Title: APPARATUS FOR, AND METHOD OF, DETERMINING VISUAL RISK ASSESSMENT

Abstract: The present invention relates to an apparatus for, and a method of, determining visual risk assessment. In many jurisdictions, Health and Safety Regulations require an employer to provide employees with an appropriate eye test, particularly where an employee has to use Display Screen Equipment (DSE). The invention is a method for determining visual risk assessment comprising the steps of: obtaining a characteristic measurement of an eye; deriving data from said measurement; and processing the data to derive a value indicative of a state and/or function and/or operational condition of the eye at a given instant; and transferring data to an output for assessment. Thus by use of the invention, and the related apparatus, it is possible to ascertain the risks associated with the type and amount of strain to which an eye is being subjected.
Apparatus and Method of Determining Visual Risk Assessment

Background

The present invention relates to an apparatus and method of determining visual risk assessment.

In the United Kingdom current Health and Safety Regulations 1992 state that an employer shall ensure that a user is provided with, at their request, an appropriate eye and eyesight test. For current employees this may be as soon as practicable after requested. For new employees this has to be prior to the employee commences using Display Screen Equipment (DSE), screens and other electronic displays. Thereafter tests must be at regular intervals.

Additionally, where a user experiences visual difficulty, which may reasonably be considered to be caused by work on display screen equipment (DSE), the employer shall ensure that the user is provided, on request, with an immediate assessment, in addition to providing regular risk assessments.

Risk assessments are legally required by various Health and Safety regulations. A risk assessment should fully assess all aspects of the employees' work and working conditions. They should be carried out at regular periods, or when there is a change in work conditions, environment or personnel.

Users or operators who interact with visual display units (VDUs) or Display Screen Equipment for even relatively short periods of time may be susceptible to, and/or at increased risk of, acquiring harmful visual coping strategies characterised by computer vision syndrome (CVS).

CVS is a condition associated with a range or collection of harmful symptoms indicative of the visual systems physiological and/or neurological response to being under strain. Such physiological and/or neurological strain gives rise to what is often referred to as "Visual Stress". Visual stress can also trigger the onset of eye and headaches. If such eye and headaches are experienced regularly they can give rise
to, or even promote, increased emotional stress, which can manifest itself as performance anxiety. This in turn can lead to problems with employee attendance and/or increased reporting of time off as sick. There is also evidence that these effects may be associated with lower employee self esteem, poor morale and a fourfold increase in risk of harm through other hazards linked to the workplace including higher staff turnover and driven by a generic work/life disaffection. All of these factors have been shown to contribute to an insidious reduction in performance, productivity and efficiency in human resources.

There is therefore an ongoing need for an apparatus for and a method of assessment for determining visual risk assessment to individuals in order that employers and others to not only comply with current (or future) legislation but also support well-being and improve care.

**Prior Art**

Display Screen Equipment (DSE) risk assessments have, by and large, been limited to the ergonomics of the work station to mitigate the rise in muscular skeletal disorders MSD's omitting the visual functionality of the operator other than a basic refractive sight test carried out by an experienced optician or optometrist, usually by conducting a simple eyesight test. For a large number of employees this has been expensive and time consuming as a form of risk assessment, particularly in some jurisdictions where responsibility or liability for providing and/or reimbursing the cost to the employee has not been sponsored by the employer.

In 2000 in the UK a survey by Dollond and Aitchison, Europe's largest optical group, found that over 70 per cent of those questioned expressed concerns that prolonged VDU work could affect their eyesight. Four out of every ten who used computers stated that they had experienced sore eyes from staring at computer screens for too long.

In the UK respondents to the British Trade Union Council (TUC) 1996 safety survey indicated that screen-related eyestrain was up by 29 per cent since 1992.

VDU-related temporary visual impairment in now an officially recognised occupational health problem in the US. The American Optometric Association has
labelled the condition "computer vision syndrome" (CVS). It says CVS can include any or all of the following symptoms:

- Temporary myopia, the inability to focus clearly on distant objects for a few minutes to a few hours after using the computer;
- Eyestrain or eye fatigue, a tired, aching heaviness of the eyelids or forehead;
- Blurred vision for near or far objects, and sometimes double vision or after images;
- Dry, irritated or watery eyes;
- Increased sensitivity to light; and
- Headaches, neck aches, backaches and muscle spasms from holding the body in awkward positions to maintain a desirable angle between eyes and screen.

A number of workplace factors can lead to CVS:

- Poor position in relation to the computer;
- Lighting that produces glare or reflections, fuzzy images or images that are too dim or too bright;
- Failure to blink often enough to moisten the surface of the eyes;
- Use of corrective lenses that are inappropriate for the user's position and distance from the screen;
- Minor visual defects that might go unnoticed if not exaggerated by intense computer use.

It is an object of the present invention to overcome this problem by providing a (reasonably practicable) method of determining visual risk assessment, (for those experiencing difficulty accessing text and) particularly for users of (DSE and/or) visual display units (VDUs).

It is an object of the present invention to provide an apparatus for determining visual risk assessment, particularly for users of visual display units (VDUs).
Summary of Invention

According to a first aspect of the present invention a method for determining visual risk assessment comprising the steps of: obtaining a characteristic measurement of an eye; deriving data from said measurement; processing said data to derive a value indicative of a state and/or function and/or operational condition of the eye at a given instant; and transferring data to an output for assessment.

Preferably both the left and right eyes are measured. Measurement may be made simultaneously or individually. Each axis of an eye is the preferred datum for the measurement or assessment.

Advantageously measurement of eye movement is performed over a time period of a few seconds and most preferably this procedure is repeatable and/or repeated over one or more interval(s) of time and ideally over an interval of two-three minutes.

Data collected from the measurement of eye movement may be presented in a graphical form, for example on a VDU. Data on a visual display unit may be manipulated, for example so that it overlaps data in respect of another eye in order to make a comparison between the eyes. Alternatively data may be normalised against a predetermined theoretical or personal datum.

The data collected from the measurement of the position and movement of the eyes can be stored for subsequent analysis or comparison. This enables statistical analysis of the data presentation, reproduction of results and reporting contributing to the body of research data collected.

According to a second aspect of the present invention an apparatus for determining visual risk assessment comprises: a means for measuring eye movement; means for deriving data indicative of said movement; a processor for processing said data and an output for recording and displaying the data.

Ideally means is provided for measuring eye movement simultaneously or individually. Ideally measurement of eye movement is performed over a time period
of a few seconds and most preferably over an interval of two-three minutes. This process allows benchmarking over time for comparison.

Means may be provided for manipulating data on a visual display unit for example so that it overlaps data in respect of another eye in order to enable an operator to make a comparison.

The apparatus ideally includes: an eye movement tracking device and a means for managing and/or recording output from the tracking device in order to provide a feedback signal for controlling sampling said tracking device.

The means for outputting data may include a means for interpreting and/or displaying and/or reproducing and/or publishing the data.

The means for managing and recording an output may include: hardware, such as a hard disc storage medium, compact disc (CD) or digital versatile disc (DVD), a memory chip, memory stick or other data recording or transfer medium.

The means for interpreting, displaying, reproducing and publishing the data can also be implemented in hardware or software.

 Preferably there are separate eye tracking devices for each eye. The tracking devices may be attached to a two-way data channel link. The two-way data link cable ideally enables data to be transferred by a single device such as a modem. The two-way data channel link may be connected so as to transfer data to a display device.

 Preferably a cable, for example a fibre optic cable, transfers data. The display device may be implemented as apart of a personal computer (PC).

 Data can be displayed in graphical form. There may be separate graphical outputs in respect of each eye. Software can be configured to produce graphs, in the form of an aptitude indicator of a user. The aptitude indicator may be configured to operate over time interval.
The graphical display may be manipulated to operate in a preferred manner, for example, raw data may be presented in the form of graphs for each eye may overlap one other or overlap previously recorded data for rapid visual comparison.

The aforementioned method would allow the analysis and comparison of eye performance against statistically normal less stressed visual system or eyes.

The eye movement tracking device is ideally adapted to track movement of the eye as it scans text, which is typically black symbols on a white background were visual performance may be compared with a range of other coloured backgrounds.

The eye movement tracking device obtains information about visual coping strategies. Coping strategies are techniques which the visual system employs to try and overcome any persistent operational or refractive difficulties experienced.

Examples of visual system coping strategies include: increased or reduced blink rate, eye turns/squints; limited stamina, eye and/or headaches; suppression of visual data from one eye; compensatory head movements; finger tracking during reading; and/or avoidance of prolonged exposure to text.

The method for visual risk assessment may be carried out on a scale of presenting visual coping strategies. Preferably the data gathered is compared to the status, scale of reading impairment and visual health history of a user. This data may be presented on a visual display, thereby assisting a skilled operator, occupation health or professional, ophthalmologist or optometrist to advise, inform and guide the user toward remedial therapeutic treatment.

The benefits from the method for risk assessment also enable users to be treated for CVS. This increases their efficiency, reduces the risk of long-term visual and emotional stress and/or harm or early onset of more permanent impairment to the functionality of their visual system.
Brief Description of the Drawings

Preferred embodiments of the invention will be described, by way of example only and with reference to the Figures in which:

Figure 1 shows a block diagrammatical view of an embodiment of the invention and includes a tracking device attached to a computer by a two-way data channel link;

Figure 2 shows a flow chart of the method; and

Figure 3 shows an example of a graphical output on a visual display.

Detailed Description of the Preferred Embodiments of the Invention

Referring to the Figures generally, there is shown an embodiment of an apparatus for determining visual risk assessment 10 comprising devices 30a and 30b for measuring movement of each eye and a means for deriving data from said devices 30a and 30b indicative of said movement 22. A microprocessor 20 processes data from each of the devices 30a and 30b and produces an output for displaying data on a visual display unit 40.

Ideally the microprocessor is part of a computer system which utilises dedicated software for conducting eye monitoring or an optical test. Software can be used to process data of eye trace readings.

Referring to Figure 2 a flow chart shows keys steps of a method of determining visual risk assessment. The first step 12 is that of measuring the movement of left and right eyes simultaneously. The movement is measured with respect to two axes, horizontal and vertical, over a set period of time. Each eye undertakes a task. Such a task may be for example scanning an array (an array task), such as reading a piece of text; or the task may be a non-array, task such as identifying specific objects from multiple objects, which may involve tracking, discriminating and focussing.
During the task, eye measurements are taken. During this time eye tracking devices 30a and 30b are detecting visual coping strategies, which each eye uses under visual stress. It is the visual coping strategy (and hence the amount of stress) that is being detected, measured and stored for comparison or otherwise.

The next stage is shown at step 14 and this is the transfer of data collected from measuring behaviour of the eyes to a computer system 20 by hardware. Data may be transferred in real time, whilst performing eye tracking or it may be stored locally and transferred as a single data packet, for example to a remote location for analysis, processing or storage.

The preferred data transfer medium is fibre-optic cables 24, 26 and 28. The data gathered from each individual eye can be combined together and transferred to the computer system 20 via a bi-directional data bus 22.

Step 16 is the interpretation of data and is performed under control of a microprocessor, for example this may be performed by a personal computer, operating in accordance with dedicated software. Data gathered from the eye tracking devices 30a and 30b is interpreted and manipulated, so that a display unit 40 can displays it in a meaningful form to an optometrist. The preferred display format is a graph on a computer screen; however, a reading or output in another format may be used. Data may be stored in a convenient form or on a suitable medium, so that it may be reproduced at a later time.

Figure 3 shows an example of a graphical display 40 of data gathered from the eye tracking devices 30a and 30b. Ideally a single graph for the right eye 41a and the left eye 41b is produced. Each graph 40a and 40b is displayed in a format aptitude with respect to time. Both graphs 40a and 40b are displayed on a display 40 simultaneously. The display 40 can be manipulated to a preferred configuration, so that for example the graphs for each eye may overlap each other or overlap previously recorded data for visual comparison.

Referring again to Figure 3, step 18 depicts data that has been previously gathered to be reproduced and graphically displayed. This allows comparisons to be made
with statistically normal users and may give a history of a user. Thus an optometrist is able to assess performance of each eye with respect to the other, with eyes at regular check-ups or assessments (eg six-monthly or annually) or between desired optimum or normal performance.

By way of a regular "check-up" or assessment it is possible to detect the onset of strain and put in place a different work regime and/or exercise regime and/or prescribe new corrective lenses for spectacles. As a result potential problems can be spotted in advance to them becoming more serious or before permanent damage occurs.

Referring again briefly to Figure 3 there is seen a "dip" in the signal shown on the amplitude of 41a, which corresponds to the right eye. When this signal in 41a is compared with the corresponding signal from the left eye, it is apparent that this discrepancy, may indicate a laziness or over-compensation which could give rise to strain in one (or both) of the eyes. The information or conditions at which the measurements are obtained may be stored in a computer memory (with an optional flag or alert) so that an alert or warning can be given to an optometrist. Ideally the test that gave rise to the discrepancy can be repeated, under similar conditions, at a subsequent date, so that the condition may be monitored and/or the efficacy of any remedial exercises or vision corrective action (spectacles) can be assessed.

It will be appreciated that variation may be made to the embodiments described without departing from the scope of the invention. For example it is understood that the above description is not intended to be limiting in that the optimum relationships between parts of the invention, may include variations in size, materials, shape, form, function and manner of operation, assembly and use; and all are deemed readily apparent to one skilled in the art.

All equivalent relationships to those illustrated in the drawings and described in the specification are intended to be encompassed by the present invention.
Claims

1. A method for determining visual risk assessment comprising the steps of: obtaining a characteristic measurement of an eye; deriving data from said measurement; processing said data to derive a value indicative of a state and/or function and/or operational condition of the eye at a given instant; and transferring data to an output for assessment.

2. A method according to claim 1 wherein the output device which displays the data in a visual means.

3. A method according to any preceding claim wherein the measurement is a measurement of movement of the eye.

4. A method according to any preceding claim where both eyes are measured.

5. A method according to claim 4 wherein eyes are measured individually.

6. A method according to claim 4 where the eyes are measured simultaneously.

7. A method according to any preceding claim wherein the measurement of the eyes is measured over a period of time.

8. A method according to any preceding claim where the measurement of the eyes is measured by eye tracking devices.

9. A method according to any preceding claim where the measurement of the eyes is measured while the eyes are undertaking a task.

10. A method according to claim 9 where the task is viewing an image, reading symbols or text.

11. A method according to claim 9 where the task is identifying objects.
12. Apparatus for determining visual risk assessment comprising: a means for measuring a characteristic of an eye; a means for deriving data from said measurement; processing means for processing said data to derive a value indicative of a state or condition of the eye; and means for transferring data to an output device for assessment.

13. Apparatus according to claim 12 wherein the output device is from the group consisting of: a screen, display and monitor.

14. Apparatus according to claim 12 or 13 wherein means is provided for measuring a characteristic of both eyes.

15. Apparatus according to any of claims 12 to 14 wherein the means for measuring a characteristic of an eye is a tracking device.

16. Apparatus according to any of claims 12 to 15 wherein the display device is a computer.

17. Apparatus according to claim 16 wherein the computer is arranged to interpret the data in a graphical display.

18. Apparatus according to claim 17 wherein the data gathered from the measurements of the eyes can be stored.

19. A method according to any preceding claim where software interprets the data.

20. A method for visual risk assessment as hereinbefore described with reference to the Figures.

21. An apparatus for visual risk assessment as hereinbefore described with reference to the Figures.