

Assisted Evaluation Method as Periodic Medical Control for Professional and Regular Drivers

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Abstract. The paper describes how a revolutionary method was proposed, developed and tested regarding the assisted testing of the visual function in the case of drivers, within the procedures of periodic medical control. The main purpose of the method is to ensure a much more efficient and objective medical control than current methods. Another advantage would be that the method could help the examiner, being clear and easy to apply. At the same time, the objectivity of the assisted procedure could drastically reduce fraud situations. Until now, researches have focused on the aspect of medical control from the point of view of visual function, but in the future they will also expand to other aspects related to periodic medical control (pulmonary function, auditory function, locomotor function, etc.). Specifically, the method consists of a staged test of the visual function from all points of view (acuity, 3D perception, chromatic perception, visual field, etc.), it being intended for both regular and professional drivers. The basis of the assisted assessment procedure was the design, programming, testing and continuous improvement of a software interface, presented as a virtual instrument within the reach of optometrists and specific medical personnel.

Keywords: Evaluation, Visual Function, Interface, Testing, Medical Control

1 General aspects

1.1 Current methods of medical examination of drivers

Nowadays, generally, periodic medical control among drivers involves going through several check sections, for lung capacity, visual, auditory and locomotor functions. Each one involves interfacing with a team of doctors, specific to each section, meaning the advantage of face-to-face interaction and, usually a quick passage through all procedures. The shortcoming of these, however, may arise from the fact that subjective interpretations may appear. This could result in some people being able to drive even though they, objectively, would not meet the medical conditions, while others, even though they would actually have all the abilities, due to erroneous subjective interpretations would risk being deprived of the right to drive [1], [2].

1.2 The importance of visual function assessment in drivers

It is known that among the five senses sight means the most important one, about 80% of the information amount from the surrounding environment arrives visually. Consequently, it is obvious that in the strategy of periodic medical control among drivers, checking the visual function, under all aspects, represents the most important step. For this reason, until now, researches have focused in particular on the aspect of medical evaluation from the point of view of visual function [2], [3].

2 Proposed solution

2.1 Method implementation issue

Unfortunately, there are many situations where, under certain circumstances, some people could obtain the right to drive from a medical point of view despite not having the necessary medical skills. On the other hand, there may situations where, due to requirement excess or erroneous subjective judgments, for small deficiencies in some tests, people who would be fit cannot obtain the right to drive. A more precise, impersonal and objective evaluation from this point of view would therefore be more than welcome [1],[3].

Thus, an evaluation based on clear, strict, some even standardized criteria is considered as a good solution. At the same time, because in present, the general trend is towards the digitization of services and computerized access to databases, the problem arose of finding a solution through which the medical evaluation, in all its aspects, could be computerized and much faster and objective. [3] Thus, until now, research has focused on the development of a method for assisted medical testing from the point of view of visual function [4], [5].

2.2 Evaluation procedure description

The software interface development for assisted testing was based on the theoretical foundations of a standard procedure for assessing the visual function among drivers in all its aspects.

Due to the quickly changing traffic conditions both during the day and night, it is clear that the assessment of visual function must include several aspects. In fact, many of these are also taken into account in the classic examination procedures, they being essential in driving.

Knowing that it is desirable that a complete and objective assessment procedure can be applied to both ordinary and professional drivers, the examination strategy should take into account the following aspects: distance and near visual acuity, 3D and color perception, visual field and hand-eye coordination, all being related to driving skills. However, it was considered that in order to take into account both drivers categories, there should be a differentiation in the assessment of visual function. It

was considered that the same aspects should be tested for both categories, for professional drivers the criteria for passing the test should be more severe [6], [7].

2.3 Software interface

In the first research stage, based on the considerations above, an algorithm was designed for the software interface programming and development. The design of it was carried out starting from the aspects related to the usefulness of the method; it is about how the interface should work so that it is friendly to the examiner, and also to ensure an effective and objective assessment. For this, the first issue was that the interface should be flexible, addressed to both regular and professional drivers. Besides, it was aimed that the assisted testing would allow the examiner to choose whether or not to save the data. Another skill was to allow the examiner to go through the test step by step, in its entirety or punctually, with the possibility of saving the results for each stage of the testing, in part.

Specifically, each stage of the test was designed to represent each of the aspects of visual function presented in paragraph 2.2, with the possibility of displaying the partial father-in-law for each stage separately. In figure 1 there is presented the way to select the category of drivers for which the test must be carried on. What was considered to be the most important was to display the final score, with the possibility of data saving, besides a final conclusion. Thus, depending on the result obtained, three types of conclusion can be drawn up: 1) the test was successfully passed; 2) the tested subject could receive the right to continue driving conditionally (i.e. wearing glasses, contact lenses, etc.) or 3) the subject is no longer fit to drive [7], [8].

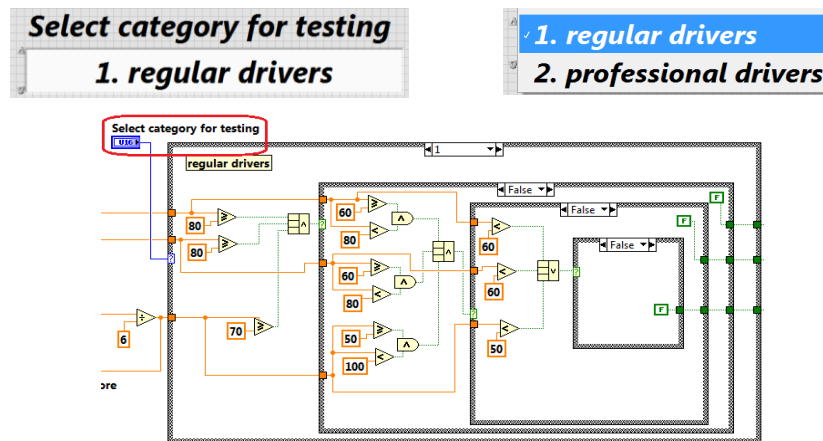


Fig. 1. Aspects of the program routine for establishing the category of tested drivers.

Next, the program routine regarding the option to save the final results was carried out. For this, a Boolean input variable was defined as a virtual button, through which the examiner can check or not this option. Related to this, a True-False structure was used, which, in turn, includes another sequential structure, for point-by-point saving

of all data specific to each stage of testing. That structure was programmed to work only for the True case (ie, for checking the save data option) (figure 2).

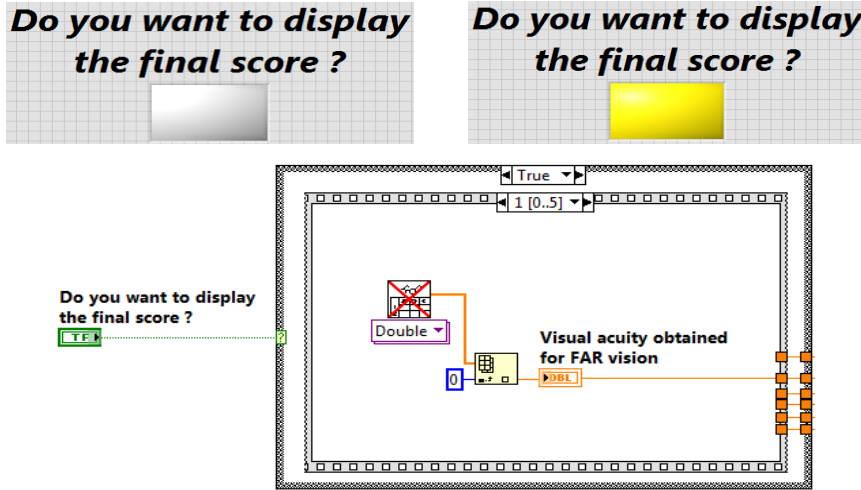


Fig. 2. Program routine for saving the final results option

Below, it is broadly presented how the program sequences specific to each test stage were built, in part.

For the first stage, visual acuity, close vision evaluation, a virtual button was used to start this stage, also a button similar for the option to save data specific.

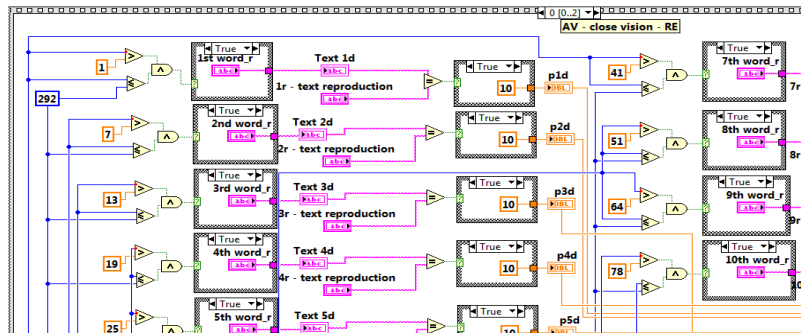


Fig. 3. Example meaning the program sequence for right eye testing

The algorithm for this first stage assumed that testing should be done in three sub-stages: testing on the right eye, then on the left eye, and then in binocular vision. For this, a sequential structure with the three sequences was used, each one including 10 iterations. These refer to 10 text messages that the evaluated person must identify correctly, depending on this receiving a partial score. Figure 3 presents one of the

three sequences, namely for the right eye (RE) testing. Similarly was proceeded for the next testing step, meaning the visual acuity in far vision.

For the 3rd stage (3D view), the procedure was the similar when programming the specific subroutines for starting the test and saving the data. Particular to this stage was a program routine that involved the use of a sequential structure with 10 sequences, for each of which using six virtual buttons as input Boolean variables and another six buttons as output Boolean variables (figure 4). The first row of buttons refers to the answers the test taker has to give based on what he sees in the 2nd row of buttons. More precisely, it must specify which of the buttons are more prominent.

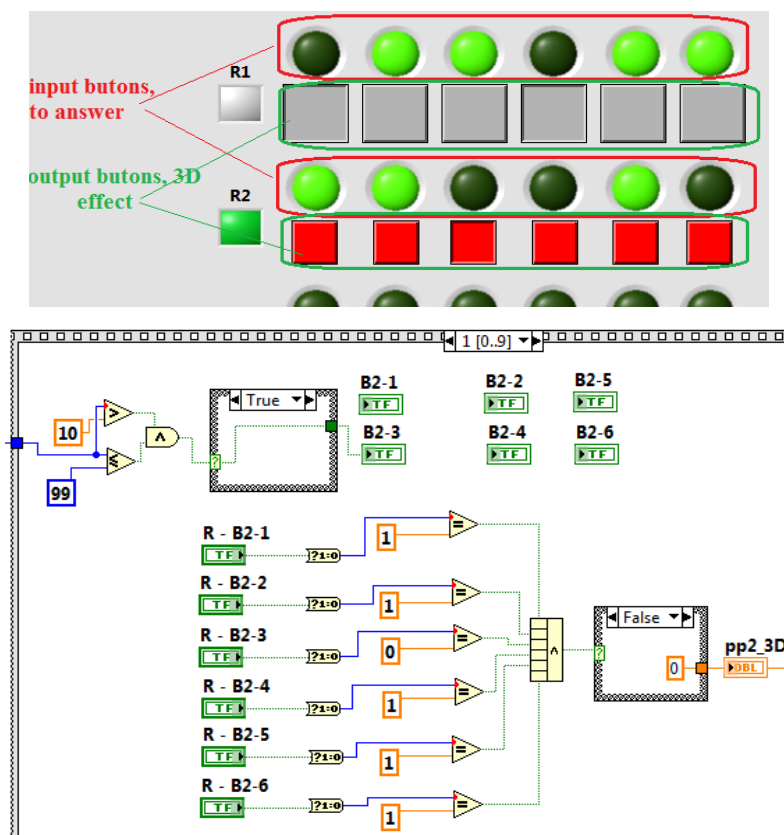


Fig. 4. Aspects of stage scheduling for 3D vision testing

The 4th stage, the programming algorithm involved the use of another sequential structure with three specific sequences (right eye, left eye, and binocular). Each one contains 144 Boolean input variables, in the form of buttons that form a background matrix on which to project a current number to be displayed. It must be recognized by the person tested, and if the number was identified then the partial score is awarded. An example can be seen in figure 5.

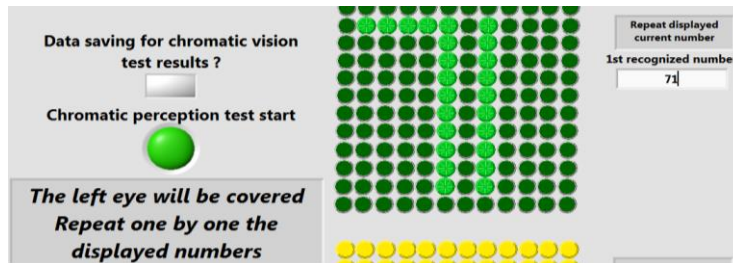


Fig. 5. Example of how color vision testing is done.

The 5th stage means the visual field and, for this, a virtual button has the role for a fixation point by the tested subject. In contrast to this, other LED buttons were used, as Boolean output variables, lighting up one by one, in a certain order, unknown to the investigated person. Their location on the display was established randomly, around the fixation point, the important being whether or not they can be observed when they light up, fixing on the central button. As programming, an While-Loop structure was used, including three sequential structures, one for testing on the right eye, one for the left eye and one for binocular vision. Each structure was intended to contain 10 successive sequences, as an algorithm for programming the successive events of stimuli turning on, this being related to the current number of origins of the specific iteration of the While - Loop running structure

The last stage refers to the assessment of hand-eye coordination, for which, in the same idea three subroutines are programmed. For each subroutine, three virtual buttons were used, one as an output variable, the other two as input variables. The output variable button, in the test cycle, has the role of the stimulus, having a ring shape, which, when the subject sees, he must react. The subject's reaction involves pressing one of the other two input variable buttons, more precisely if he presses the button located in the center of the stimulus, then his reaction is correct (he saw the stimulus and correctly pressed the confirmation button). However, there is also the case where the subject can see the stimulus, but does not react properly, that is, he can mistakenly press the other button, the background button. The 3rd situation is where the subject has no reaction, because he didn't even see the stimulus when it came on (figure 6).

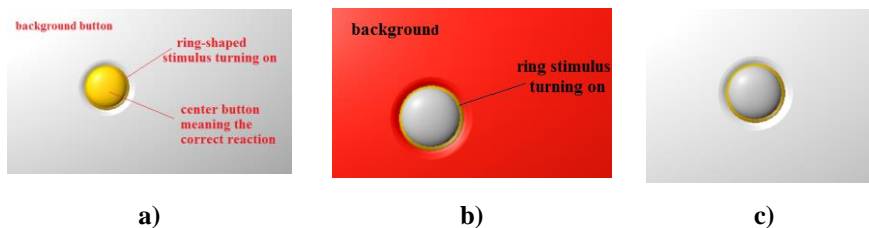


Fig. 6. Exemplifying the 3 cases involving the test person's reaction: a) correct reaction; b) wrong reaction; c) loss of reaction

The algorithm specific to this stage was designed so that, at the end of the cycle, it is possible to count how many correct answers, how many wrong answers or how many missing answers the subject gave, related to the number of stimulus displays. Thus, depending on these results, the partial score for this stage can be calculated. For this, the buttons as Boolean variables were defined within a While-Loop structure, these, generating a vector of Boolean values (logical 0 and 1) regarding the number of correct or incorrect reactions, as well as the number of stimulus turning on.

About the interface using, the examiner would have to go through the following steps: 1) choosing the category of subjects (ordinary or professional drivers); 2) choosing whether or not to save the data; 3) going through the tests step by step, with the option of saving partial data and observing and finally interpreting the results.

3 Results and Discussion

The research stage that followed the software interface development focused to test five subjects, both female and male, three of them being regular drivers and the other two being professional drivers. The people selected for testing were classified into three age categories, the 20 to 30 year old group, the 30 to 40 year old group and the 50 to 60 year old group. The reason for choosing subjects from several age categories was to observe to what extent they can adapt and accept a computer-assisted assessment.

It should be mentioned that three of these subjects, at their last ophthalmological consultation, were considered emmetropic subjects, and the other two had ametropia of various degrees, they wearing glasses. Upon evaluation of the three emmetropic subjects, they passed the test successfully, two of them being regular drivers and the third being a shooting driver. When testing the other two visually impaired subjects, the results were very different. For the person with low myopia (-1.5 DS), there were no problems, he passed the test, obviously the person in question was wearing distance glasses during the assisted test. The other person with refractive diseases was recorded as having a myopia of -4.75 DS, associated with an astigmatism of -1.25 DC (axis at 175°) on the right eye, respectively a myopia of -3.5 DS, associated with an astigmatism of -0.75 DC (axis at 160°) on the left eye. However, it should be noted that the person in question had his last medical check-up more than two years ago, and he had been wearing the corrective glasses for three years. In the case of this person, being classified as a regular driver, obtaining an overall score of 63/100 points, the final verdict was that he will be able to obtain the right to drive again on the condition that he must undergo a new eye test and change the glasses.

Table 1 shows the results when testing the first 2 subjects (both emmetropic). Table 2 shows the results of the testing of the other three subjects, two of them are wearers of glasses, and for one of them an ophthalmological consultation and a new prescription of glasses is recommended [6].

Table 1. Detailed results for the first two tested persons

Testing stages	1 st subject	2 nd subject
visual acuity (near vision)	93.33	86.67
visual acuity (far vision)	90	90
3D vision	100	100
chromatic perception	90	90
visual field	63.33	67.33
hand-eye coordination	88.33	66.67
General score	87.5	83.45

The 1st subject is regular driver, while the second is shooting driver.

Table 2. Detailed results for the other three tested persons

Testing stages	3 rd subject	4 th subject	5 th subject
visual acuity (near vision)	70	70	86.67
visual acuity (far vision)	76.67	43.33	76.67
3D vision	100	78.67	90
chromatic perception	86.67	66.67	83.33
visual field	66.67	55	80
hand-eye coordination	66.67	65	95
General score	77.78	63.11	88.33

Third and fourth tested persons are regular drivers and the last one is shooting driver. It should be specified that the 5th tested subject (shooting driver) wears glasses [6]. From the point of view of conducting the tests, the following can be stated: The examiner was a graduate student of the Optometry specialization from Transilvania University in Brasov.

The tested subjects were generally open to the idea of step-by-step assisted evaluation, a small exception being in the case of the 3rd subject, who is the oldest (57 years old), however, once it was clarified by the examiner what the evaluation consists of agreed to be investigated. In the same vein, all the subjects did very well in terms of what they have to do during the assessment, the examiner having an important role here too.

Unfortunately the testing of this new evaluation method, until now, could only be done through these five subjects, one of the main causes being the pandemic situation of the last period.

An advantage of the proposed method may also be that it could also be extended to test aircraft pilots. In addition, the evaluation method could be widely accepted and

implemented in several approved medical practices, which perform periodic medical checks for the renewal of the driver's license.

As a future direction of research, the expansion of this method is considered for other steps required for a medical visit, such as for example testing hearing or locomotor function.

4 Conclusion

The proposed method proved to be practical and objective, moreover, generally accepted by optometrists as possible examiners. In order for it to be approved and applied on a large scale, it should obtain the agreement of medical associations, in accordance with all laws and regulations in the field of automotive medicine.

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