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Exploitation of different technical scientific knowledge in optical systems for safety increasing in transportation

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Abstract

The article draws attention to using of headlights at different modes and with various sources of light. There are mentioned systems controlled by electronics for mostly active safety of an automobile caused by optimal illumination of road. From mentioned above results aim of the article - suggest to necessity of early and high quality preparation of specialists at field of automobile electronics.

Key words: automobile, optics, electronics, headlight, safety in transportation.

Introduction

Transportation of persons and goods is one of basic aspects of modern society functioning. There is estimation that drivers receive more than 80% of information by vision. This is reason why a lot of effort is focussed to aim: driver has to view as better as possible and his automobile has to be seen. For all that, lightning and light signalling of an automobile markedly influence active and passive safety of the automobile at road traffic. A lightning of an automobile was developed step by step and is developed by requirements of practice considering speed and density of traffic, but also depending up actual scientific knowledge and possibility to utilize it at practical activity.

Basic lightning of an automobile

Headlights, whether it is low-beam, high-beam or fog lamps, it helps to driver in case of reduced visibility to observe and to react to barrier in riding path in advance. Headlights at primary version used basic knowledge of optics: location of light source at focus of parabola caused beaming at needed direction. Optics at inside part of front window of headlights supported to form beam of headlights which illuminated road by required shape. Using of standard bulbs with two filaments for low-beam and high-beam lights produced only specific light beam, which limited used speed of vehicle to meet reasonable safety.

A principle of light beam formation required relatively large front surface of headlight, which was disadvantageous in term of vehicle aerodynamics, fuel consumption, effect to environment and all together related contexts.

Fig. 1. Headlights with standard optic reflector and modern headlight [Internet 3]

Computers with 3D design software enabled design of reflector surface which consist of several reflecting areas. These reflecting areas effectively form light beam so, that light beam illuminated road in front of vehicle by required shape. Headlight front window is clear and transmits more light which is important to a driver.

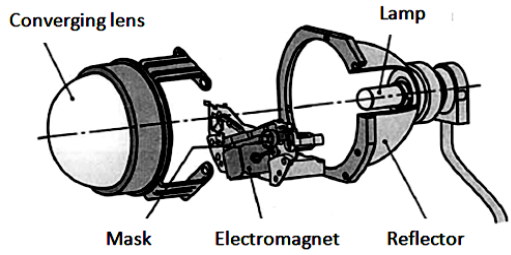

Fig. 2. Principle of projector headlight [Internet 3]

Reduction of vehicle drag and with this related saving in fuel required smaller dimensions of headlight indeed. Thereat, optics of headlight was remade and light beam forming assumed optical lens. Change of mask position is used for properly formed light beam. Mask inhibits intersection of light into unwanted area in term of oncoming vehicles.

In respect of continually increasing speed of vehicles, there was need of even more powerful source of light. This was reason why xenon lamp was established. Xenon lamp generates 2.5 times more of light than standard halogen lamp and its colour of light is more closely to natural sun light. Xenon headlight has to have automatic stabilisation of light beam altitude and washing system of headlight. Xenon lamp in cooperation with light lens is able to form suitable illumination of road as low beam and high-beam as bi-xenon headlight.

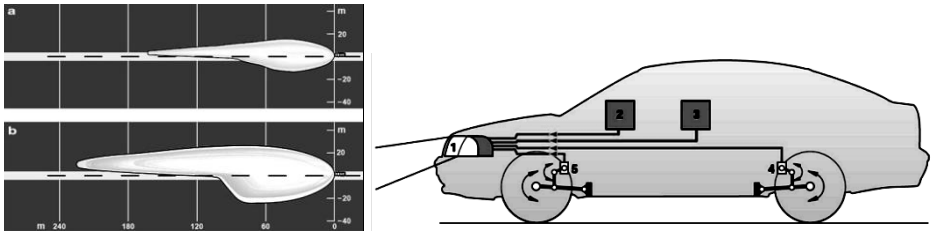

Fig. 3. Xenon headlights, vertical control of headlights [Internet 2; Internet 1]

Continually lengthen distance of headlight radius relates with: vehicle speed, reaction time of driver and technical system moreover, and necessary braking distance also. Vehicle passes particular distance per second when uses some velocity, which is shown in Table 1.

Table 1. Passed distance per second depending on velocity

Speed [km/h]	18	36	50	54	72	90	108	126	130	144	162	188
Distance[m]	5	10	13.89	15	20	25	30	35	36.11	40	45	50

Reaction time of a man to change of situation is approximately between 1 – 2 seconds, depending on the state of human body. Technical system since stimulus to beginning of effective braking has delay moreover. Braking distance depends on vehicle weight, efficiency of braking system and state of road. From given reasons results necessary distance for vehicle braking from the moment of barrier observing by driver. By upper mentioned reasons, including ecological, there are continuously developed more effective sources of light including LED sources asserted at present time and perspective laser headlights. Exploitation of Light-Emitting Diode has advantages: long lifetime of diode which suffices lower voltage and low energy consumption. LED headlights area used as low-beam and high-beam have smaller dimensions in comparison with xenon lamps.

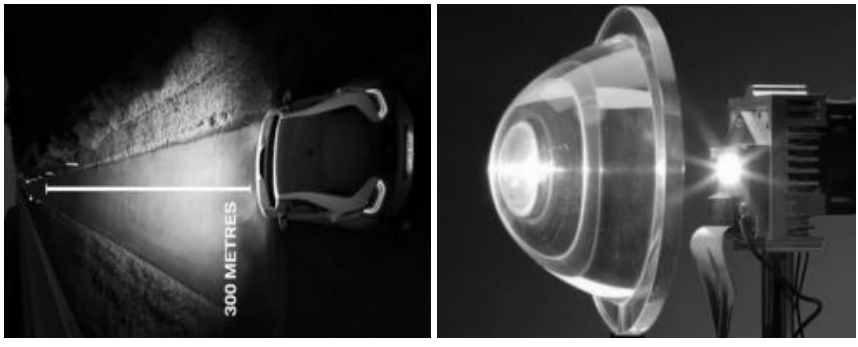

Fig. 4. LED headlight principle, high-beam distance of illumination [Internet 3]

Headlights is possible to realize by reflector or alternatively by compact system using optical lens. It is emitting cold light and is robust to impacts and vibrations. LED chip is protected by air cooling. The advantage is low energy consumption - supports lower fuel consumption and emissions CO2 decreasing.

LARP – Laser Activated Remote Phosphor is new technology based on laser diode using which works with coherent and monochromatic blue light which is thereafter trans-formed into white light. Special lenses direct beams radiated by three high power laser diodes to fluorescent phosphorus substance inside laser headlight. This phosphorus substance transforms laser beams to intensive white light which is by its similarity with daylight comfortable for a human.

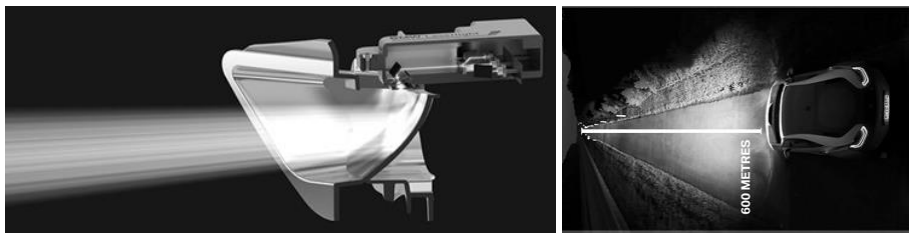

Fig. 5. Intersection of headlight based on laser technology, high-beam illumination [Internet 3]

In front of a vehicle is emitted safe and diffused light, after transformation of a laser beam, which is very close to daylight. Thanks to small dimensions of laser diode low dimensions of reflector mirror is sufficient.

Adaptive headlights

More advanced system is dynamic illumination of a road. It can be individual or can be combined with static illumination. A servomotor inside headlight, on the base of information from sensors inside vehicle which observe vehicle velocity and angle of steer-wheel turning, turns light beam to desired direction of driving. Headlight reaction is different at different vehicle speed. A light beam has to be oriented thereby it does not dazzle oncoming drivers. The advantage is continuous swivelling of light beam by swivelling of steering-wheel. The disadvantage is more complex construction of headlight and necessity of software intervention into other control modules in the vehicle. Adaptive intelligent headlights enable multi regime lighting of vehicle: country mode, motorway mode, fog lamp, cornering light, automatic switching between low-beam and high-beam. Intelligent headlights function is automatic reaction to external environment and change of situation during driving. Headlights are able to change dimension and profile of light beam in dependence on vehicle velocity and density of traffic, by which headlights offer the best visibility for driver without dazzle of other traffic partners. Intelligent headlights are able to work at different modes.

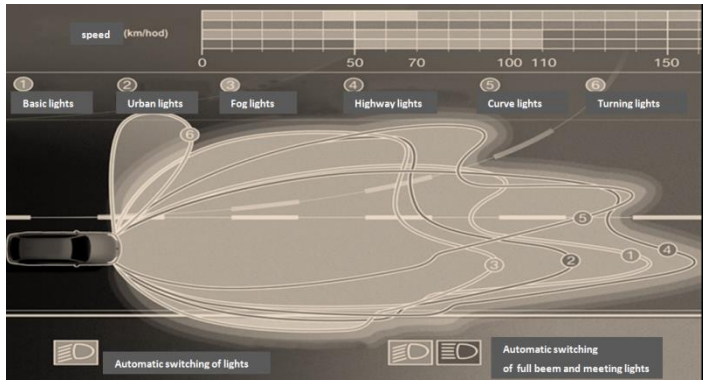

Fig. 6. Intelligent headlight system modes [Kiaba 2015]

Country mode (basic lights) enables wider and lighter illumination of left traffic lane. It increases visibility of driver to left road border, which is condition for better reaction of driver onto possible traffic obstruction.

Motorway mode (highway lights) is activated when vehicle overpass speed 90 km/h. Light beam lengthen and narrow itself. When speed is over 110 km/h the light beam lightly takes up on side of driver, it makes better visibility for driver.

Cornering light mode (turning lights) turns light beam depending up vehicle velocity and angle of turn which results in illumination of road in direction into curve but not area out of curve.

Fog lamp mode (fog lights) (rain, snow, fog) reduces intensity of light beam and extends it to the border of road to prevent dazzle of driver by reflex of light beam from wet road, snow or fog.

Urban light mode has wider angle of light beam which helps to driver make better over-view about happening at pavements and contiguous areas. Turning light relates with urban light. Turning light illuminates lateral area in front of vehicle at angle 90 degrees when traffic indicator is switched on and vehicle velocity is below 40 km/h or steering-wheel is turned.

Special Switching between low-light and high-light beam is realized by assistant of high-light beam, which is able to adapt itself, and to react to actual situation in the traffic. Lighting range can be from 65m to 300m. The system identifies vehicles in front of it and accordingly to that regulates lightning range. Headlights of intelligent light system enable to driver to see into areas which are deficiently illuminated by standard headlights. Necessary information from the camera is used by different assistance systems of vehicle. Control unit contains intelligent algorithm for image processing, detection of other vehicles and their distances, for a consideration of which it computes ideal parameters for light spread.

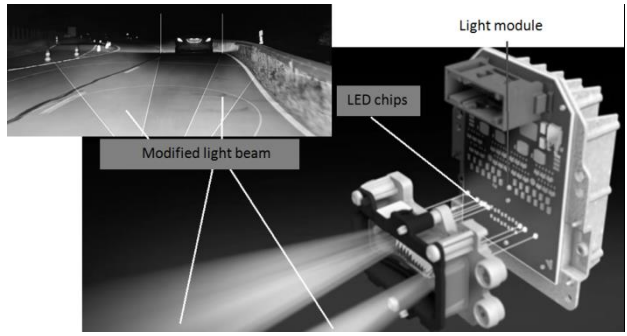

Fig. 7. Light module Multibeam [Nádaždy 2015]

If intelligent light system detects objects which must not be illuminated, specific LED diodes in LED modules of headlight are switched off and create into illumination of road and neighbour of road required space, whereas other parts of road are illuminated furthest. Suitable exploitation of LED technology enables high level of safety by optimal illumination of vehicle, expressive signalling of hazard situation and non dazzle illumination of vehicle surroundings with purpose to achieve as better as possible visibility and orientation on road.

Not everything is possible to observe by eyesight at visible area of electromagnetic radiation – light. This is reason why it is suitable to use infrared part of electromagnetic spectrum. The driver, by image on indicator of this system, is able to identify in time per-sons, animals, cyclists, or other traffic obstructions.

Conclusion

Knowledge of various sciences is using, mostly electronics at present time, to improve visual information for driver of traffic vehicle. The aim is to achieve optimal illumination of road to ensure maximal safety during driving, mostly at night and reduced visibility. Visual information for driver is not ensured by optical system mostly at present time, but by electronics on level of hardware and software which control optical systems. Educated students are needed for production process and service of modern optical systems used at all transportation vehicles.

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