTORI

# I

# POGONSKE MAŠINE

# TRACTORS AND POWER MACHINES

# 1/2

UDK 631.372

ISSN 0354-9496

Godina 26

Dec. 2021.



**Novi Sad, Srbija**

Trakt. i pog. maš., Trac. and pow. mach., Vol. 26, No. 1/2, p.1-73, Novi Sad, Dec. 2021.





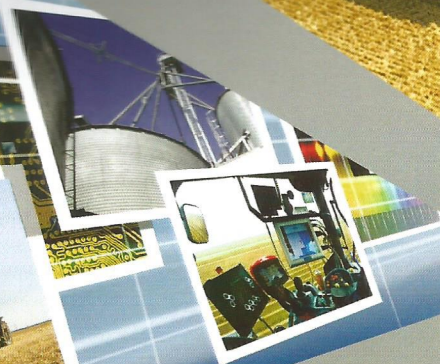
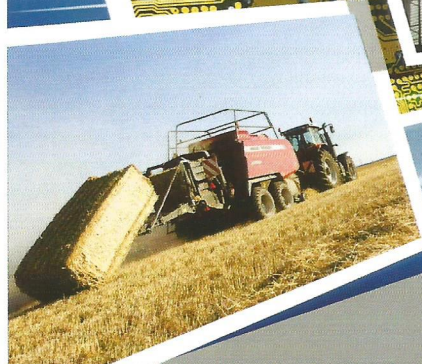
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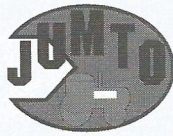
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Izdavač – Publisher



*Naučno društvo za pogonske mašine, traktore i održavanje*  
*Scientific Society of Power Machines, Tractors and Maintenance*

Suizdavač – Copublisher

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Časopis izlazi svaka tri meseca

Godišnja pretplata za radne organizacije je 1500 din, za

Inostranstvo 5000 din a za individualne predplatnike 1000 din

Žiro račun: 340-4148-96 kod Erste banke

Rešenjem Ministarstva za informacije Republike Srbije, Br.651-115/97-03 od 10.02.1997.god., časopis je upisan u registar pod brojem 2310

Prema Mišljenju Ministarstva za nauku, Republike Srbije ovaj časopis je "PUBLIKACIJA OD POSEBNOG INTERESA ZA NAUKU"

Jurnal is published four times a year

Subscription price for organization is 40 EURO, for

foreign organization 80 EURO and individual

subscribes 15 EURO

Štampa – Printed by

Štamparija "BIROGRAF COMP" doo, 11080 Zemun, Atanasija Pulje 22

Tiraž 100 primeraka



# TRAKTORI I POGONSKE MAŠINE

TRACTORS AND POWER MACHINES

1/2

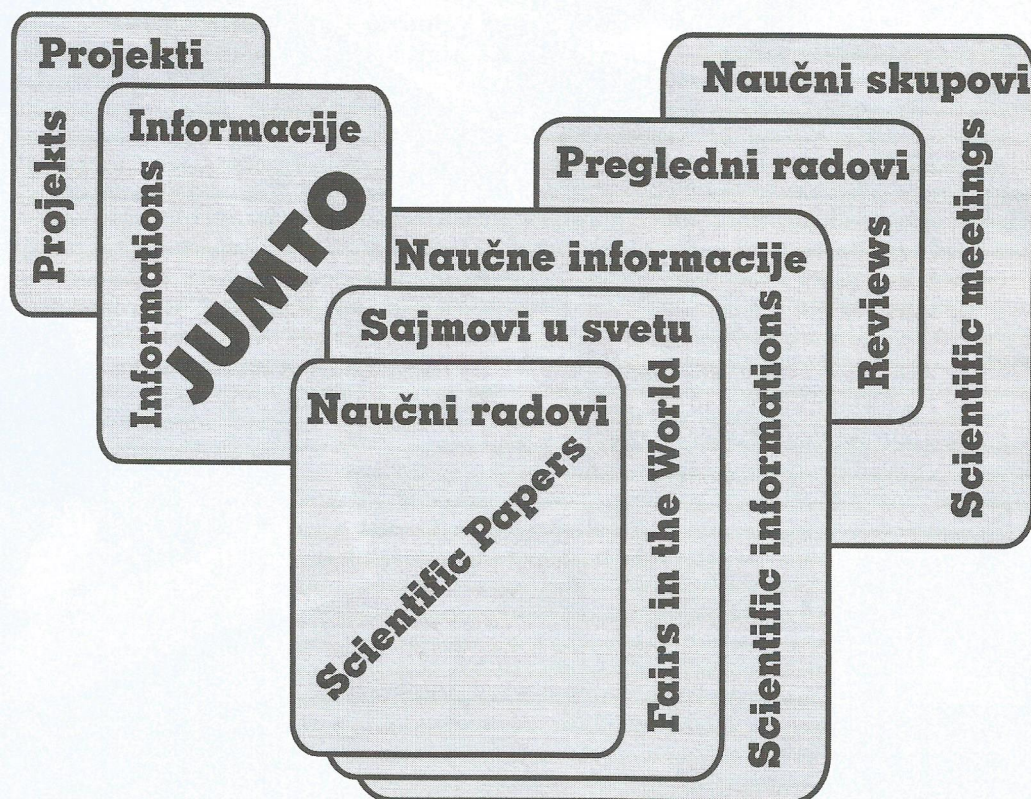
UDK 631.372

ISSN 0354-9496

Godina 26

Dec. 2021.

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Novi Sad, Srbija



**Časopis Traktori i pogonske  
mašine broj 1/2 posvećen je  
XXVIII-om naučnom skupu  
“Pravci razvoja traktora i  
obnovljivih izvora energije”**

**The journal Tractors and power  
machines number 1/2 is devoted to  
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### Place of meeting

**Poljoprivredni fakultet, Novi Sad, 03.12.2021.**

Štampanje ove publikacije pomoglo je:

Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije  
Pokrajinski sekretarijat za visoko obrazovanje i naučnoistraživačku delatnost AP Vojvodine  
Pokrajinski sekretarijat za poljoprivredu, vodoprivredu i šumarstvo AP Vojvodine



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Biblid: 0354-9496(2021) 26: 1/2, p. 21-27  
UDK: 631.372

Naučni rad  
Scientific paper

## THE AGRICULTURAL TRACTOR VISUAL FIELD ANALYSIS

Stojanović, N.<sup>1</sup>, Grujić, I.<sup>2</sup>, Glišović, J.<sup>3</sup>, Bošković, B.<sup>4</sup>

### SUMMARY

*In the period from 2016. to 2018., in the Republic of Serbia, happened 118 traffic accident with fatal outcome, in which tractors were participated, and 811 traffic accidents, in which people were injured, where also tractors were participated. On the basis of which, are arise conclusions, that and tractors are participating in traffic, how in the inhabited places as well as outside the inhabited places. There are many factors because of which are happening traffic accidents and that: driver mistake, unadjusted speed, stability loosing, landing off the road, inappropriate maintaining, etc. this paper includes the analysis of the tractor driver visual field, during exiting from the byroad, at the main road, by application of the RAMSIS software package. Also, the analysis includes and when the driver exits on the place where the visibility is poor, because of the curve or trees which are at the side of the road.*

**Key words:** traffic accident, visual field, RAMSIS, tractor.

### INTRODUCTION

During car driving in the traffic, the visual conscience is very important. However, when it comes to tractors, the situation is much more complicated, because for tractors are not existing defined standards [1], and about them is discussing very little. During the work on the field, for example during the plowing, the operator must supervise the plow constantly, as well as the plow trajectory (Figure 1). In such situation, it is very important the vehicle design, which will provide to the operator to have good visibility, as well as the sensors application, which will warn the operator about existing obstacles. Determination of the visual field of the tractor driver, by traditional methods was conducting by lights montage in the tractor cabin, and in this way, was marked the surface of the tractor driver visual field [2]. Thanks to further technology progression, the traditional investigation methods can be successfully replaced with application of some specialized software packages, such are JACK, RAMSIS, SAMMIE CAD and ManneQuinPRO [3].

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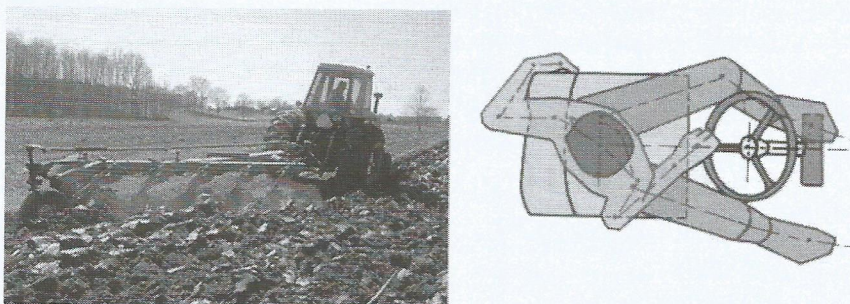


Fig. 1. Presentation of the (a) tractor and (b) position of the operator during the plowing [3]

When it comes to tractor as the vehicle, which participates in the traffic, the following irregularities can be noticed [4]:

- ◆ Driving in the alcoholic state,
- ◆ The tractor driver, during the work don't have in his possession first aid kit,
- ◆ Tractors which are participating in the traffic are not having adequate markers, as well as the trailers,
- ◆ The tractors overloading, by which are obscuring the light signalization and in this way are making harder to the other traffic participants to see them,
- ◆ Malfunction of light signalization, and etc.

Averagely, during the year, in Republic of Serbia happens around 561 traffic accident, in which of the participants was tractor. Tractors have participated in around 1.6% of all traffic accidents (Figure 2.a). Averagely, the number of people that dies in traffic accidents, where tractors participated, is around 42, which is 7% of entire number of people which have died because of traffic accident, and around 424 people be injured, which is 2% of all injured cases from traffic accidents [5]. It exists relatively stable trend of reduction of the number of dead and injured people in traffic accidents, where tractor have participated, with exception for year 2016 (Figure 2.b).

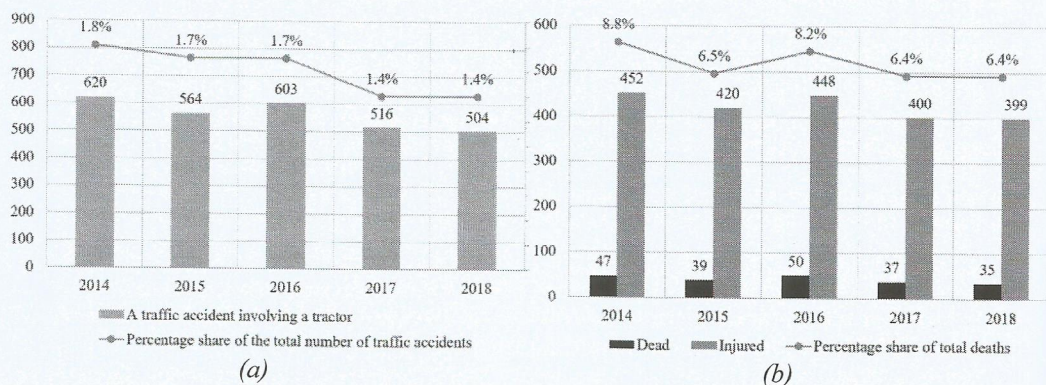


Fig. 2. (a) Number of traffic accidents where participated tractors from entire number of traffic accidents and (b) number of dead and injured in traffic accidents, where tractors have participated [5]

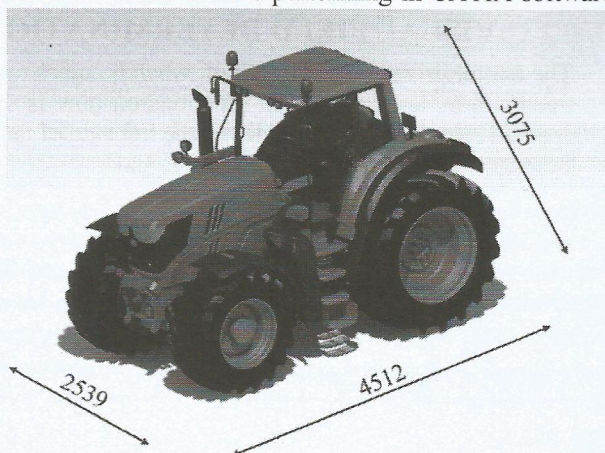


The aim of the paper is representation the visual field of the tractor driver, when it comes out from the field road on the main road, as well as the representation of the modern systems on tractor, with aim to increase the safety of the tractor drivers, even in the conditions of poor visibility.

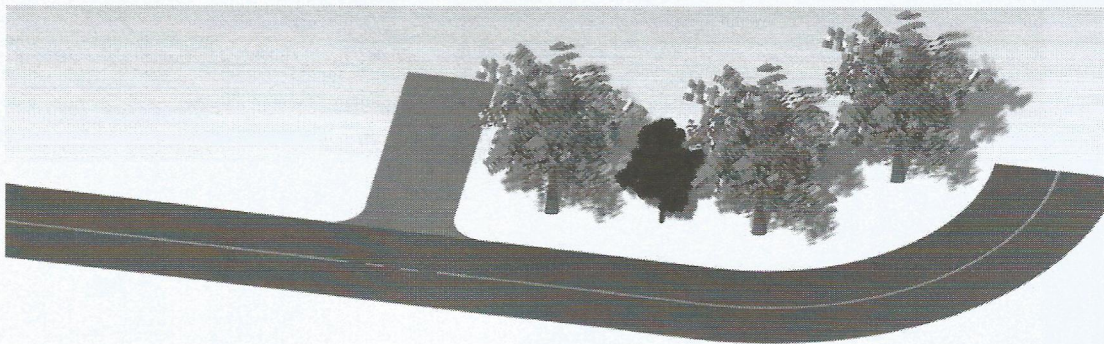
### 3D MODELS

In order to determine the tractor driver visual field, it is necessary to create the three-dimensional model of tractor in real size, Figure 3. Besides, the three-dimensional model, are given and basic overall dimensions. The next step is the creation of one virtual surrounding, in which is investigation the tractor driver visual field, Figure 4. The models of tractor and virtual surrounding were created in Solid Works software package, and after that, the assembly was saved as .step file, because, the analysis of the visual field is performing in CATIA software package, RAMSIS module.

In order to determine the tractor driver visual field, it is necessary to import human into the assembly, to define gender, to which population belongs, years and anthropometric characteristics. RAMSIS in it library has a certain people population with anthropometric characteristics, which can be used in the further analysis. However, it provides the possibility of the people population creation, where can be defined the anthropometric characteristics. For the analysis conducted in this paper, is used human model, which already exists in the RAMSIS library. The basic anthropometric characteristics of the applied human model, are given on the Figure 5.

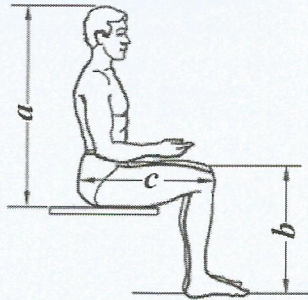


*Fig. 3. 3D model of an agricultural tractor with overall dimensions*



*Fig. 4. Virtual surrounding*





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

Fig. 5. Anthropometric characteristics of the applied human model [6, 7]

## VISUAL FIELD DETERMINATION

The tractor driver stops the tractor, when it comes to the main road (Figure 6). No matter if the tractor turns left or right, in the situation how is shown on the Figure 6, the only problem appears because of its left side. At the left side of the tractor, in the position from the Figure 6, trees are located, as well as the curve, and because of this, the visibility is reduced. While at its right side, no obstacles/objects are present, which can influence on visibility during the tractors exiting on the main road. In order to observe the current surrounding as best as possible, the tractor driver firstly turns the head, and after that if is necessary, he turns and the upper body. So, with the Figure 7.a is shown, around which joints will be performed the head rotation, and after that the body rotation in RAMSIS, all with aim for driver to see around him as best as possible. On the Figure 7.b is shown the structure of the segment of the spine.



Fig. 6 The representation of the situation when tractor comes out on the main road (a) at right side of the driver (b) from top

When driver comes to the main rod, and in the case if he watch straight ahead, what he sees and how he sees, is shown on Figure 8.a. in order to see what is at left side or at the right side, it is necessary to turn the head or head and body, and besides that, all commands should be in the reachable area for him. The next situations, when driver turns the head around the cervical joint for  $30^\circ$  and upper body around the cervical-thoracal joint for  $20^\circ$ , and in this situation driver can see all to the beginning of curve (Figure 8.b). If beside the totation of the head around the cervical joint and upper body around the cervical-thoracal joint, he turns and body around the thoracal joint for  $20^\circ$ , he can see what is shown on the Figure 8.c. he can see in this situation, a little bit more than in the situation shown on the Figure 8.b.



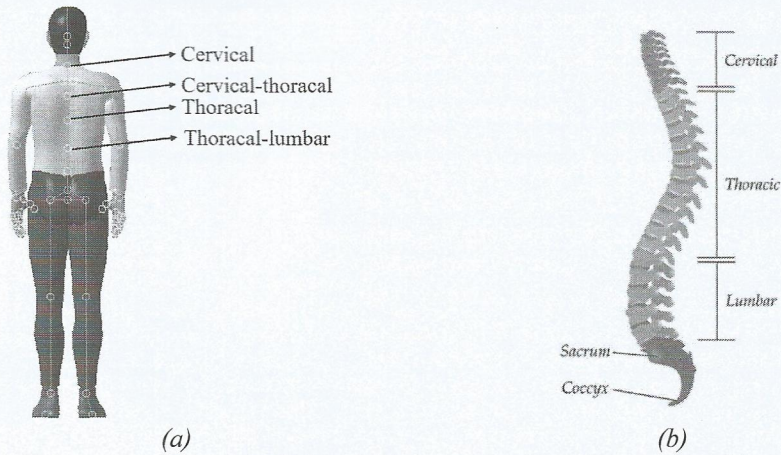


Fig. 7. (a) Human model in RAMSIS and (b) the structure of the segment of the spine [8]

However, in this case, on the visibility influences also and the pillar of the tractor cabin. Besides three mentioned joints, if driver rotates the body and around the thoracal-lumbar joint for  $8^\circ$ , the visual field of the tractor driver improves significantly, Figure 8.d. However, because of the trees at the left side, the car in the shown situation from the Figure 6.b, it is just looming. However, here comes the question, will the tractor driver will see it, or not? After long and exhausting day on the field, the concertation and attention of the tractor driver are quite lower, which lead to the conclusion that the tractor driver will not see the car.

No matter to, the taken body position as such to see the surrounding as best as possible, the trees and curve at the left side of the tractor driver, are influencing on the reduction of the visual field of the tractor driver, and by this are making critical situation, each time, when he needs to exit on the main road.

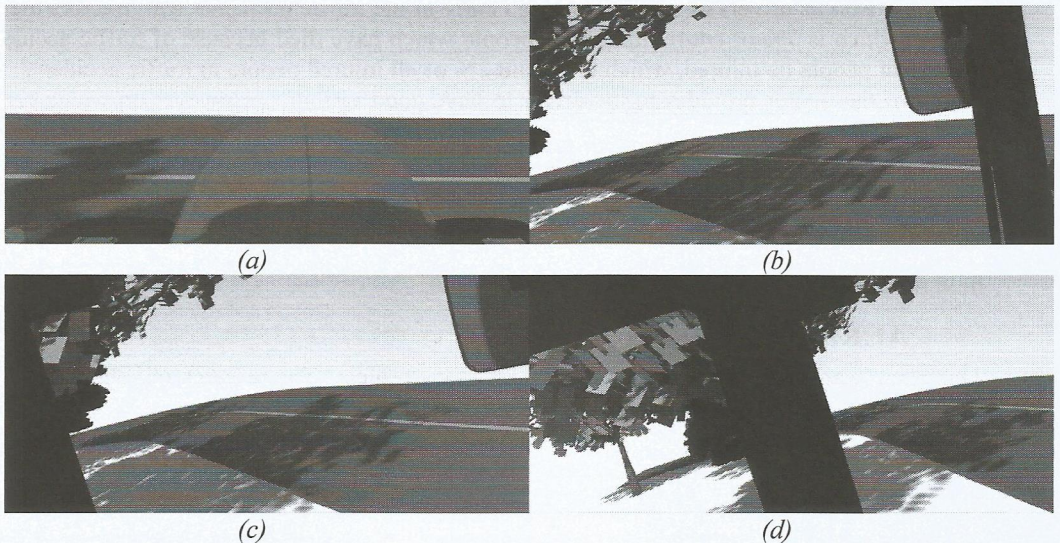


Fig. 8. The representation of the tractor diver visual field in the case when (a) looks straight ahead, (b) turns head and (c) and (d) turns head and body



## THE APPLICATION OF THE NEW TECHNOLOGIES AT THE AGRICULTURAL TRACTOR

The application terrestrial laser scanning (TLS) provides one of the most progressive methods for obtaining information's about objects, and it provides the assessment of the driver visual field during the driving of how agricultural so and forest tractor [9]. In order for the tractor driver see better the working surrounding even in the conditions when it works at night, and to notice the obstacle or people at time, the application have found systems which are using in automotive industry, and that RSM Night Vision System [10]. The working place of the driver of agricultural tractors - T7 HEAVY DUTY - STAGE V, is shown on Figure 9. The tractor is equipped with mirrors, which allowing to the driver to see what happen, in almost each moment. Besides that, on the rear side of the tractor can be found integrated camera, by which, in each moment, driver can follow on the Command Center Display what happens behind him, that is to follow the work of tools which are mounted on tractor [11].



Fig. 9. Driver working place [12]

### CONCLUSION

Tractors are participating in traffic how in urban areas, so and out of them. On the traffic accident appearance are influencing the technical condition of tractor, tractor marking, tractor driver, as well as drivers of other vehicles. Yearly in the traffic accidents with tractors dies 42 people, which is 7% of entire number of people which have died because of traffic accidents, while 424 people be injured, which is around 2% of all injured people in traffic accidents. The design of the tractor provides to the driver to have good visibility. However on which cannot be influenced, are obstacles/objects, which can be found near to the roads where tractor are going, and which can reduce the tractor driver visual field, which was shown in this paper. Besides application of modern systems on tractors, with aim to facilitate tractor control, it is necessary the increased control on the roads and the introduction of stricter measures in case of non-compliance of prescribed traffic signs on sections, where the main road are crossing with field roads.

### ACKNOWLEDGMENTS

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.

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Rad primljen: 24.09.2021.

Rad prihvaćen: 10.10.2021.