AUTOMOBILE ACTIVE SAFETY INCREASE
BY DRIVER BEHAVIOUR FORECASTING

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Introduction

Today it is possible to say with confidence that progress in motor industry changes a direction. Experts believe that the next years to 90 % of the automobile novelties, that directly influencing on a cost at change of a line-up, will assign on electronic systems. The motor industry future is impossible without schemes of electronic management and comfort maintenance in salon. Besides, the driver independently no means always can to estimate correctly a situation on road. According to reports about quantity of road and transport accidents the human factor is named as one of the main reasons of road accident. Therefore, I consider the engineering of system for the analysis and optimisation of safe fulfilment of manoeuvre is rather actual.

The adaptive safe manoeuvring monitoring system is designed by monitoring and the subsequent analysis of the parameters influencing on manoeuvre fulfilment, to define optimum strategy and to give to the driver the information about optimum manoeuvring parameters, and also to analyse the driver readiness for manoeuvring and if he is inactivity or does wrong actions to transfer control to automatics. For time reduction of the driver reaction to the information and regulation of his psycho physiological condition the special attention is given feedback maintenance in HMI system. The advantage of this research consists in system learnability that is transition from the statistical data to individual at the driver behaviour forecasting, by fixing of the driver psycho physiological reaction in a certain situation and the subsequent application of the fixed data in a similar situation.

The offered adaptive safe manoeuvring monitoring system is developed taking into account the tendencies in the automobile industry set forth above. It is directed on simplification of the driver work, reduction of his fatigue and stress, on the one hand, and on reduction of the human factor in forecasting of danger of road accident, thereby, increasing traffic safety, on the other hand.

1. The description of the adaptive safe manoeuvring monitoring system

The system described in this work represents difficult system which by analysis of entrance parametres defines optimum parametres of maneuver realisation and gives results to the driver in the most comprehensible form to him.

Entrance parametres can be divided into 3 mainframes: "Environment", "Car", "Driver". Let's consider each block in detail.

"Environment" carries out monitoring of external surrounding conditions of the car during movement. Using system GPS navigation the car route is informed to system. Thanks to that the system beforehand "knows" about an arrangement of obvious maneuver fulfilment places. There isn't enough only this information for safe car movement, becouse road situation is characterised by a number of random factors, such as an arrangement of other traffic participants, weather conditions etc. For elimination of this lack the in addition system receives the information about objects being in immediate proximity with the car by means of the ultrasonic radar established on the car and-or near to a road. Besides, by means of gauges for weather conditions definition the system receives the information about such parametres, as a condition of a road surfacing, visibilities, force and a direction of wind, etc., which also make essential impact on definition of maneuver fulfilment parametres. Foreknowing about maneuver fulfilment conditions it is capable for system not only to define optimum parametres of realisation of the last, but also to inform the driver in due time.

"Car" gives to system the information about technical characteristics and a current technical condition of the car. This information is necessary at strategy definition, because possibility of the technically maneuver realisation depends on these parameters.

"Driver" represents a subsystem, for definition and forecasting of the driver behaviour. The entrance data for a subsystem are the type of the driver person and his psychophysiological condition at present time. The type of the driver person is defined by means of testing. The driver gives to system the information about a type he concerns. There are stored in system a data about psychophysiological parametres and the preferences corresponding to certain mental conditions of the driver, according with his person type. These parametres are average. Hence, in addition the system should define psychophysiological condition of the driver at present time. It is carried out by means of the gauges fixing physiological parametres of the driver, by comparison of the received data to the biographical. Proceeding from it, the system chooses optimum parametres of the interface for reduction of a driver mental condition to normal or strengthenings attention of the driver at the moment of maneuver fulfilment. For transition from the average data about the driver reaction to individual the system is equipped by the self-training program. Reaction of the driver on defined irritant in certain conditions is remembered and then in a consequence in a similar situation not biographical particulars about driver behaviour, there are applied date which were kept by system, i.e. the individual. It allows to reduce appreciably an error probability at forecasting of the driver behaviour and to make more effective regulation methods of his mental fortune.

After reception of the information from all three blocks there is its comparison and the analysis for a choice of strategy of maneuver realisation. Having defined an optimum, the system informs corresponding target parametres to the driver in that form which is chosen by the most comprehensible, according with features of the driver nervous system. The long-term nervous system tension of the person leads to fast exhaustion, and consequently, to attention reduction. In order to avoid it, it is expedient to strengthen attention of the driver directly ahead of maneuver fulfilment.

As one of the main tasks of the this research is road accident minimisation, in case of the driver incorrect actions which can cause emergency occurrence, driving passes in an automatic mode and proceeds before the maneuver end. In case of failure in system work there is provided a possibility of driver system switching-off and driving transfer in a manual mode.

2. Classification of drivers

In this system classifications of the drivers are based on their individually-typological features – congenital, biological lines, qualities with which the person was born. Making a start from psychological school of K.K. Platonov, classification is lead on following biological bases of the person:

1. Leading type of perception

2. Temperament type.

The perception is a complete reflexion of subjects and phenomena of the validity surrounding the person, at direct influence on sense organs. Opening sense of the given definition, it is necessary to notice that, being reflexion of the surrounding validity, the perception is property or display of mentality. Thus influence on sense organs should be direct, i.e. it should be occur at the moment of perception display. The perception is most closely connected with the analysis of the information arriving from an environment. Thus those images with which operate attention, memory, thinking and emotions are formed [1].

In psychology it is allocated two kinds of perception classification:

– On the leading analyzer - i.e. visual, acoustical etc.

– On object which is reflected in perception: perception of size and the form, perception of distance and dimensions of a subject, perception of time, movement, space.
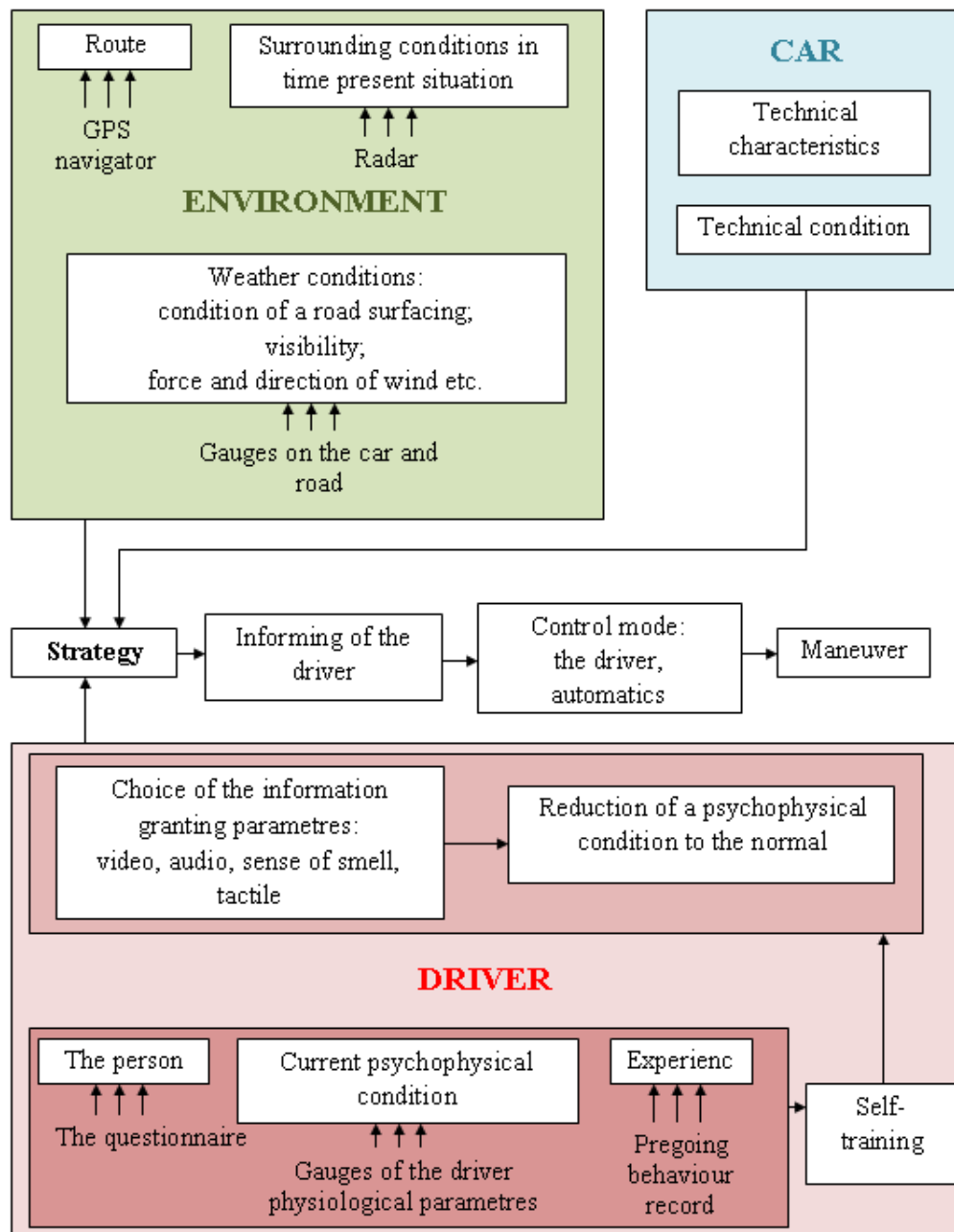
Figure 1: The block-scheme of the adaptive safe manoeuvring monitoring system

At the heart of allocation of perception types the first classification lies, i.e. perception types differ depending on analyzers (sense organs) which provide them. The basic types of perception are presented in table 1.

Table 1: The basic types of perception

The types of perception	The analyzer (sense organ)
Sight	Eyes
Hearing	Ears
Touch	Skin
Sense of smell	Nose
Taste	Language

There are also exist, so-called, difficult types of perception, - when some analyzers perceive equally intensively. From all listed types of perception, there are only three types can become leaders - sight, hearing or touch. It is connected by that loss of one of these perception types will make the person the invalid, his ability to live will appear defective. Whereas taste or sense of smell infringement does not lead to such global consequences. The leading type of perception means that this perception type reacts to signals and stimuluses of environment faster and more often. It is put in each person from a birth and it is individually-typological property of the person. It is possible to define leading perception type of the person by means of testing, for example: the test "to See, hear or feel?", developed and made by the czech psychologists; the test offered by V.A.Ananev in a course of nejro-linguistic programming. People with leading type of perception - sight, name visualists. If the hearing becomes conducting perception type – the person names audiolist. If touch becomes the most active perception type such person is called kinesthetic. Except three listed names, there is one more, directly not connected with the perceptions type, it is discretist, - the person perceives world around through a spectrum of cogitative operations. There are cases when two (and, very seldom, three) perception types prevail. It means that the person has difficult perception type when at once some analyzers react equally quickly [2].

The concept temperament directly is connected with a structure of nervous system. The nervous system type of the person is congenital, it is also a part of his physiology. I.P.Pavlov's classification is the fullest and recognised approach to understanding of temperaments at the present stage. Pavlov has come to a conclusion that the difference in temperaments depends on a difference in course of the main nervous processes - nervous excitation and braking [3].

The main properties of excitation and braking:

– Forse or its antipode weakness;

– Steadiness - an unbalance;

– Inertness or mobility.

Force depends on endurance and working capacity of nervous system. Steadiness is their comparative characteristic, it is comparison of force, speed and sensitivity. Pavlov named a mobility of excitation and braking as a speed from which one nervous process passes in another. Besides, modern searches in the theories of temperaments, produced by B.M.Teplov, V.D.Nebylitsyn, V.S.Merlin, have revealed some laws. First, they have established that force of excitation and braking is two-polar property. It consists of sensitivity and endurance. The nerves are more sensitive, the less hardy, and they are more hardy, the less they are more sensitively. Secondly, mobility of excitation and braking is double too. It consists of one process in another transition speed and of each of these processes flash and extinction. Among other things, psychologists have come to a conclusion that excitation and braking has one more property - dynamism. It is a speed from which exciting and brake conditioned reflexes are born. And, at last, scientists have found out that steadiness extends on all qualities - both on force, and on mobility, and on dynamism of excitation and braking [4].

In described adaptive safe manoeuvring monitoring system I suggest to use classification of drivers as temperaments, being based on researches of psychologists of Voroshilovgrad medical institute, under the direction of B.J.Pervomaisky. They assert that there are excitable people, with strong process of excitation, there are brake people, with strong process of braking, and there are equable people. Both braking, and excitation can be different in force and endurance. Also, mobility of processes is differed: at one type of people whom both braking, and excitation are movably; at others - one is mobile, and another is inert; but there are people at whom both processes are inert. It is as a result received 24 types of temperaments. Classification is presented in table 2.

Table 2: Classification of drivers as temperament

Force	Endurance	Mobility
Strong process of excitation	More enduring process of excitation	Both excitation, and braking are movably
		Excitation is movably, braking is inert
		Braking is movably, excitation is inert
		Both excitation, and braking are inert
	More enduring process of braking	Both excitation, and braking are movably
		Excitation is movably, braking is inert
		Braking is movably, excitation is inert
		Both excitation, and braking are inert
Excitation and braking processes are equable	More enduring process of excitation	Both excitation, and braking are movably
		Excitation is movably, braking is inert
		Braking is movably, excitation is inert
		Both excitation, and braking are inert
	More enduring process of braking	Both excitation, and braking are movably
		Excitation is movably, braking is inert
		Braking is movably, excitation is inert
		Both excitation, and braking are inert
Strong process of braking	More enduring process of excitation	Both excitation, and braking are movably
		Excitation is movably, braking is inert
		Braking is movably, excitation is inert
		Both excitation, and braking are inert
	More enduring process of braking	Both excitation, and braking are movably
		Excitation is movably, braking is inert
		Braking is movably, excitation is inert
		Both excitation, and braking are inert

3. Monitoring of psychophysiological parametres of the driver and ways of regulation of its mental condition

In described adaptive safe manoeuvring monitoring system the monitoring of a mental condition of the driver is spent on his following physiological indicators:
– Frequency and rhythm of pulse;

– Frequency and rhythm of respiratory movements;

– Intensity diaphoresis of palms;

– Frequency of the driver movings in an armchair;

– A pressure force on an armchair back;

– Force from which the driver holds a steering wheel;

– Position of the driver hands on a steering wheel;

– Change of electroconductivity of a skin;

– Change of the face temperature.

Let's consider in detail the ways of these parametres measurement and the value of their sizes for various mental conditions of the driver.

There are three types of gauges of pulse, depending on their connection: wireless, wire and built in. Built in a wheel of the car gauges are very convenient, as there is no necessity to attach gauges to a body of the driver. Differently, it is possible to supervise constantly frequency of warm reductions simply while the driver keeps hands on a steering wheel. Such gauges are widely used, for example, in sports training apparatus and in the medical equipment. The Japanese scientists have created special seats which experimental equipment the gauges defining on pulse and breath a condition of the driver are built in. This conceptual working out differs from the previous themes that the driver doesn't need to put on itself any devices and to press any buttons in the car - gauges are started in action automatically. Besides, they "listen" to the person even through a thick layer of warm clothes.

Perspective way of development of touch technics is application of multitouch systems on the basis of not selective materials and the methods of data processing received from such touch systems on the basis of modern achievements in recognition of images. It is possible to concern "The electronic nose" from such systems, it is the analytical device combining a file of not selective sensor controls, possessing high cross sensitivity and ability to images recognition, and multidimensional calibration for data processing from such file. It is possible to define palms diaphoresis intensity of the driver having applied similar devices in the car and having placed gauges on a steering wheel and handles of the shift lever [5].

It is possible to define fussiness, mobility of the driver in a seat, pressure upon a sitting back both by means of force gauges, and thanks to application of the newest fabrics.

There is also a set of devices and systems for the person skin electroconductivity definition. Basically this equipment is applied in medicine. There is device Aura Video Station using in its work a biosensor control, measuring electro-skin activity, skin electroconductivity of a hand, temperature in a real time.

Application of similar technologies in the car will allow to measure a skin electroconductivity of the driver.

There are probably used a thermovision display devices for measurement of temperature of the driver face. It is possible to show absolute harmlessness and noninvasivest as basic advantages of diagnostic. With the help of thermovision chamber it is possible to lead repeated measurements of integuments separate sites of the person without influencing his physiological condition.

The average values of the set forth above parametres are resulted in table 1.

**Table 1: Average indicators of a condition of the driver
with the counterbalanced nervous system**

Physiological parameter	Mental condition				
	Norm	Drowsiness/ Exhaustion	The excited condition		Fear/ Stress
			Negative emotions	Positive emotions	
Pulse	60-80 blows per minute	40-60 blows per minute	The acceleration is 0,03 sec on any blow	The acceleration is 0,06 sec on any blow	200 blows per minute
			Increases about 20-40 blows per minute		
Breath	16-20 in minute, rhythmical	12-14 in minute, rhythmical	18-30 in minute, arrhythmic		Fast deep breath with on-follow increase of breath to 40 in minute
Pressure force on a seat back	70 % driver body weight	0-30 % driver body weight or 70 % driver body weight	60-80% driver body weight		0 N or 100 % driver body weight, wince of muscles of a breast and shoulders
Frequency of movings on a seat	≈0 1/sec	≈0 1/sec	1-120 1/sec		

Diaphoresis	No	No	It is observed a diaphoresis	It is observed a diaphoresis	It is observed a diaphoresis
Force of hold of a steering wheel	1.2-1.5 N	0-1.0 N	1.5-2.3 N, frequent change of size 2-0.5 1/sec		2.3-4.5 N or 0 N
Hands position on a steering wheel	«10-2», «9-3»	Hands is within one sector	«10-2», «9-3»		«10-2», «9-3» or steering wheel is let off
Electric resistance of a skin	20 kOm	To 200 kOm	To 2 kOm		
The Fase temperature	Without changes	There are observed considerable changes			

As it was marked earlier, there is an interrelation of physiological and mental conditions of the person. Thus, influencing at the person on physiological level it is probably to change his mental condition.

In this adaptive safe manoeuvring monitoring system this fact plays the important role. The driver will make the least number of errors being in the normal, counterbalanced condition, according with his type of temperament. In case the driver is too tired or hyperraised, his attention and working capacity decreases that in turn can lead to emergency occurrence.

Knowing type of temperament and perception of the driver, system can affect him on physiological level thereby regulating his state of health.

Depending on the driver perception type the priority way of the information granting is selected when maneuver is made. So visual will react in higher degree adequately and quickly on the video information, audial - on sound information, and kinesthetic - on tactile information. But the priority doesn't mean the unique. Informing of the driver occurs from all channels of perception: sight, hearing, sense of smell, touch. It is possible to calm, weaken or encourage the driver by influence on him by means of aromas, colours, sounds and vibrations.

Spraying the aroma corresponding to a driver mental condition in car salon, it is possible to regulate the driver temper and to lead him to normal state or to strengthen concentration of attention during maneuver fulfilment. In table 2 lists of aromas corresponding to the various driver mental conditions are brought.

Table 2: The aromas regulating the driver mental condition

The Driver mental condition	The Aroma
Drowsiness/Weariness	coffee, wood berries, orange, musk, basil, carnation, ginger, anise, fur-tree, coriander, fir, rose-wood, pine, sweetflag, cardamom, lima, myrrh, parsley, pimento oil, caraway seeds, lignaloe oil , elemi
Stress/Depression	fresh cookies, nutmeg, valeriana, cinnamon, tangerine, black pepper, celery, citrus, grapefruit, palmarosa oil, pettit-grejn, benzoin (styrax), origanum, hyssop, cassia
Overexcitation/Hyperactivity	vanilla, wood, lavender, sage, marigold, ylang-ylang, cedar, cypress, melis, mint, neroli oil, wormwood, chamomile, sandalwood tree, euctolite, guaicum, kananga, incense, myrtle, fennel
Attention strengthening before maneuver	rose, rosemary, lily of the valley, geranium, grapefruit, lemon, patchouli plant, bergamot, jasmine, juniper, thuja, citronella grass, thyme, camphor oil , kajaput, cubeb oil

Certain colours and their combinations can cause pleasure, grief, anxiety or a melancholy of the person. Let's consider influence of some chromatic and achromatic colours on a psychophysiological condition of the person in more details.

It is possible to notice an interesting feature – the periodicity. Exciting action of colour as though is in periodic dependence on length of a wave. Function of exciting action can be represented in the form of a sinusoid. Balming waves lengths are more convenient to postpone on a horizontal axis in decreasing order. The first colour under the account is red – the most exciting. But it reaches the maximum degree of this quality not in the beginning of visible area of a spectrum, and having receded from the beginning a little, i.e. where this colour gets the maximum brightness for the colour tone. Orange and yellow are the toning up colours, i.e. their exciting action is moderate, it is reduced quantitatively. Green is the physiologically neutral colour as it is colour of the biological environment which there was a person. Calming action, which in process of transition blue to dark blue and violet increases, is already obviously felt in blue colour. And at last, violet colour influences depressing. However, suiting from red to the violet end, the spectrum aspires to become isolated. Extreme measures converge. There is something from red, i.e. something raising, in the violet. A circle becomes isolated by the purple colour uniting in property of red and violet. For the first time this legitimacy was noticed by S.Ferri what M.Deribere has mentioned about in the book "Colour in activity of the person" [6].
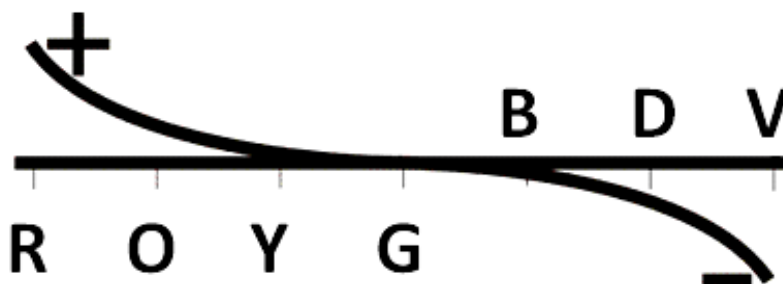
Let's consider figure 2.

Figure 2: The Curve of a spectrum colours waves lengths
Explanatories to drawing: + toning up influence; - calming influence.

It is known that music can influence brain job strongly. It is confirmed with works of Dr. Lozanov from Bulgaria. He has found out that music with rate of 60 blows in minute (as, for example, it is Largo in the baroque period music) strengthens alpha activity on 6 % (which is connected with relaxation), thus by reducing beta activity on 6 % of percent (which is connected with normal awake consciousness). Thus pulse is slowed down on 4 divisions of mercury column, on the average, and people speak about "the weakened consciousness condition".

Musical composition perception is deeply individual process, depending on spiritual, temperologic and physical structures of the person. The genres and composers preference is very selective. The considerable part of the western culture people which have been brought up on 7-note music, hardly perceives east music based on 5-note octave. Besides, 5-10 % of people perceive classical music reluctantly and even negatively (by experience, 1-2 persons complain of discomfort at listening of classical product from 20 persons in group). Besides, it is important for many to hear voice which is often absent in classical music. Correctly chosen by the psychotherapist musical composition can essentially correct and balance mental and physical condition of the person[7].

All these facts testify about truth of the statement that physiological and mental conditions of the person inseparably linked among themselves. And change of one inevitably involves change of another. So, it is possible to support the condition of the driver, its comfort and attention concentration in demanded limits using sound, tactile, colour and aromatic influence for this purpose.

4. The conclusions

In this work the adaptive safe manoeuvring monitoring system has been described. It is directed on simplification of the driver work, reduction of its fatigue and susceptibility to stress, on the one hand, and on reduction of the human factor in road emergency danger forecasting, thereby, increasing safety of traffic, with another.

This research is actual in the light of recent trends of motor industry development.

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