

Recovery of Visual Strain during VDT Work

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Abstract - The recovery of the visual strain has examined by using a new developed eyes' cooling equipment. By the results of the present study, a VDT working time was from 90 to 120 minutes, and 3 minutes of the eyes' cooling time was the most sufficiently. So the body and mind of the operator is keeping VDT work within a range of a day's visual strain.

1. Introduction

Nowaday, the world super highway's conception for the information has proposed by Vice President Al Gore in U.S.A.. And its conception will be realized in the multimedia. So the visual strain of a operator using a computer's display has excessived. The visual strain sprung from VDT work couldn't be the evaluation until now because the visual strain was appeared in the amplitude of visual accommodation, the eye, the brain, and the bodily positions other than the eye and brain¹⁾. The authors' studys have carried out an evaluation of visual strain. The results were published in the proceedings of the IS&T's 1998 PICS Conference²⁾.

Using an evaluation of visual strain, the present study is investigated as follows. So the recovery of the visual strain is examined by using a developed eyes' cooling equipment.

- (1) A VDT working time is investigated for the eyes' cooling.
- (2) The eyes' suitable cooling time for the recovery of the visual strain is investigated from relations between the eye's cooling time and a VDT working time .
- (3) The indexes of the visual strain for a rest in a

VDT work are investigated from the results of the stress tests.

From the investigational results of the above-mentioned 3 items, the applicatory method of a developed eyes' cooling equipment in VDT work has established from the relations between the eye's cooling effects and a day's visual strain of the operator.

2. Development of eyes' cooling equipment

The eyes' cooling take the recoverable effect of the visual strain. A new eyes' cooling equipment has developed for the recovery of the visual strain of a operator. The construction of eyes' cooling equipment is shown in Fig. 1, and its picture is shown in Fig. 2. A new eyes' cooling equipment installed to Peltier module is recovered of the visual strain by the eyes' cooling. Peltier module is the thermoelectric cooling module used to the metallic plate for the junction on both sides of a p-type and a n-type semiconductors. A heatsink and a cooling plate are put on both sides of Peltier module. Peltier module used to the new eyes' cooling equipment has the capacity for cool

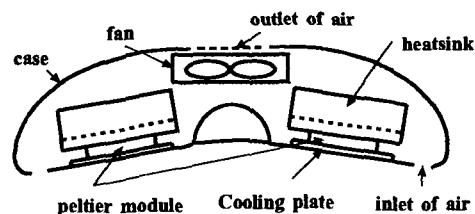


Fig. 1 Construction of eyes' cooling equipment installed to Peltier module.

down 11 degree from the using environment. Also, a new eyes' cooling equipment is put on the AC adapter, the autotimer, an inlet and an outlet of the air, and the fan.

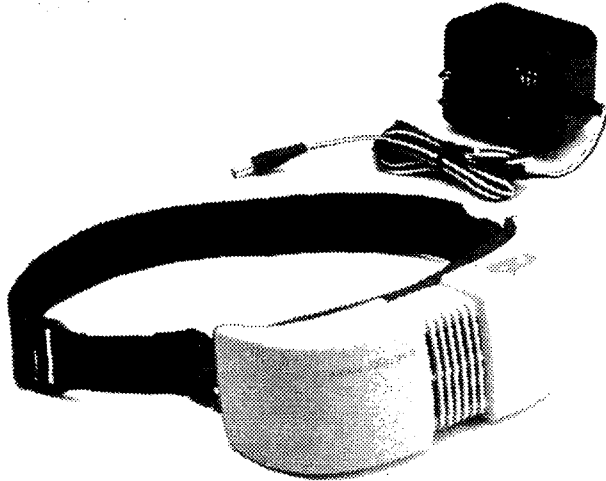


Fig. 2 Eyes' cooling equipment.

3. Stress and recovery tests of visual strain

For selecting operators with visual acuity from 1.0 to 1.5, the difference of visual acuity between the left and right eyes is defined to be within 0.3.

They are in good conditions, and don't feel tired. Twenty operators were selected in accordance with the above conditions. Visual distance between the operator and VDT is $H \times 2$ because the screen height of VDT is H .

Visual object is a thin film transistor addressed liquid crystal display (TFT-LCD), and the screen diagonal of TFT-LCD is 14.2 inch³⁾. The stress test of a fatigue was carried out for 600 alphabet (40(W) \times 15(H)) output on a screen of TFT-LCD. Screen output to the random arranged 600 alphabet, i.e., each 20 of B, K, U, and other 540 alphabet was made 14 kinds for 30 minutes of VDT works. Screen of VDT works were prepared for 5 times of the stress or recovery tests. The operator can be check each 20 of B, K, U output on a screen using the mouse. New random arranged 600 alphabet output on a screen at once. The luminance contrast for the screen of TFT-LCD is 0.83, i.e., the red color's luminance of the

background is 4.3 cd/m² and the white color's luminance of alphabet is 24.6 cd/m².

The recoverable effect of the visual strain of the operator has investigated by the eyes cooling. The flow of 5 times of the stress and recovery tests for the visual strain describes in Fig. 3¹⁾. So the recovery test for the visual strain has added to the measurement by the eye' cooling within the stress test.

After visual work using TFT-LCD, the eyes cooling time has 5 minutes. All of operators have complained of the headaches because the bone in forehead has rapidly cooled in 5 minutes by a new eyes' cooling equipment. For the above-mentioned reason, the very eyes' cooling time of after visual work using TFT-LCD has investigated to both a minute and 3 minutes without 5 minutes.

Using the measurement equipments on both the visual sensation (Visual acuity, strabismus and flicker) and the visual organ movement (Accommodation and convergence in near point), the visual depression sprung from the visual strain by a VDT work has measured in the stress and recovery tests^{5) 6)}. Simultaneously, the physiological variations of the operators have also measured by biological change (Sphygmomanometer and heart rate meter)^{6) 7)}. The measurement of the visual strain caused by VDT works couldn't any detection. It can be shown the natural recovery from the visual strain. If the visual strain can be some detection using the measurement equipments, the self-recovery of the visual strain is impossible and the medical treatments by a specialist is required.

4. Subjective evaluation at visual strain using the scales of 5 categories^{7) 8)}

After 5 times of the stress tests at the visual strain, if "(5) Don't be able to try a VDT work for the visual strain" in 5 categories is check, the visual strain will be remained in the tomorrow morning. It will be stored in the body and mind of the operator. Both "(3) Feel the visual strain" and "(4) Fairly feel the visual strain" aren't remained in the tomorrow morning. They are the subjective indexes of a day's visual strain. Consequently, the study is investigated with the categories of "(3)

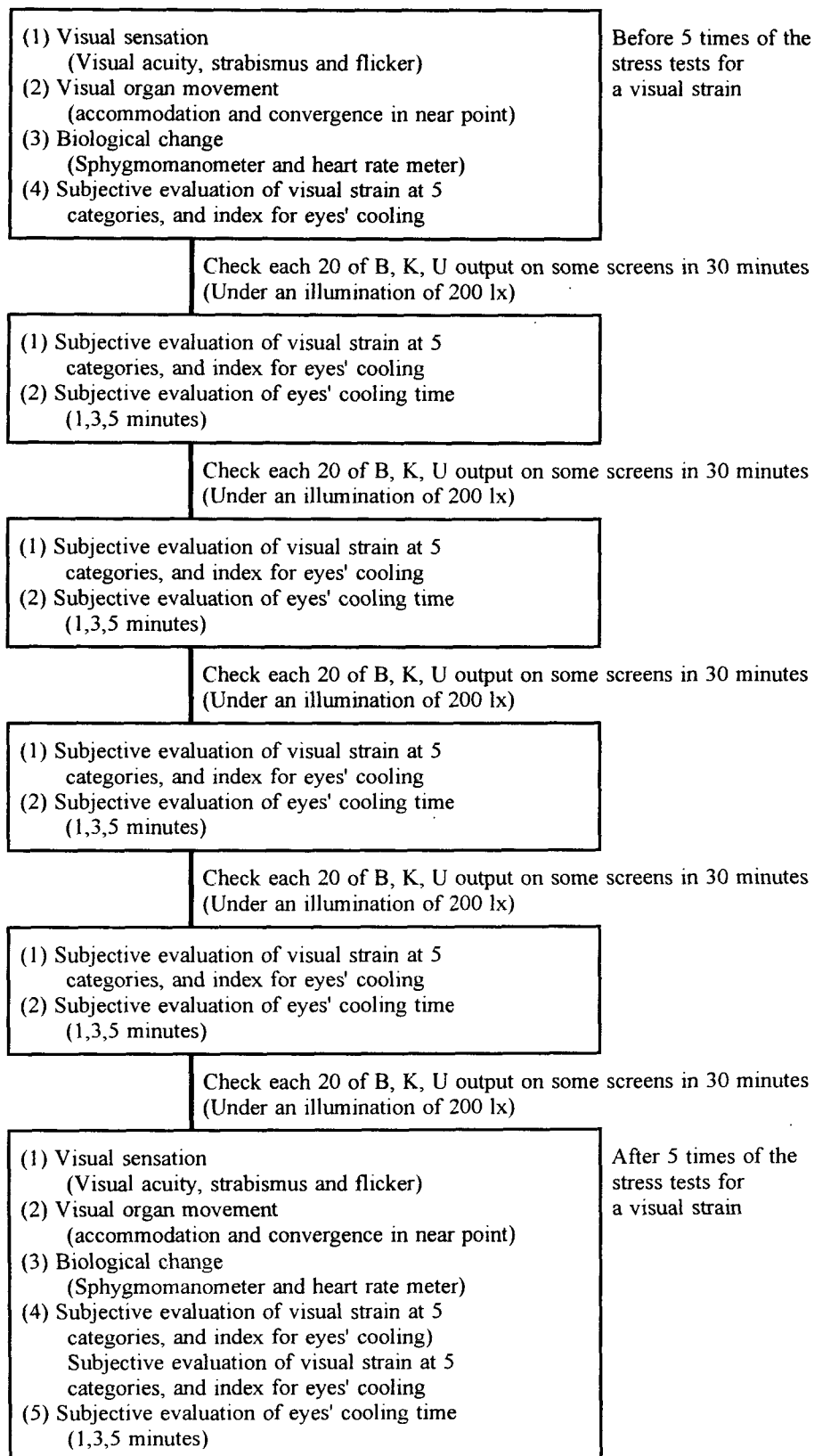
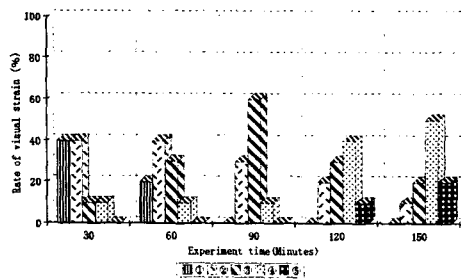
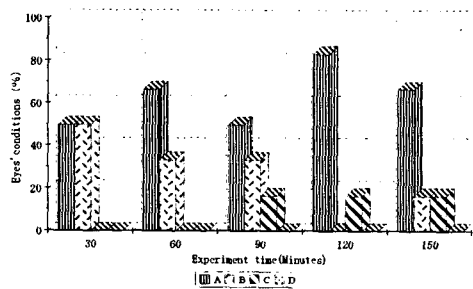


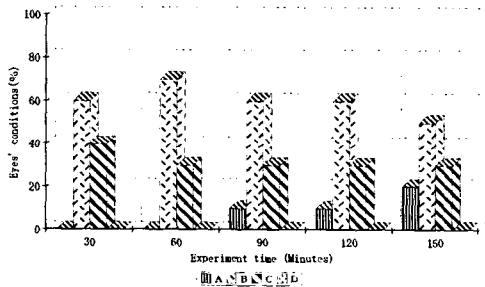
Fig. 3 Flow of 5 times of the stress and the recovery tests for a visual strain.



Non-eyes' cooling



A minute of eyes' cooling



Three minutes of eyes' cooling

Fig. 4 Subjective evaluation at visual strain used to the scales of 5 categories.

Where Five categories

- (1) Don't feel the visual strain.
- (2) A little feel the visual strain.
- (3) Feel the visual strain.
- (4) Fairly feel the visual strain.
- (5) Don't be able to try a VDT work for the visual strain.

Feel the visual strain”and“(4) Fairly feel the visual strain”. Subjective indexes given by the

expressions of “(3) Feel the visual strain”and“(4) Fairly feel the visual strain”were more than 50% after VDT work of 90 minutes. Then“(5) Don't be able to try a VDT work for the visual strain”was appeared from after VDT work of 120 minutes. From the above-mentioned results, a VDT working time is from 90 to 120 minutes. The body and mind of the operator is keeping VDT work within a range of a day's visual strain.

The eyes' cooling for a minute was compared with the non eyes' cooling. The eyes' cooling for a minute is effectived to the recovery of the visual strain. So the results of both “(1) Don't feel the visual strain” and “(2) A little feel the visual strain” have indicated more large value than other categories in all of VDT works. But the eyes' cooling time is a little insufficiency for appeared from “(3) Feel the visual strain” to “(5) Don't be able to try a VDT work for the visual strain”.

By the eyes' cooling for 3 minutes, the incidence of both “(1) Don't feel the visual strain” and “(2) A little feel the visual strain” have remarkably appeared in VDT works for 90 minutes. Thereafter, the incidence of both “(2) A little feel the visual strain” and “(3) Feel the visual strain” have increased. But “(5) Don't be able to try a VDT work for the visual strain” didn't have appeared. Consequently, the eyes' cooling is effectived to the recovery of the visual strain.

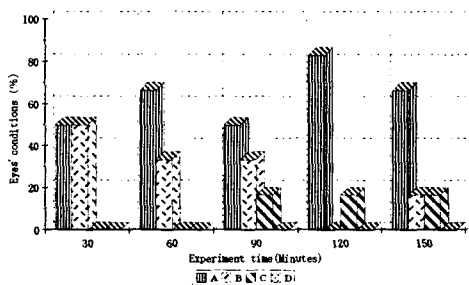
5. Indexes of fatigue during VDT work using eyes' cooling^{2), 9)}

The indexes for the eyes' cooling using the fatigue of operator are shown in Table 1. The indexes in Table 1 has published to the proceedings of IS&PIC International Conference '98. The appearance positions of fatigue had divided to 4 kinds, i.e., the amplitude of visual accommodation, the eye, the brain, and the bodily positions other than the eye and brain. The subjective indexes of 4 classes to the appearance positions of fatigue were shown with the conditions from a mild case to a serious case. For the above-mentioned reasons, the subjective indexes of 4 classes to the appearance positions of fatigue are only described as follows.

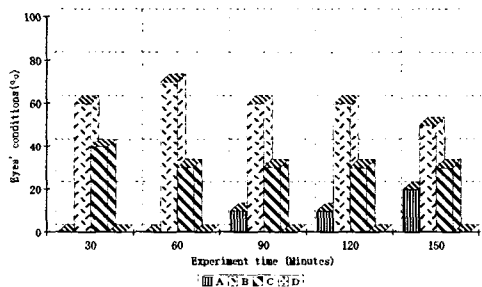
Table 1 Index and appearance rate of visual strain for eyes' cooling.

Appearance positions of fatigue for eyes' cooling	Indicator of fatigue	Appearance rates of indicator	
		TFT-LCD(%)	CRT(%)
Decrease of the amplitude of visual accommodation	Feel the flicker on eyes	30 (M in.) 80 (M ax.)	20 (M in.) 60 (M ax.)
Visual strain	Feel the dry of eyes	45 (M in.) 65 (M ax.)	35 (M in.) 65 (M ax.)
Brain	Don't clear the head	20 (M in.) 75 (M ax.)	15 (M in.) 50 (M ax.)
Positions in a body other than eyes and brain	Feel heavy in a body	15 (M in.) 50 (M ax.)	15 (M in.) 40 (M ax.)

6. Relations between the eyes' cooling and the recovery of visual strain



A minute of eyes' cooling



Three minutes of eyes' cooling

Fig. 5 Relations between the eyes' cooling and the recovery of visual strain

Where Four categories

- (A) Insufficient time for eyes' cooling.
- (B) Suitable time for eyes' cooling.
- (C) Overtime for eyes' cooling.
- (D) Feel uncomfortable on around of eyes too much eyes' cooling.

The suitable eyes' cooling time of the operator

has investigated for the recovery of visual strain from the eyes' cooling time. The results are shown in Fig. 5.

By a minute of the eyes' cooling, 10 operators have put the marks for 3 categories eliminating “(D) Feel uncomfortable on around of eyes too much eyes' cooling” in after 30 minutes of the visual work. “(A) Insufficient time for eyes' cooling” in 3 categories has most put the marks. The psychological fatigue has more increased from 60 minutes up. So the operator doesn't have a feeling of satisfaction depend on a minute of eyes' cooling.

By 3 minutes of the eyes' cooling, “(A) Insufficient time for eyes' cooling” and “(C) Overtime for eyes' cooling” have put on both sides of “(B) Suitable time for eyes' cooling” in after 90 minutes of the visual work.

From above-mentioned results, 3 minutes of the eyes' cooling time is sufficiently, but a minute of the eyes' cooling time is insufficiently.

7. Power of VDT work

Relations between the visual strain and the power of VDT work has investigated. VDT work using TFT-LCD is increased to the visual strain. Increasing the visual strain, the power of VDT work is to be decreased. But the operators don't have to decreased the power of VDT work from the increase of the visual strain because they are made the mentality for the inhibition to the visual strain during VDT work. However, the operators are keeping the standard poains. Keeping the standard power of VDT work in disregard of the visual strain, the serious visual strain is shifted to the psychosomatic disease in a short time. And there is decreased in the power of VDT work.

The average powers of VDT works are shown in Fig. 6. The power of VDT work during 60 minutes obtained from the non eyes' cooling has been increasing, but has gradually decreased for the visual strain after 60 minutes. Then the power of VDT work after 60 minutes obtained from 5 minutes of the eyes' cooling has decreased because all of operators have felt a sharp pain in the skull on the forehead of brain. Both a minute and 3 minutes of the eyes' cooling compared with 5

minutes of the eyes' cooling have increased the powers of VDT works. So the effects of eyes' cooling from a minute to 3 minutes are satisfied for the operators. Comparing a minute and 3 minutes of the eyes' cooling, 3 minutes of the eyes' cooling is better than a minute of eyes' cooling.

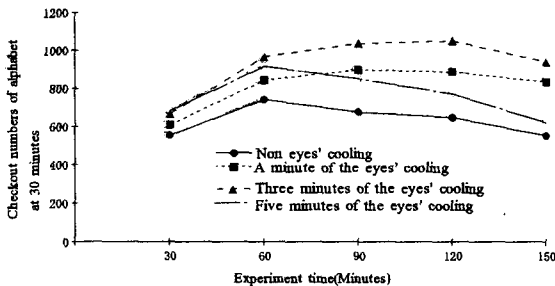


Fig. 6 Average powers of VDT works.

8. Conclusion

A new developed eyes' cooling equipment has applied to the recovery of a day's visual strain for operator. The present study has investigated to 3 items, i.e., a VDT working time, the indexes estimating the visual strain and the eyes' suitable cooling time. The results of subjective evaluation for the visual strain obtained from the present study describe as follows.

- (1) A VDT working times to the eye's cooling have chosen from 90 to 120 minutes.
- (2) The indexes of visual strain for estimating both the VDT working time and the eyes' cooling time have obtained from the results of the present study. So operators are felt the visual strain during VDT work by the indexes of visual strain. The stress on both the eyes and the brain have alleviated by the eyes' cooling.
- (3) Both a minute and 3 minutes of the eyes' cooling have increased the powers of VDT works. So the effects of eyes' cooling from a minute to 3 minutes are satisfied for the operators. The most suitable eyes' cooling time during the VDT work is 3 minutes. Eventually, it has obtained from relations between the recovery effect of visual strain and the power of VDT work.

If the operator wears the eyes' cooling equipment after visual work depend on the above-mentioned results, the psychological stress of the operator will be mitigated within a range of a day's visual strain.

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