Modern Methods of Visual Training for Children with Strabismus and Amblyopia through Assisted Serious Games

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Abstract. This paper describes how a solution was developed in case of visual problems that frequently occur in childhood could be largely avoided or drastically reduced. It presents a research stage focused on the prevention of the most common vision pathologies in children. The development of the method proposed at this stage of the research was based on the following hypotheses: the first of these is that, unfortunately, not enough importance is given to screening and, as the case may be, visual training among children. The second one is that, according to some statistical studies, more than 20% of the children tested have a visual problem, more or less severe, and pathologies such as strabismus, amblyopia or ametropia have the highest frequency. A third hypothesis is that non-invasive, short-term and interactive methods (as serious games) of visual investigation and training, have a positive impact on both children and optometrists. Thus, a non-conventional method has been developed, complementary to classical methods, whereby vision testing and game training constitute the main activity in some therapy sessions. It was proceeded to the conception, design and testing of visual testing and training methods in as serious assisted games, dedicated to amblyopia and strabismus among school and preschool children. The method was repeatedly tested and improved throughout its development and finally it was tested on a sample of 10 children. It could be concluded that the procedure could be implemented from the point of view of screening and training vision type testing in schools and kindergartens.

Keywords: Amblyopia, Squint, Children, Interface, Serious Games, Visual, Training.

1 Amblyopia and squint in children

It is known that the visual function provides the most information, more precisely approximately 80% of the amount of information coming from the environment, arrives via visual function [1], [2].

On the other hand, it is known that vision in children develops the latest of all the 5 senses, with the visual sense continuing to develop until approximately 14 years of age. In general, until this age there is a physiological Hyper-metropia that gradually resorbs, along with the physical development of the eyeballs in the orbits. However, there are also cases in which this hyper-metropia cannot be completely resorbed, there being what is called a residual hyper-metropia [1], [3].

But from the point of view of visual function in children, the most common problems are related to pathologies such as amblyopia or strabismus. Both pathologies can have physiological causes, as well as causes determined by the environment in which children carry out their daily activities (at home, at nursery school, at kindergarten or at school). The good part is that, especially the two pathologies mentioned above, detected from an early age can be drastically improved or even completely remedied thanks to conventional and non-conventional visual training procedures. [3], [4].

The first of the two most common eye pathologies in children, strabismus is characterized by the lack of synergy in the coordination of both eyes and, implicitly, by fixation and fusion problems of the two images on visual cortex, providing from both optical ways [1], [2], [7]. Amblyopia, also called the pathology of the lazy eye, is characterized by the fact that the specific eye makes the processes of fixation and accommodation much more difficult and in a much longer time than in the case of the healthy eye. In addition, for the fixation and accommodation processes of an amblyopic eye to ensure, a sufficiently strong contrast against a target background is necessary.[3], [4], [7].

But the main problems related to this aspect are on the one hand in many situations the negligence or ignorance of the parents and, on the other hand, they can be related to the fear or not taking the procedures for visual testing and training seriously by the children. In order to be able to resolve such impediments as best as possible, on the one hand, large-scale campaigns are currently being carried out to raise awareness (primarily by parents and educators) of the importance of control and, if necessary, of visual training from as young an age as possible (even under 2 years old). [3], [5]

On the other hand, to reduce as much as possible the reluctance of parents and also the fear or boredom of children towards these screening or visual training procedures, in recent years the development of friendly non-conventional methods has taken on an unprecedented scale in this sense [6], [7].

2 Proposed non-conventional vision testing method

Knowing that it is extremely important, at the national and international level, to carry out visual screening procedures from the earliest possible age, in schools, kindergartens and even nurseries, the question arose of motivating parents, educators and children for this purpose. The importance of this aspect is due the fact that, unfortunately, a significant percent from the people (meaning especially the parents or educators) does not pay enough attention to this aspect. On the other hand, children's fear related to the idea of going to the doctor is not to be taken into account, a fact that complicates the solution of such a problem even more. The same problems are encountered when it comes to visual training in special cases, until it is necessary to correct through repeated exercises and procedures a certain vision problem in the case of a school or preschool child [8].

Solving these types of problems could consist of two distinct aspects: on the one hand, campaigns to promote and clearly explain the importance of regular eye testing for children at the earliest possible ages and, on the other hand, finding strategies through which testing to be more transparent and attractive. The research stage described in the paper focuses mainly on the second aspect. Thus, in the context where the concept of serious gaming is currently becoming more and more widespread in personality development procedures, in healing therapies, in the development of skills and intelligence, especially in children, it is currently being implemented at ever wider scale and in the matter of visual function. Related to this aspect, the purpose of the research focused not only on the development of methods for testing and training the visual function in this context, but also on finding simple, effective methods with costs as affordable as possible even for families with financial problems [10] , [11].

As a result of the fact that in the development of vision in children there is an increased frequency of the appearance of certain hereditary or acquired pathologies, such as amblyopia, myopia, strabismus, the methods proposed for this purpose focused on two of these pathologies: amblyopia and strabismus. The main goal of the research is to develop methods by which visual testing and training in recovery in the case of these pathologies can successfully complement traditional methods. But what is specifically aimed at is the considerable increase in the attractiveness of children in such methods of play testing, increasing the degree of attention and involvement from the child, but also from the parent or educator [11].

Concretely, for this purpose, in this stage of the research two software interfaces were successfully designed, programmed and tested in order to test and train the visual function for each of the two pathologies [12]. The development of the two game-assisted tests was based, on the one hand, on the generally known attraction of children for games on smart-phones, tablets or laptops and, on the other hand, the recommendations of optometrists specific to strabismus and amblyopia. Specifically, in the case of strabismus, the recommendations are that training should be done in binocular vision, but the strabismus eye should be forced to fixate on a target in an opposite direction. for example, if the strabismus eye is the left and the strabismus manifests outward (towards the temporal area), then the subject will fixate a target located towards the central part of a display, and if the strabismus manifests itself towards the nasal area, then the fixated target should be located on the left side of the display, etc. On the other hand, in the case of amblyopia, the specialists' recommendations are that the healthy eye should be occluded, and the amblyopic eye be forced to fixate and accommodate both on a fixed and on a dynamic target.[13], [14].

Thus, the software interface *Assisted serious games for Amblyopia.vi* was developed for detection, but especially for visual training in the case of amblyopia, and in the case of strabismus, the interface *Gaming tests for squint.vi*. Both software interfaces were developed in LabVIEW, then describing how they were designed, programmed and tested.

For amblyopia play testing and training, the LabVIEW software interface *Assisted serious games for Amblyopia.vi* was designed to run through four stages of the play test, all of which are accessible to children, yet as attractive as possible. Besides, the graphic aspect, of the chromatics, was also followed, so that all the fundamental colors appear in the graphic interface, on a strong contrast, this, in turn, is intended to arouse curiosity and the desire to solve the tests through the game. Moreover, through the tasks that must be solved at each stage of the test, the motivation of the child in question was followed, the idea being that of rewarding the correct and timely solution, through the examiner (parent, optometrist or educator) [13], [14].

Thus, the four stages designed for this specific play-testing interface for amblyopia training procedures are as follows: stage 1: step-by-step filling (in distinct primary colors) of four entities familiar to children (house, plane, car, flower); 2nd stage: following a predetermined route (by coloring some dots that make up the route) from a START zone to a motivating entity, namely a candy (following the route with as few mistakes as possible and in good time to the entity candy attracts rewarding the child with real candy from the examiner); 3rd stage: extinguishing some dots of different sizes from a certain category from a chromatic point of view (e.g. extinguishing red dots) from a multitude of differently colored and different sized dots; 4th stage: selective coloring of certain square-type entities located next to some virtual switches arranged in a certain orientation (e.g. coloring of squares located next to switches oriented to the right).

Obviously, the entire procedure of play testing through this software interface must be carried out under the following conditions: the child must be continuously assisted throughout the duration of the test. This is necessary both to be assisted in case he has doubts about what to do in the immediate next moment. On the other hand, the assistance of the subject is necessary in order to follow several aspects: to have a correct posture during the solving of the test, not to cheat, to be able to be evaluated by the examiner the way in which the test is solved (the way he looks towards display, gesture mimicry, etc.). In other words, with regard to the conditions for carrying out the test, the child in question must have occluded the healthy eye, solving the test in monocular vision, using the amblyopic eye, to force him to fixate on the graphic entities in order to solve the tasks.

Another particularly important aspect is the fact that, in the case of amblyopia, visual training therapy must involve a longer period, for example for 6 months or even 1 year, including at least 3-4 weekly training sessions. A training session, according to the recommendations of optometrists and ophthalmologists, should include several activities, all in a 1-2 hour session. These activities should involve following stimuli through conventional methods (for older children) but also through non-conventional methods such as physical or virtual play testing. In the present case, we are talking about the virtual game testing method, but obviously this method must be interspersed with the other methods mentioned above. It is also recommended that the sequence of procedures for testing in a training session be done alternately, to avoid boredom and to avoid the risk of memorizing work steps.

For amblyopia, the software interface programming for assisted screening and visual training was based on the following logic diagram:

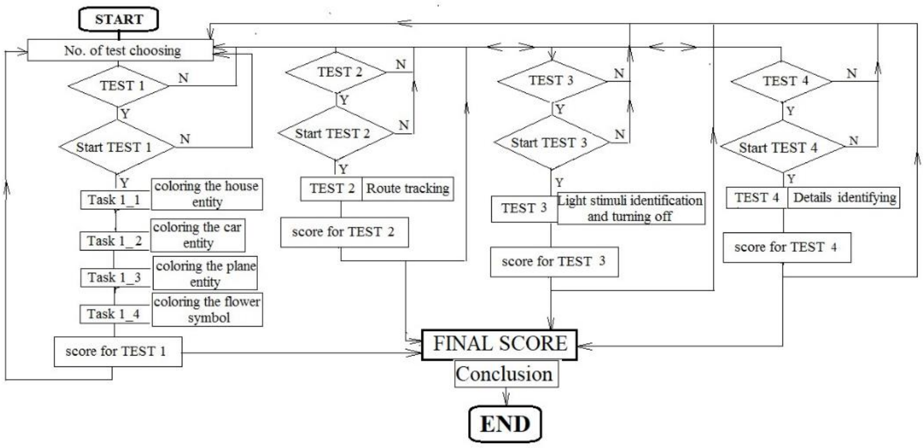

Fig. 1. Logic diagram for software interface programing for amblyopia assisted training

Resuming to the software interface for training and game testing in the case of amblyopia, the following describes briefly how the graphical programming of the interface was done, specific to each stage of the testing procedure.

Thus, for the first stage of the test, namely the coloring of the virtual objects, each of them was constituted by a series of status LED sub-entities in Boolean logic, with the off and on states. For example, for the house object, 10 Boolean status LEDs were defined, which were graphically modeled in different shapes and sizes and having distinct colors in the logical on state. An example can be seen in figure 1 for the house object, before and after coloring in the first stage of solving the test [13].

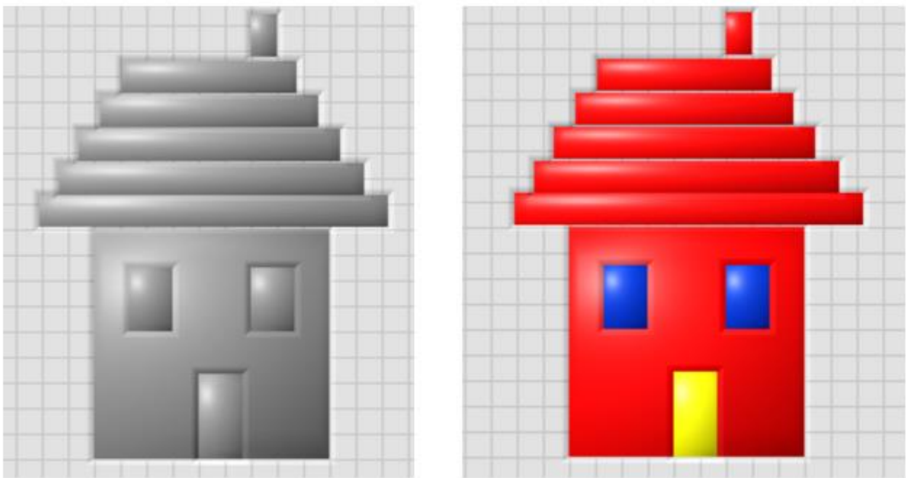

Fig. 2. Example of a virtual object before and after coloring in solving the first stage of the test in the case of the amblyopia training procedure.

From the aspect of graphic programming, the 10 Boolean entities were related to a True - False structure, specific to the two states off and on, with manual actuation, the entities being of input type. These, together with the structure, were included in another repetitive structure of the While-Loop type, which, by running, imposes the condition that the test can be run further only after finishing the coloring of the current object. Obviously, this structure was also provided with a timer by which the coloring time of the current object could be counted automatically. A sequence of graphical programming specific to the coloring of the house entity in the first stage of testing is exemplified in figure 3 [13].

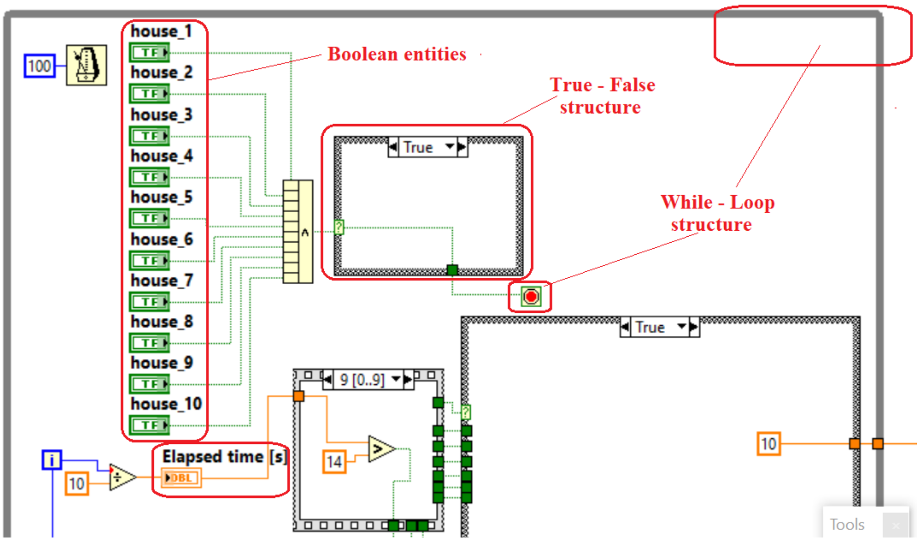

Fig. 3. Example of graphical programing specific to the first task for the first testing step (filling the virtual house).

For each virtual object coloring in this first step, string input and output variables were defined and related in the programming algorithm, through which the current message specific to each task in it could be displayed stage. For example, for the first task, the message to be displayed is *Fill color the house*, for the 2nd task the current message is *Fill color the car*, etc. These string variables were each related by a *True - False* structure, conditioning the appearance, in successive order, of the messages after different time intervals during the course of the first stage of solving the test (figure 4). The programming algorithm specific to the first stage included another aspect, namely the quantification of the answer according to the duration in which the tasks are solved. For this, an output variable of numeric type was defined, related to the index of the *While-Loop*, through which the duration in which each task was solved in this first stage of the test could be displayed. Thus, depending on the solving time, the programming algorithm assigns a grade for that task. For example, if the first task (coloring the house) was done in less than 6 seconds (time assessed by optometrists as normal for a subject without visual problems), then the grade given is 10 [13]. If the duration is between 6 and 7 seconds, then the grade awarded is 9, if the duration is between 7 and 8 seconds, then the grade awarded is 8, etc.

For this first stage, as for all stages, the algorithm was programmed to display as a numerical output variable in decimal format the grade specific to the stage. In the case of the first stage, the algorithm consisted in calculating the arithmetic mean of the 4 intermediate grades, for each of the 4 tasks of this stage.

Figure 4 shows the graphical interface during the first stage of the test [12], [13].

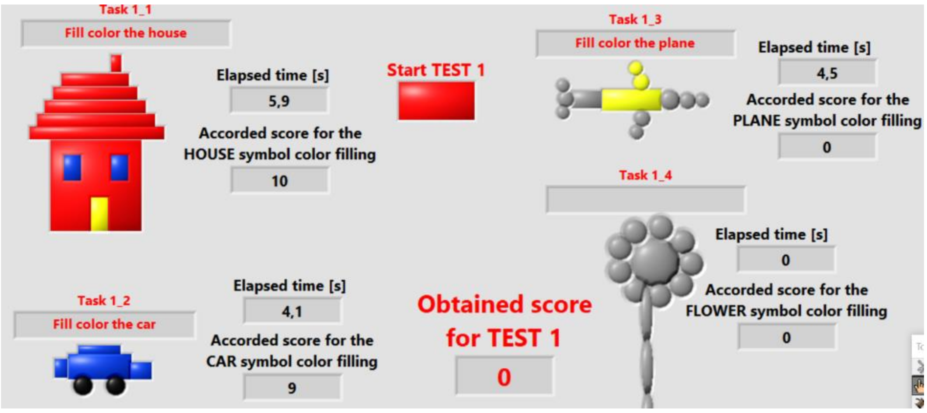

Fig. 4. The first test step during its current solving.

For each virtual object that must be filled, the established time reported to the accorded scores was different depending on their complexity, due to the specialist's requirements. The programing algorithm was applied considering the average between all stages (equation 1):

$$S_1 = (1/n) * ((v * C_{ts}) / \tau_i) - v * W_{ts} \quad (1)$$

where S_1 means the score for the 1st test ($S_1 = 1 \div 10$), n – the number of stage for the 1st test, C_{ts} – the number of correct turned on entities, W_{ts} – number of wrong turned on entities, v – the value coefficient for each correct or wrong turned on entity.

For the second stage, the programming algorithm assumed, in the first phase, the definition of a set of virtual Boolean LED, strung together, constituting the route. From a graphical point of view, both the starting area of the route and its end, represented by the candy (as a reward), were also made up of virtual LEDs with the two logical states (off and on). Thus, in fact, traversing the route means nothing more than switching on the lit state of all the virtual LEDs between START and END. All the virtual status LED entities constituting the path in the 2nd stage, from the point of view of graphics programming, were related by a logical *AND* multiplexing function linked to a *True-False* structure. In this way, the condition was imposed that only after the completion of the route is the completion of this current stage of the test validated. Obviously, in order to receive a reward (a candy), the course must be completed meaning maximum of 1-2 errors in a time small enough that the grade given is at least 8. Figure 5 shows the second stage of the test run during its solving [13], [14]. For each stage of the test, its start was conditioned by pressing a virtual Boolean button called *Start Test i* (i = 1 to 4), as can be seen in figures 5 and 6.

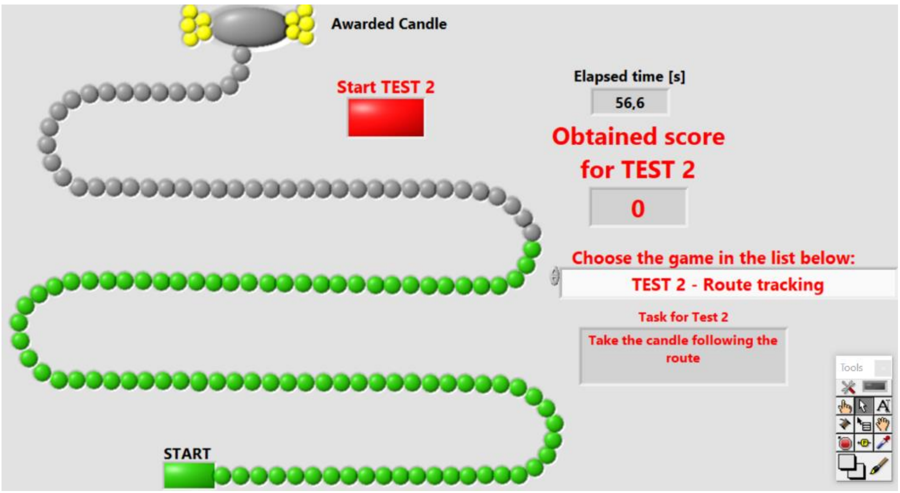

Fig. 5. The second test step during its current solving, meaning to follow the route.

In terms of accorded score for the 2nd stage, it was establish depending on the necessary time to finish all track, by successively entities composing the route turning on. For example, if the necessary time is up to 75 seconds the maximum score (10) will be accorded, if the necessary time is between 75 and 80 seconds than the accorded score will be 9 of 10, if the time for response is between 80 and 85 seconds the accorded score will be 8 of 10 and so on. All these considerations for the programing algorithm have been considered due to different optometrist requirements.

For the 3rd stage of the test, which requires entities from a single color group to go out, the status LEDs in the form of dots have been defined and grouped into two broad categories: Status LEDs from the TRUE category, namely those that, by their extinction, imply a correct solution of the current task and those from the FALSE category, meaning false-positive errors, i.e. a wrong solution of the current task. Their grouping into the two categories was done with the help of a sequential structure, with the two associated sequences. Also for this stage, the scheduling algorithm imposed the condition that only after all entities in the specified color category were extinguished could the current stage's solution be validated. For this reason, all the entities in the *TRUE* category were related by a multiplexing function to a symbol specific to the completion of the *While-Loop* continuous loop [13]. The other category of entities, the one of type *FALSE* was grouped by concatenation into a vector of Boolean values, later converted into binary values, which, accumulate the penalty score for this third stage. Figure 6 shows the 3rd stage of the test during its solution.

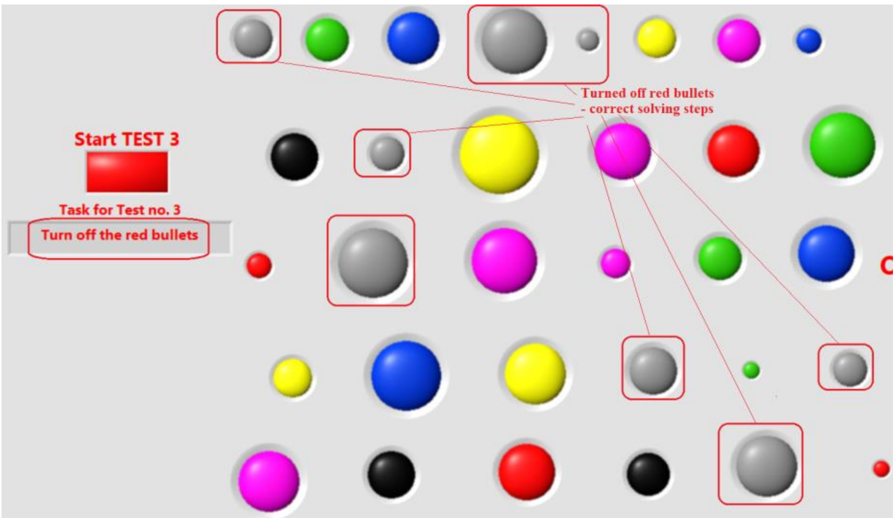

Fig. 6. The 3rd test step during its current solving, meaning turning off the specified colored category of entities (i.e. red bullets).

For the 3rd stage, the accorded score took into account two main aspects: the 1st one refers to the necessary time to finish the task and the 2nd refers to the number of false – positive errors during solving the current step. This was implemented into an algorithm based by the following equation:

$$S_3 = S_\tau - (1/9) * N_{\varepsilon\_fp} \qquad (2)$$

where S_3 means the score for the 3rd testing step, S_τ is the score depending only by the necessary time for solving (i.e if the time is up to 24 seconds this score is maximum (10), else as the time is longer, as the score is lower); N_{ε_fp} – the number of false – positive errors during solving the current step

For the last stage of the test, 2 groups of virtual buttons were defined, the first being of the switch type, the second group being of the square type. The group of switch-type entities, in turn, was divided into two sub-categories, the first with switches to the left, the other with switches to the right.

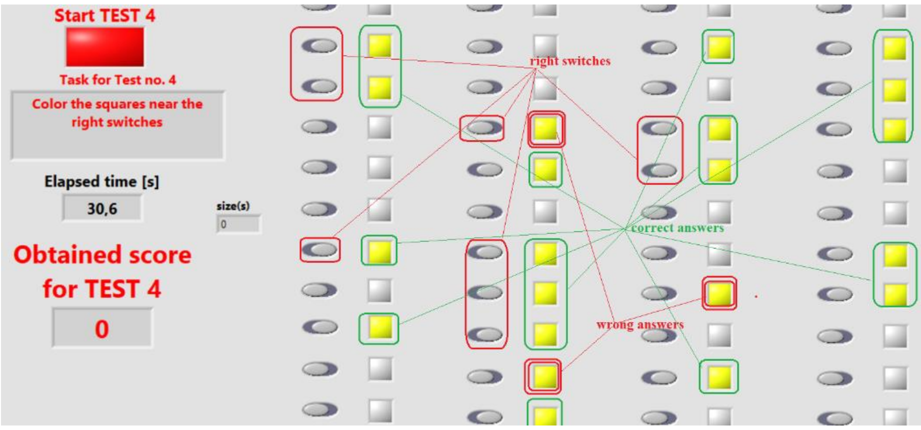

Fig. 7. The 4th test step during its current solving, meaning turning on the yellow square buttons from the right switches to the right.

The programming algorithm for validating the test stage by checking all correct answers, but also for counting errors, is somewhat similar to the one presented above, specific to the 3rd stage. Figure 7 shows an example showing how to solve the test in its last stage.

Regarding the use of the software interface specific to the game-test training in the case of amblyopia, the stages necessary to run it are the following: 1 – reinitialisation of the interface, through the commands *Edit – Reinitialise all values to default*, 2 - selection (one by one) of the current stage for testing from the dialog box, *Choose the game in the list below*, starting the current stage of the test, through the command *Start test 1, 2 3 or 4*, tracking the solution of the test and viewing the final grade after completing the test.

An essential role that the examiner has in assisting the child in the training procedures through this evaluation method is to note and compare the results obtained each time, obviously the testing must take place in identical conditions and at approximately the same times of the day. The subject must definitely be rested, perfectly healthy and not have any kind of physiological problem at the time of the visual training procedures.

The most important aspect is that, at the end of the duration of the visual training procedures, noticeable improvements in the obtained results are observed, this being evidence that the amblyopia in the trained eye has been largely or even completely resolved.

Regarding the other pathology, namely nasal or temporal strabismus, the 2nd software interface was designed so that, with the healthy eye in occlusion, the subject goes through the test games, following three distinct work steps. A logic diagram for the entire programing algorithm is shown in figures 8 and 9.

The first stage of the test was designed so that with the free eye (affected by strabismus), the child identifies by switching some virtual 3D buttons the selective lighting of some light stimuli from a string arranged on the display. The arrangement of the stimuli and switch buttons should be such that they are in an antagonistic position to the squinting eye. Thus, if the strabismus manifests itself towards the nasal area of the left eye or towards the temporal area of the right eye, then the entities to be tracked will be located on the left side of the display. If the strabismus manifests itself towards the nasal area of the right eye or towards the temporal area of the left eye, then the entities to be tracked will be located on the right side of the display.

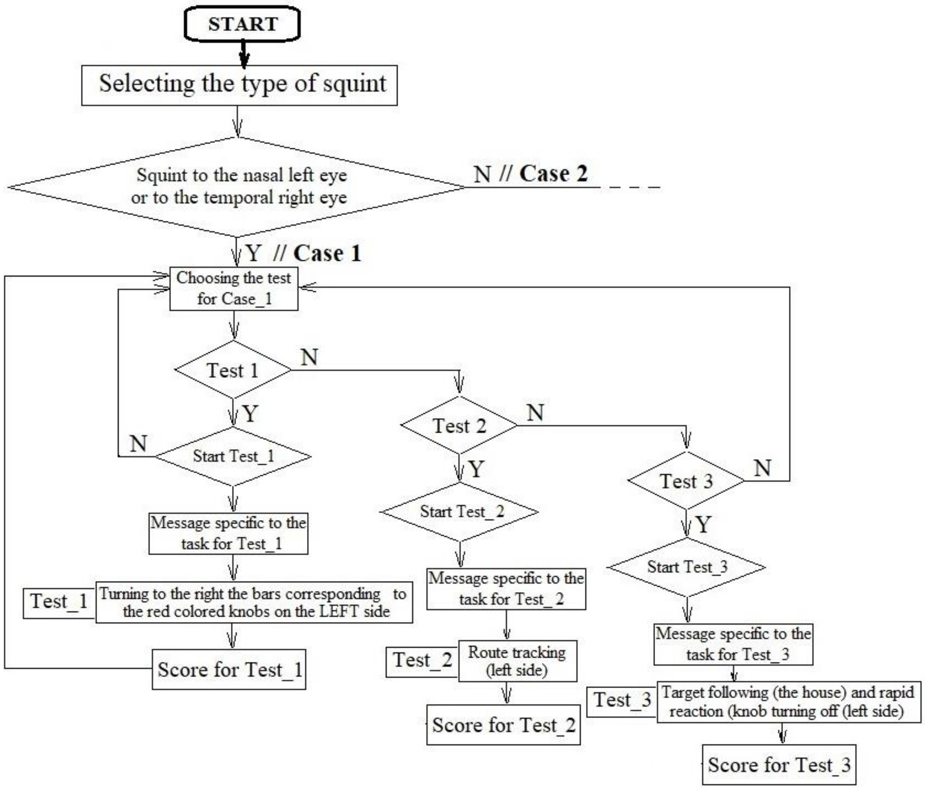

Fig. 8. Logic diagram for software interface programing in case of visual training to correct the eye squint_1st case (squint to the nasal LE or to the temporal RE).

Following the same procedure, from the point of view of the placement of the graphic elements, for the second stage of the testing, the current task that needs to be solved is to complete a Patch-type route, the correctness and duration of its completion being of interest here. The design of the interface assumed that in the third stage the reaction time on the part of the subject was tested at the end of a dynamic cycle simulating the automatic travel of a road to a house-type entity. The subject's reaction must consist of pressing a virtual button that is colored, at which point the time during which he had the reaction is automatically recorded.

For the first stage of testing, the programming algorithm involved defining a string of Boolean output entities, only a few of which would fire for 1-2 seconds at a time during test running.

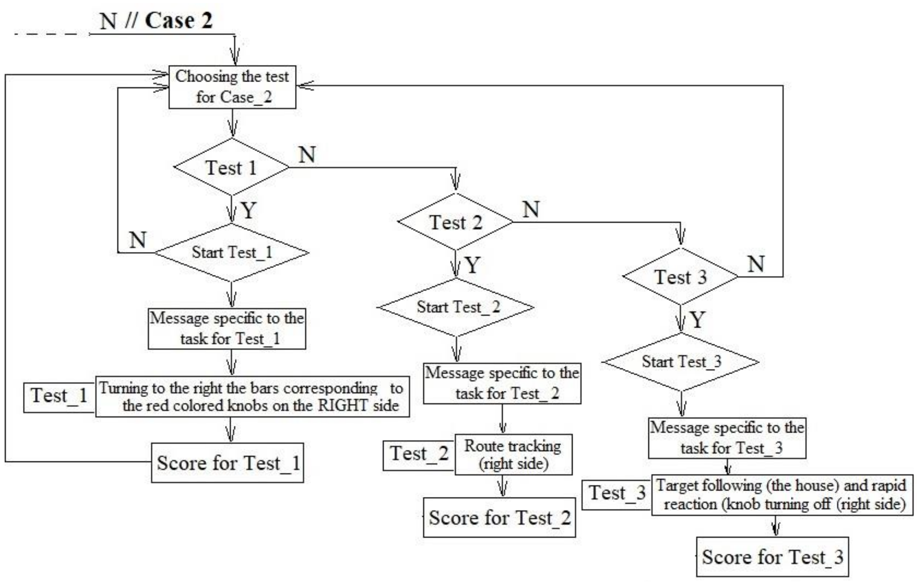

Fig. 9. Logic diagram for software interface programing in case of visual training to correct the eye squint_2nd case (squint to the temporal LE or to the nasal RE).

For this, it was also necessary to use a closed loop structure of the While - Loop type, in relation to which the moment when the selective ignition of those entities can be related. Through other Boolean switch-type input entities, the subject can respond to what it has seen and remembered about the entities lighting up. Figure 10 shows a sequence of this programming algorithm.

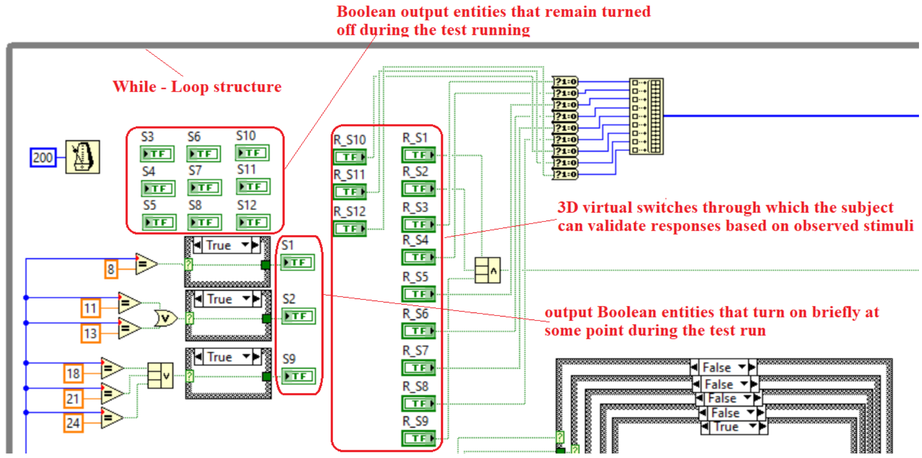

Fig. 10. Sequence of programing algorithm specific for the 1st testing step.

The programming of the algorithm that quantifies the correct and erroneous answers, but also the duration of solving this task is similar to that in the case of the 3rd stage of testing in the case of amblyopia training. An example of solving the test in the first stage is shown in figure 11.

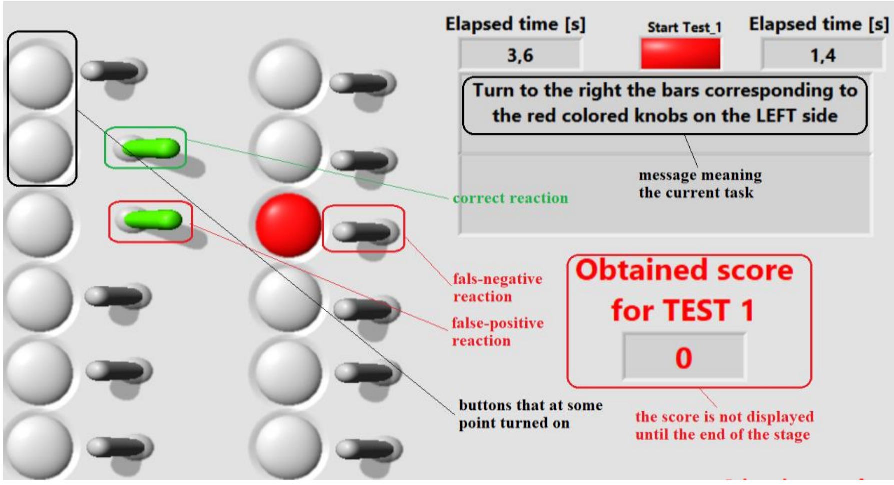

Fig. 11. Example of solving the first step of the testing in case of training procedure for squint.

The definition of strings of virtual Boolean buttons, was necessary in the programming algorithm for the second step of testing, since the condition was also imposed here (through the *While-Loop*) that only upon completion of the entire route to validate the current work stage. Obviously, in this case too, the duration of the route is of interest, the grade being awarded at this stage depending on this aspect. The scoring algorithm for awarding the grade was similar to that of the 2nd step test for amblyopia training procedure. However, in contrast to the case of the interface for amblyopia, at this stage, a subroutine was included in the programming algorithm through which, every time there is a deviation from the route (a square that constitutes the route is not found and clicked outside, in the background) to count one error each, the score for this stage being affected by this aspect as well.

The Boolean output entities that make up the path that is automatically traveled by simulation, specific to the 3rd stage, were related according to the *While-Loop* structure index, so that, when simulating the automatic path to the home entity, these elements to flash automatically at intervals of less than one second. The algorithm for this step has been programmed in such a way that, upon completion of the turning on of all output Boolean entities (completion of the route simulation), the automatic turned on of the house entity (consisting of several virtual Boolean buttons of output). Thus, only after this moment can the manual switching of the input button, namely the subject's reaction, be taken into account. In these conditions, immediately after switching the input button, the running of the *While-Loop* must be stopped, so that at the end the duration from the turning on of the house-type stimulus can be timed. An example of solving the test in the last its stage is shown in figure 12.

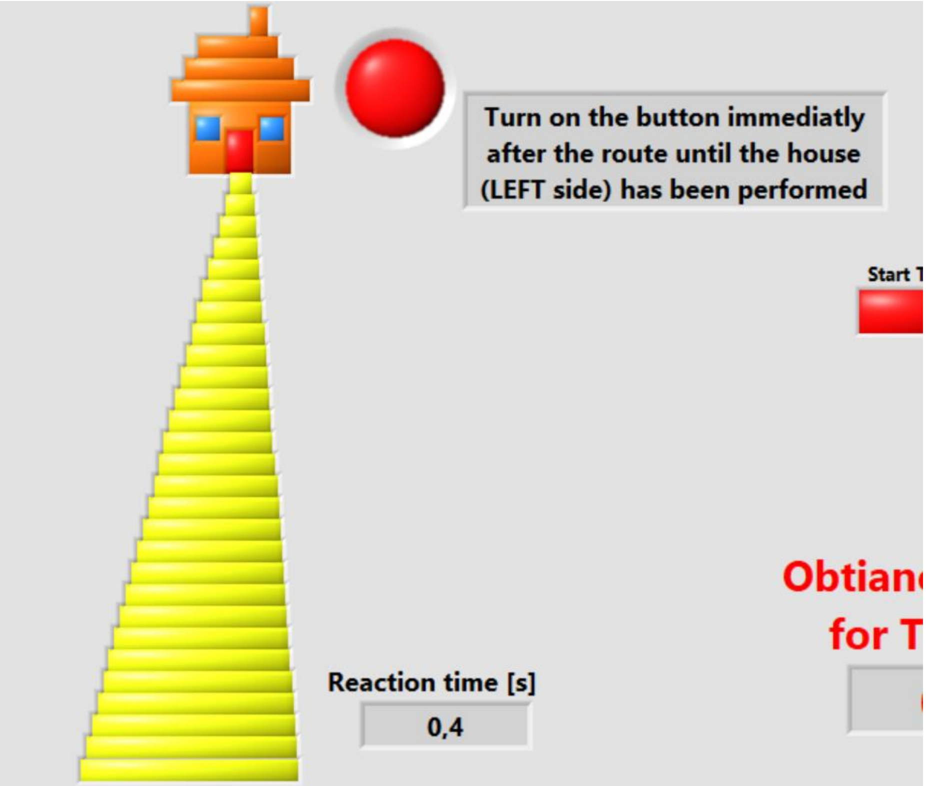

Fig. 12. Example of solving the last step meaning the reaction time.

As for the procedure for training through assisted testing in the case of strabismus, the working stages for using the software interface described above are the following: 1 - selecting the stage for testing (there is also the possibility of going through selective stages); 2 - choosing the type of strabismus for which the training is done; 3 - starting the test for the current work stage; 4 - passing the test; 5 - display of final results. Figure 13 exemplifies the procedure to be followed specific to the first two steps required to start the test. Testing, as with the amblyopia training software interface, involves manually turning ON the button to start the test in its current step.

For each stage completed within the test, the respective note can be viewed, thus the examiner can get an overview of the evolution of the visual training of the subject in question in terms of combating strabismus. This fact is very important because very useful information is obtained regarding the aspects of visual training that should be emphasized more. The information is particularly useful and effective both for the examiner and the tested subject.

Regarding the training procedure through physical alternative games, complementary to the virtual ones (presented above), in this research, two low-cost physical games, made of recycled materials, were developed [13].

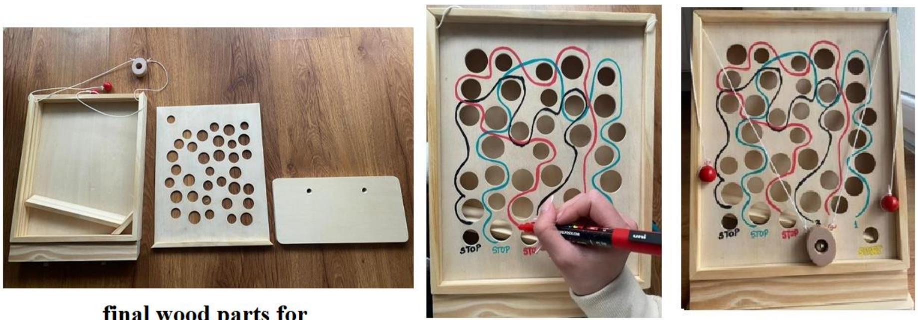

Fig. 13. Manufacturing the first test game in physical format following colorful tracks.

The first of these consists of making a route created from colored lines between hole-type entities that have been drilled into a thin plywood. The image of this physical game can be seen in figure 16. This first physical game-test was designed and manufactured for training in case of amblyopia [13].

The second game-test, labyrinth type, was designed and made for the purpose of visual training in the case of strabismus and required the following components: a cardboard box, plastic sticks and two wooden balls of different sizes. The stages of practical implementation and the final version of this test are presented successively in figure 14.

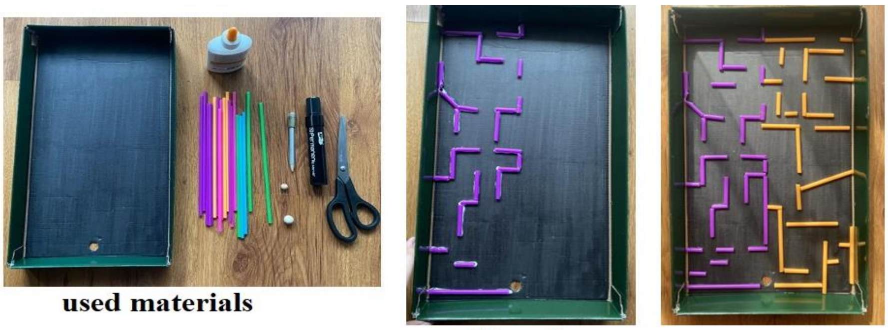

Fig. 14. Manufacturing the second test game in physical format, labyrinth type for visual training in case of squint.

3 Results and discussion

The testing procedure described above was applied alternatively with the testing procedure through physical games (such as following a route, arranging some entities by size and color categories, etc.).

The paper presents the three most representative examples from the sample of 10 examined children, in these cases the effect of the improvement of the pathologies being the most spectacular. The presented cases were specific to more severe pathologies, as follows: for the case of three children, two of whom were previously diagnosed with amblyopia and one being diagnosed with strabismus [12], [13].

Table 1. Testing results in case of the 1st child (having squint).

Game type	Understanding game performance	Reaction time	Solving time	Accorded score per test
2nd physical game	good	very good	33.38 seconds	10.00
2nd virtual game	good	enough	11.2 seconds	7.00
Additional data				
receptivity	very good			
relaxing	very good			
coordination	good			

Regarding the first subject, he followed an alternative testing procedure through physical and virtual games, specific to training in the case of strabismus, the results of the tests can be quantified both subjectively and objectively in table 1.

The 2nd subject, diagnosed with amblyopia, was obviously tested by test-games specific to the training to combat amblyopia, i.e. by the first test-game in physical format, respectively by the first software interface for assisted testing in the virtual environment. Test results of subject no. 2 are presented in table 2 [13].

Table 2. Testing results in case of the 2nd child (amblyopia).

Game type	Understanding game performance	Reaction time	Solving time	Accorded score per test
1st physical game	good	enough	87 seconds	8.00
1st virtual game	good	not enough	128.9 seconds	3.00
Additional data				
receptivity	good			
relaxing	good			
coordination	enough			

Subject no. 3, having amblyopia like the 2nd subject, followed the same procedure of physical game and virtual game testing as in the case of subject no. 2. The results can be viewed in table 3.

Table 3. Testing results in case of the 3rd child (amblyopia).

Game type	Understanding game performance	Reaction time	Solving time	Accorded score per test
1st physical game	good	good	65 seconds	8.00
1st virtual game	good	enough	43.6 seconds	5.00
Additional data				
receptivity	very good			
relaxing	very good			
coordination	good			

4 Conclusion on the proposed and applied method

The objective of the study was to evaluate the effect of visual training on people with strabismus and amblyopia through a procedure that included virtual test games and physical test games. The results and conclusions were obtained from the analysis of the monitored data in Excel for each subject.

It was found that for the children having amblyopia it was more difficult to pay concentration on the tests solving, but even these have been attracted by the idea of testing due to physical and virtual games.

The study on the 10 examined children represents only one stage in the research regarding the development and implementation of this new method of evaluation and training of the visual function [13]. To complete the study, but also to be able to certify to a much better extent the efficiency and usefulness of this proposed new method, in the next researches it is considered to apply it to much larger samples of children. For this purpose, a strategy has been proposed that in the next year screening actions will be carried out in schools and kindergartens, a number of approximately 100-150 children examined is expected, and in the next two years it is desired to expand the sample to over 300 of children [4], [6]. Based on statistical information that approximately 2-3 children out of 10 have visual problems such as strabismus or amblyopia, an application of the case study on assisted visual training procedures is estimated for approximately 60-80 children. In this way, it will be possible to prove to a much better extent the degree of efficiency and the usefulness of the method under the aspect of visual assisted and alternative training [12], [13].

The further researches on this theme will be focused on the proposed non-conventional testing by serious games method implementation as visual screening and training procedure in children having sight diseases especially in case of squint or amblyopia.

Resuming the obtained results it can be observed that the alternative testing methods of squint and amblyopia have given some important information representing a very good base for the furtherly study. It could be found the high potential of the gaming tests as innovative solution not only in the Optometry, but even in Medical Engineering domains [13].

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References

1. Baritz, M.; Braun, B.: Modelling synergistic eye movement in the visual field, 6th International Conference Engineering Graphics Design, ICEGD 2015, by SORGING, Brasov, Romania, 11th – 13th June, 2015, Fascicle 3, Section Engineering Computer Graphics, ISSN: 2344-4681, pp. 1-4 (2015), link: http://www.sorging.ro/ro/revista/volume-10-special-issue-fascicle-3/modelling-synergistic-eye-movements-in-the-visual-field.
2. Baritz, M.; Braun, B.: The correlation between ocular physio-pathological manifestations and bipodal postural reactions, the 6th IEEE International Conference on E-Health and Bioengineering - EHB 2017 Grigore T. Popa University of Medicine and Pharmacy, Sinaia, Romania, June 22-24, 2017, pag. 567-570 (2017).
3. Baritz M.I.: Evoluția funcției vizuale, pg.5-8,Notițe de curs, Platforma elearning, Universitarea Transilvania din Brașov (2022).
4. Hull Jennifer, Vision Screening, 04/2020, link: https://aapos.org/glossary/vision-screening-description.
5. Kenneth W.Wright, Peter H.Spiegel, Lisa S.Thompson: Handbook of Pedriatic Strabismus and Ambylopia, Library of Congress Control Number: 2005932932 ISBN 10: 0-387-27924-5 e-ISBN 0 387-27925-4 ISBN 13: 978-0387-27924-4.
6. Barbu, D.: Analysis and modeling of the visual function, Transilvania University Publishing House, ISBN:973-635-130-0 (2003).
7. Baritz, M.: Analysis of human bio-behaviour and eye movements correlated with induced positive / negative emotional level, The International Scientific Conference e-Learning and Software for Education, ELSE, Bucharest, pag. 38 – 44 (2016).
8. Consilium Ophthalmologicum Universale: Visual acuity measurement standard, International Council of Ophthalmology, Pag. 15,16 (1984).
9. Pop R.: Oftalmologie, Casa Cărții de știintă (1995).
10. Mufarriq, S., Mirzaman, K., Muhammad, K.; Mohammad, Y., Saeed, N..: Causes of visual impairment in children with low vision, Journal of the College of Phisicians and Surgeons, Pakistan, JCPSP 21 (2), link: https://www.researchgate.net/publication/49847509_Causes_of_visual_impairment_in_children_with_low_vision, pp 88-92 (2011).

11. Talepasand, S.; Eskandaripour, M.; Taghinezhad, A.: Comparison of Working and Visual Memory in Children with and Without Dyslexia, Zahedan J Res Med Sci, Semnan University, Iran, November 2018, pp. 3-5 (2018).
12. Braun, B., Baritz, M.: Flexible method for „serious" games category for assisted visual training for children with visual impairments, 16th International Scientific Conference e-Learning and Software for Education, Bucharest, April 23-24, 2020, ELSE (2020).
13. Șoldan, C.: Proiectarea și dezvoltarea unei metodologii alternative pentru antrenamentul vizual al copiilor strabici și ambliopici, Diploma Project, coordinator: Lecturer Dr. Eng. Braun Barbu (2022).
14. National Instrumets: Introduction to LabVIEW 8.6, site: www.ni.com (2008).