DEVELOP AN INTELLIGENT TELEMATICS SYSTEM FOR THE MEASUREMENT OF THE INDEX COMFORT PASSENGERS FOR THE PUBLIC TRANSPORT COMPANIES

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The existing demand to increase the atractivity of the public transport activities requires developing an intelligent telematics tool in order to be able to define and measure the comfort passangers function. At the moment such tools are considered insufficiently developed to address the current challenges to the public transport demand quality. Addressing these issues can be done only through multilateral scientific approach based on mathematical algorithms, psycology functions, quantitative and qualitative behaviour parameters, transport science, electronics and software development.

In order to tackle this challenge, our team has developed a telematics integrated platform system that was tested this year on all types of vehicles at RAT Timişoara (Romania). The paper also contributes to develop a new evaluation parameter for the passengers comfort quality in real traffic conditions related to the driving skills and the model of the driver behaviour.

It has also an important contribution at the development of the right behaviour and skills for the future drivers related to the passengers comfort quality function. In the same time the telematics platform that has been developed could be used in order to test and evaluate in real time any driver in any vehicle in respect to the passengers comfort function.

Keywords: telematics, quantitative/ qualitative behavior parameters, intelligent systems, passengers comfort quality index, real time.

1. Introduction

The telematics platform system named LG-DS KIT (Ladies&Gentlemen Drivers System) was developed in two main versions for two main purposes. One purpose is to be used the LGDS platform as a tool in order to be able to measure the passangers comfort index (PCI) in real time (LGDS-R&D). The second platform version(LGDS AiO BB) was developed to fulfil the market requirement in the field of the practical training, assessment and testing of any type of driver.

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LG-DS platform is depicted in the figure nr. 1 and how LGDS GUI is used as a "tool for researcher to make remarks in real time" is presented in figure nr. 2. LGDS represents an open and advanced computerised telematics intelligent IT system similar to the black box system that is installed in any plain [1],[2]. LGDS represents an intelligent tool that includes a data acquisition platform with integrated software, mathematical algorithms and a hardware sensors system for the driver behaviour evaluation in real time. It includes: a software that process/ analyse in real time the quality factors related to the comfort passenger functions, the driver behaviour, 2/4 video cameras with special lens embedded with an audio system and together integrated with a special rack/mounting system, a set of movement sensors for 3D directions, a GPS system and a PC tablet with touch screen [3].
The LGDS platform is complementary with other tools that are used in the traffic psychology, personnel tests and psychological assessment areas for the drivers training as Vienna Test System (VTS)[4]

Fig.1 LGDS-KIT

Fig. 2 Tool for researcher remarks

The tool developed has a user-friendly interface through the symbiosis of hardware, software, mathematical algorithms and psychological expertise integrated. LG-DS could be used in different situations as follows: to measure the comfort passengers index for any type of public transport vehicle, by any Public Transport Company, by any Training Center, by the Drivers Schools during the practical training of the future drivers, during the final drivers examination, during different tests to improve the driving skills for different existing categories of drivers (that transport dangerous goods, firemen, military transports, etc) or for the companies that have big fleet and yearly based shall test the skills of their employees, etc.
LGDS platform has unique, innovative and different features compared to VTS system, that is strictly towards psychological assessment for individual people without to have directly any link to a vehicle. The practical tests are based on a computer integrated system and is done in real time direct on the vehicle. The LGDS platform could also highlighted the green-feature for each type of vehicle related to a certain driver behaviour that could be used in assesment in real time of

the green-transport feature of any transportation mean for any transport company. In the first sections of this paper is described briefly how it works in practice the LGDS platform. Further, this paper refers at the first version of the LGDS platform used to measure the passenger comfort and the different psychological quantitative and qualitative criteria, cognitive analysis are presented related to the passengers conform function [5] in order to develop the passenger comfort index diagram, as quality factor for a public transport company.

2. How it works the LG-DS platform?

The platform could be easy installed in any type of vehicle and further done the plugging in a computer. The platform is ready when the red led of the LG-DS platform stops flashing, and then only start the LG-DS software [6] for the new session. Other complementary examples related to the diver behaviour are presented in reference [7]. An overview of the road and how is recording the data are represented in figure nr.3 and figure nr. 4, respectively. In the database could be easy found the file that shall be loaded by using LG-DS load function. The data recorded either could be processed locally on the tablet PC or centrally on a server site or both. If is processed centrally, then the data are sent through 3G/4G network in XML format via a communication device direct to the server site. There are recorded the 3D data on all 3D axes: X, Y, Z in real time. For example:

- red line showing the longitudinal forces undergone by the car (braking (up) or accelerating (down))
- blue line showing the centrifugal forces undergone by the car (turning right (up) or left (down))
- the green line showing the vertical forces undergone by the car (going up and down)
- the beacons corresponding to the remarks made by the checker (red, green, blue and yellow arrows).

In order to navigate trough the time line, shall be used a double click function anywhere and the movies (camera 1 and camera 2) will be forwarded or rewinded to that moment.

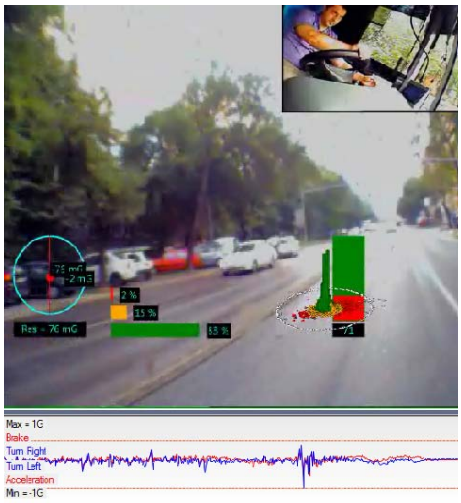


Fig. 3 Overview on the road

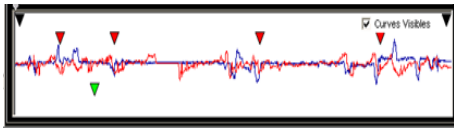


Fig.4 Data recorded-example

Fig. 5 An overview of an particularly event

Not only the images and the sound, gps data are synchronised, but the furthermore a yellow label appears with the corresponding remark. If suddenly appears a particularly event, the LGDS system is recorded as well. An example is presented in figure nr. 5. In the picture, the grey cursor indicates exactly the moment of the movie that the user is visualising. When double clicking on a green or red beacon, this cursor goes in fact to the corresponding moment, and even a few (from 0 to 10) seconds before: this is made to take into account the reflexes time of any checker. It is also possible to make a zoom on a particular zone of the journey or event as follows:

a)use the pen and draw a line from top left to bottom right to define the zone.
b)to zoom out, then a draw a line from bottom right to top left.
Every protocol offers several possibilities for the final quotation that could be: logical, mathematical or manual.

3. Data recording: data acquisition and data representations

The data are acquired and processed in real time by the LGDS platform, either locally or centrally or both. The data recorded were done in August 2014 at RATTimisoara (Regia Autonomă de Transport Timişoara, Romania) during a pilot project. All itineraries included in the pilot project are depicted in figure nr. 6 [8]. There were involved 12 vehicles in total, 4 for of each type and 12 drivers.

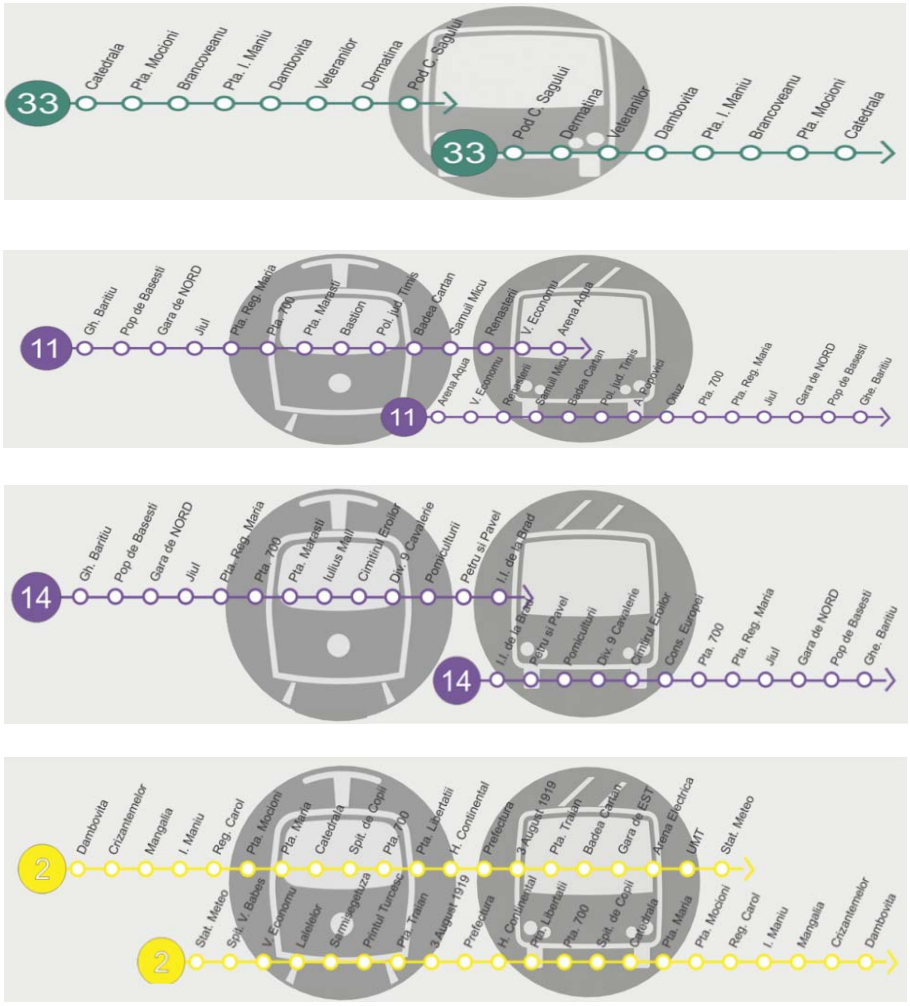


Fig. 6 Examples of itineraries at RAT Timisoara [8]

In the next figures are presented a few examples of the data recorded for buses (itinerary nr. 33), trolleybuses (itineraries nr. 11 and 14) and trams (itinerary nr. 2), respectively done at RAT Timisoara in August 2014. The data recorded from all the vehicles involved in the pilot project were about 1 TB/week. For each type of vehicle is presented a pair data: data recorded in real time & map representation. In the figures nr. 7 and nr. 8 are presented the pair data /map representation for a bus, in the figures nr. 9 and nr. 10 are presented the pair data /map representation for a trolleybus and in the figures nr. 11 and nr. 12 are presented the data /map representation for a tram, respectively.

Fig.7 Bus on the road-data recorded

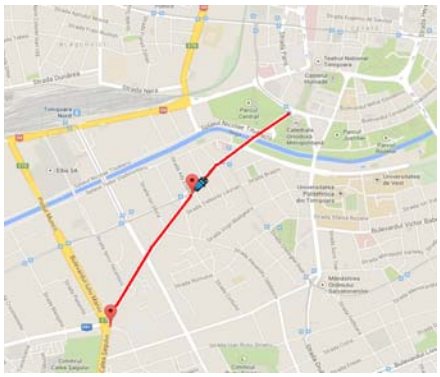


Fig.8 Itinerary for bus

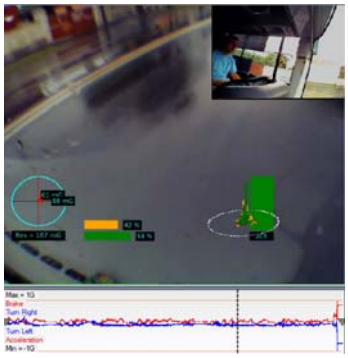


Fig.9 Trolleybus on the road-data recorded

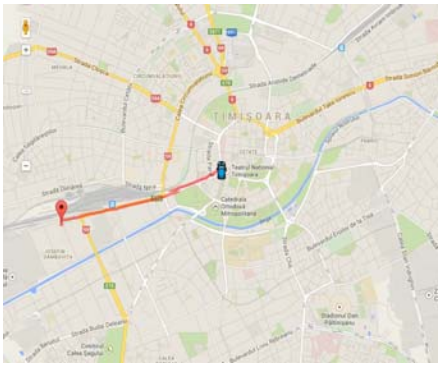


Fig.10 Itinerary for trolleybus

Fig.11 Tram on the road-data recorded

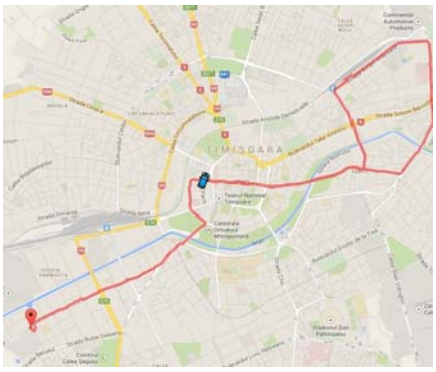


Fig.12 Itinerary for tram

4. Define the passenger comfort index

In order to define and further to measure the passengers comfort index diagram as a public transport quality factor, in this section is proposed the following 3 stages procedure as follows:

Stage 1) define a 2D and 3D matrix for the passengers comfort function: based on the data recorded for each type of vehicle and for each itinerary, there are proposed to define a 2D and 3D matrix for passenger comfort function foe each vehicle/itinerary in respect to the level of the g acceleration. The 2D/3D matrix is represented for each type of transportation mean below in this section in the figures nr. 13, 14, 15 respectively. The PCI for a vehicle is depicted in figure nr. 16. An example of the passengers comfort index diagram generated in real time with all 6 areas is represented in the figure nr. 16.

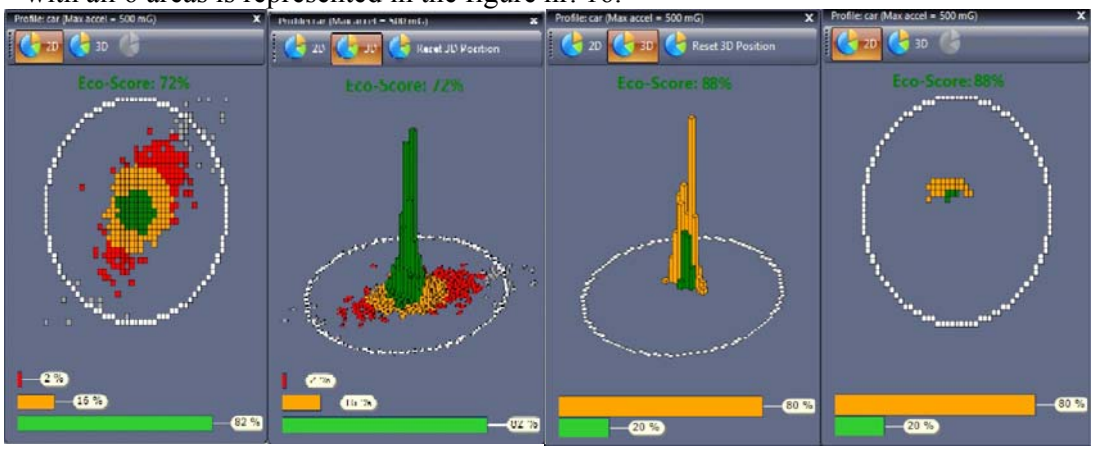


Fig. 13 3D/2D matrix representation for bus

Fig. 14 3D/2D matrix representation for trolleybus

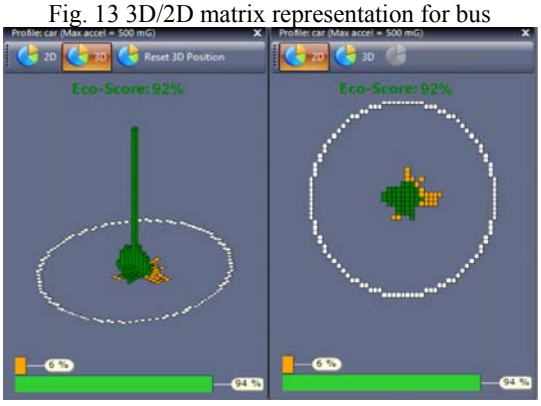


Fig. 15 3D/2D matrix representation for tram

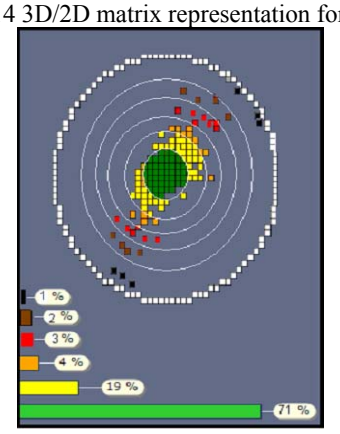


Fig. 16 The comfort index for a public transportation vehicle

Stage 2) develop the 3 steps mechanism for building the passengers comfort index diagram: for each type of data recorded, it is proposed in this section the following mechanism in 3 steps in order to build the passengers comfort index diagram as follows:

Step 1: acquire the data for forces, acceleration, speeds, gps in charts

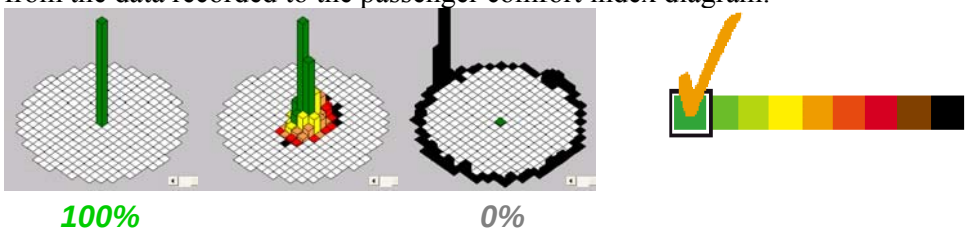
Step 3: translate the charts in 2D/3D histograms

Step 3: translate the 2D/3D histograms in passenger comfort index

Stage 3)define the 6 definition areas for the comfort passengers: for each type of vehicle and itinerary analysed, the passenger comfort index defined in this papers consider maximum 6 definition areas, each area divides the g acceleration in 6 sub-areas as follows:

- **green area**: very good comfort for passengers (0-1/6g)
- **yellow area**: good comfort for passengers [1/6g-2/6g)
- **orange area**: satisfactory comfort for passengers[2/6g-3/6g)
- **red area**: very poor comfort for passengers [3/6g-4/6g)
- **brown area**: unsatisfactory comfort for passengers [4/6g-5/6g)
- **black area**: very unsatisfactory comfort for passengers [5/6g-g)

The values of the limits of the passengers comfort index diagram are depicted in the figure 17. The 3 steps mechanism described above in order to build the passengers comfort index diagram is depicted in figure nr. 18. Those 6 defined areas are not compulsory to be all founded after the double mechanism translation from the data recorded to the passenger comfort index diagram.



From **green**= *from very good comfort* to the **black**=*the worst comfort for passengers*

Fig. 17 The values of the limits of the passengers comfort index diagram

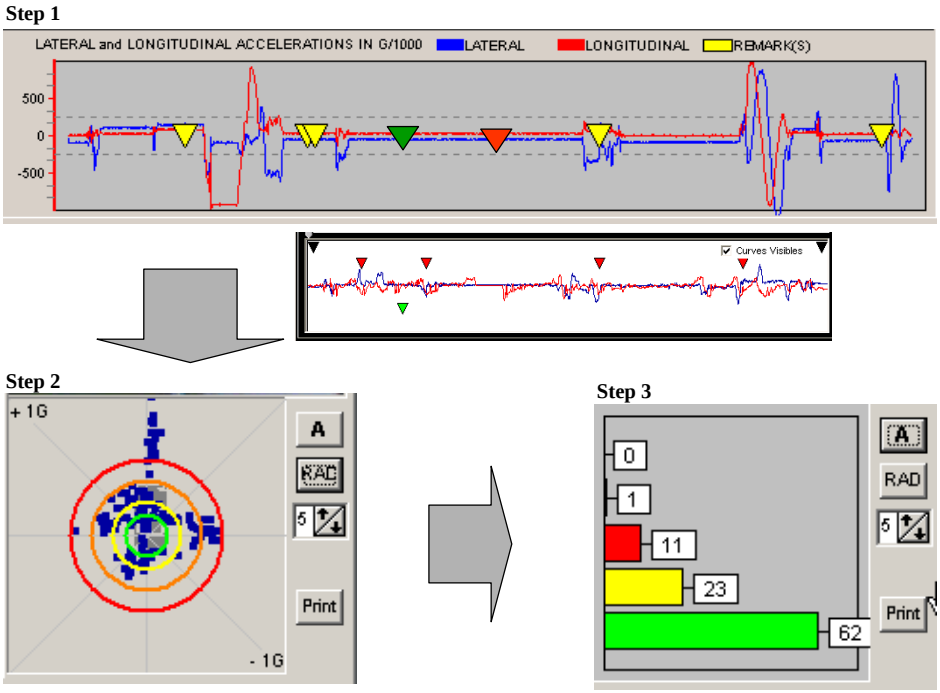


Fig. 18 The 3 steps mechanism to build the passengers comfort index diagram

5. Conclusions

In this paper were presented the development of the passengers quality index diagrams for 3 types of public transport vehicles on certain public transport itineraries, namely buses, trolleybuses and trams. In a similar manner could be developed and used further for any type of public transport vehicle, itinerary and certain driver. The were considered the qualitative and quantitative factors related to the driver behaviour model that could be applied to any type of transportation means: e.g. buses, trolleybuses, tram, metro, vans, trains, etc for both public and private transport companies.

The definition of the passengers comfort index diagram (PCI) described in this paper represents a quality factor for any public transport mean. The data are measured in real time traffic environment and has a very important role in order to assess if a transport company has or not the right level of the passenger comfort feature. As greener is the passenger comfort index as better is the public transport and that will provide more attractiveness for people to use it instead of the private cars. Every public transport company that is active on the transport market shall

quantify for every itinerary and every vehicle each year the level of the passengers comfort index diagram, as a index of their attractiveness.

The LGDS tool was developed for this purpose in order to help the stakeholders within the public transport companies to implement the right ecological transportation policy in order to improve the public transport quality and the attractiveness for people. The protocols used include different psychological quantitative and qualitative criteria, factors and mathematical algorithms that model the real driver behaviour in traffic. The LGDS could also contribute to develop the driving skills and the model the driver behaviour as ecological/green-feature in real traffic environment. In the same time could be used in order to assess and to evaluate a certain itinerary and a certain driver in real time.

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