The prototype of measuring instrument of equivalent viewing power for magnification

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How do we select a near low vision aid? We estimate the *magnification* or the *Equivalent Viewing Power (EVP) in diopter* for near low vision aids, using conventional methods such as Sloan M system (standard distance: 40cm), Keeler A system (standard distance: 25cm), The N point system (standard distance: 25cm), Kestenbaum method (reciprocal of Snellen distance chart), Logarithmic scale by Bailey (any reading distance) [Chiristine M. Dickinson, 1991], and MNREAD (standard distance: 30cm). EVP is normally estimated using methods as mentioned above, but do not utilize any mechanical instrumentation. EVP is measured by the telescope for near vision due to variability of telescopic length and differing outcomes. Some ongoing issues are for example; manually fixing the telescope in a usable position. Because of this, during the experiment focusing the telescope and keep it in a fixed and usable position was difficult. As a result, a more convenient method for using an auto-focus telescope to reduce manipulation by the investigator was required.

【 Methods 】

The prototype instrument consists of target letters on the modified optical bench and auto-focus telescope for near vision (Figure 1). The target was controlled with a speed controller switch to alternate forward and backward motion. The calibration of EVP from 10D to 37D was printed on the optical bench for the investigator to read EVP for magnification. Students were asked to tell the investigator to indicate when the target was in their sight, while the target was moving from far to near for them. A total of 10 students whose corrected decimal visual acuities were from 0.03 to 0.4 were recruited to compare values of diopters, for magnification between the new instrument method and recent common method using Japanese reading chart.

Auto-focus telescope with attachment lens of 3D and 6D
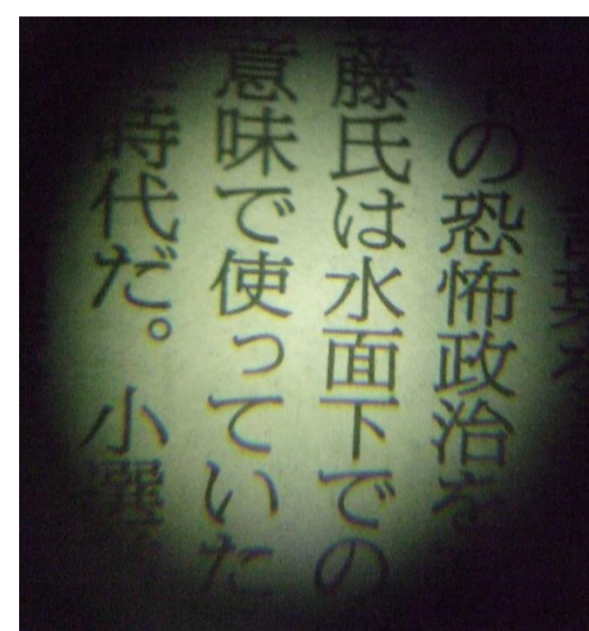
Letters of news paper through the auto-focus telescope. Virtual image is at infinity even if the target letters is approaching to the objective lens
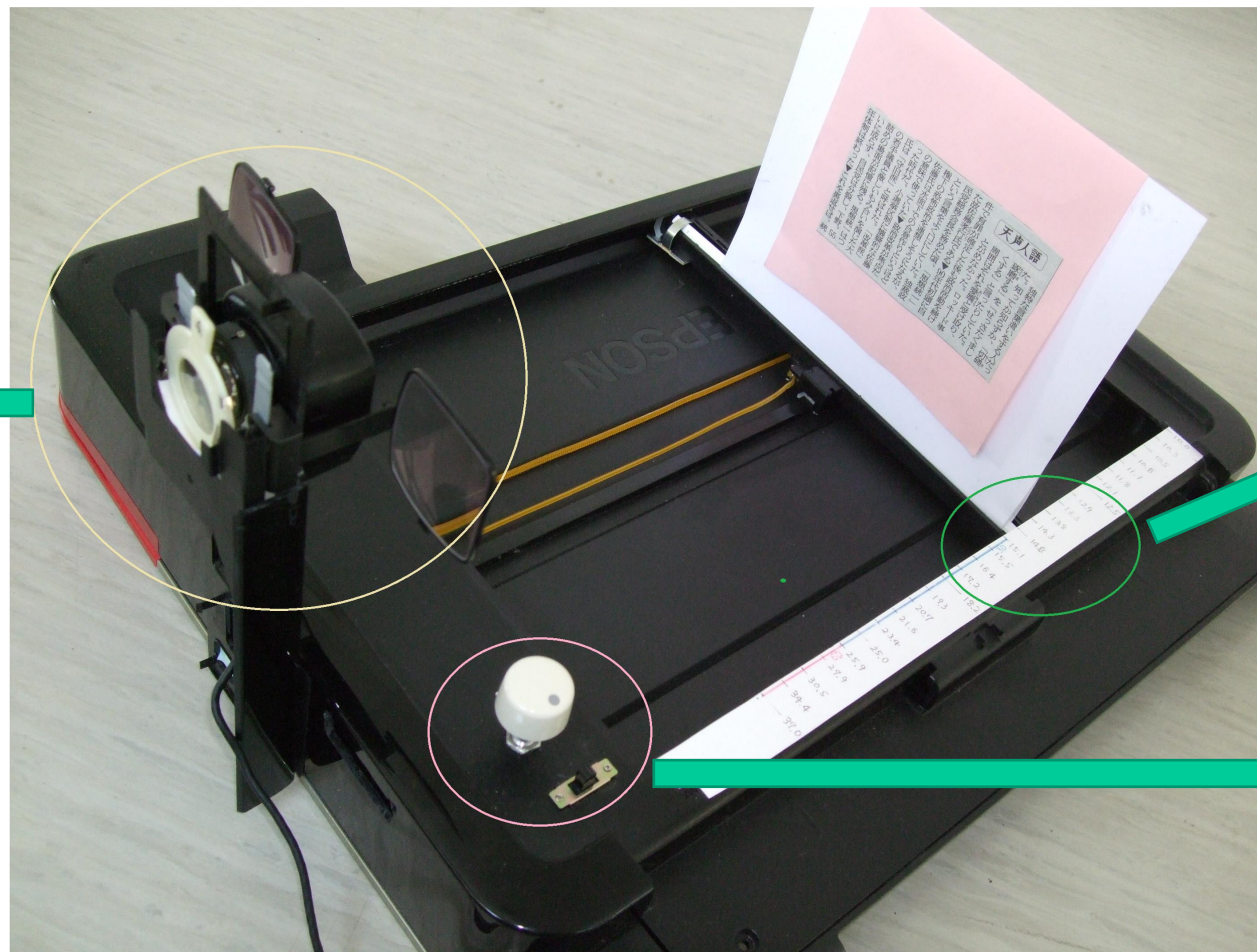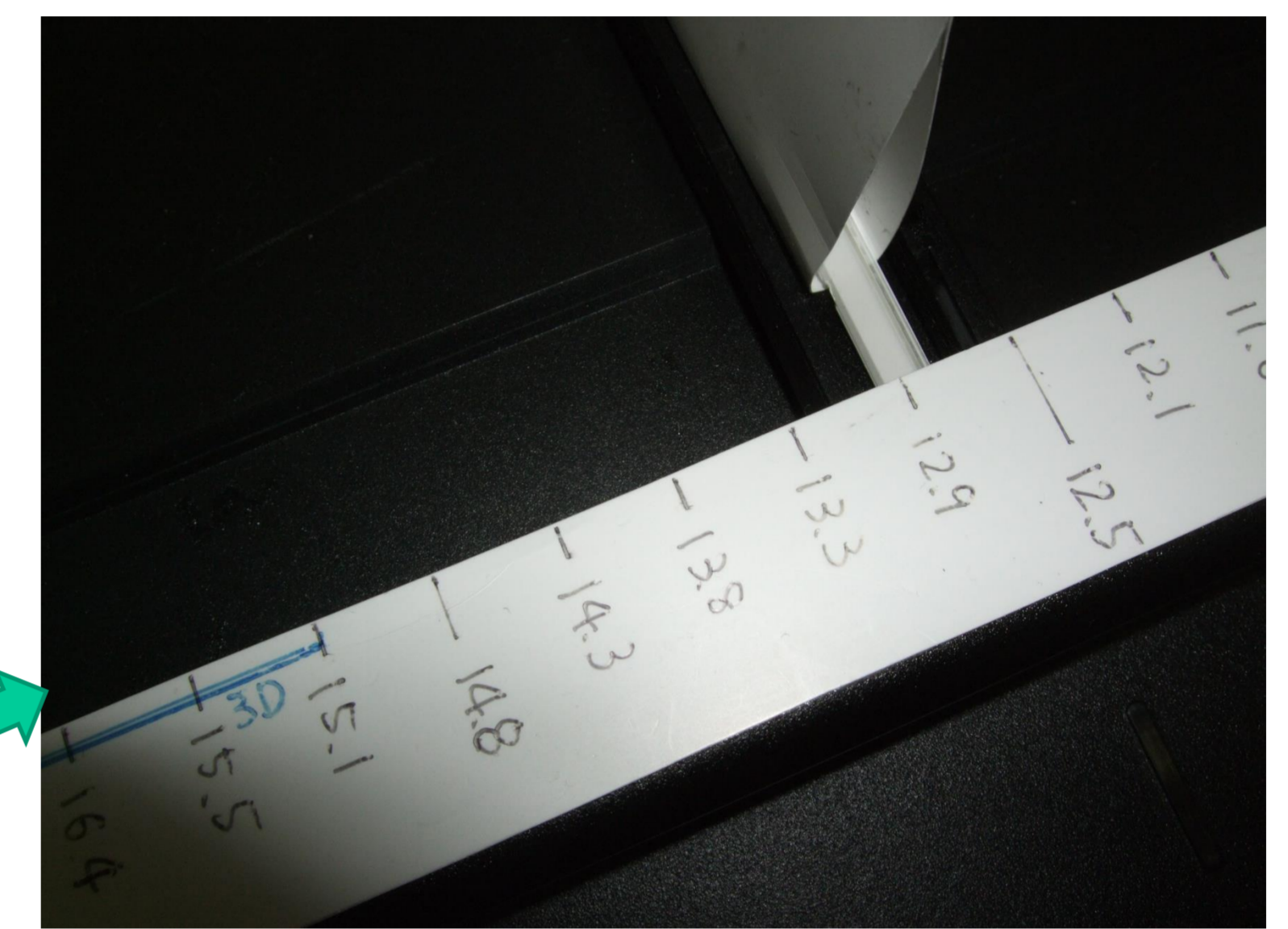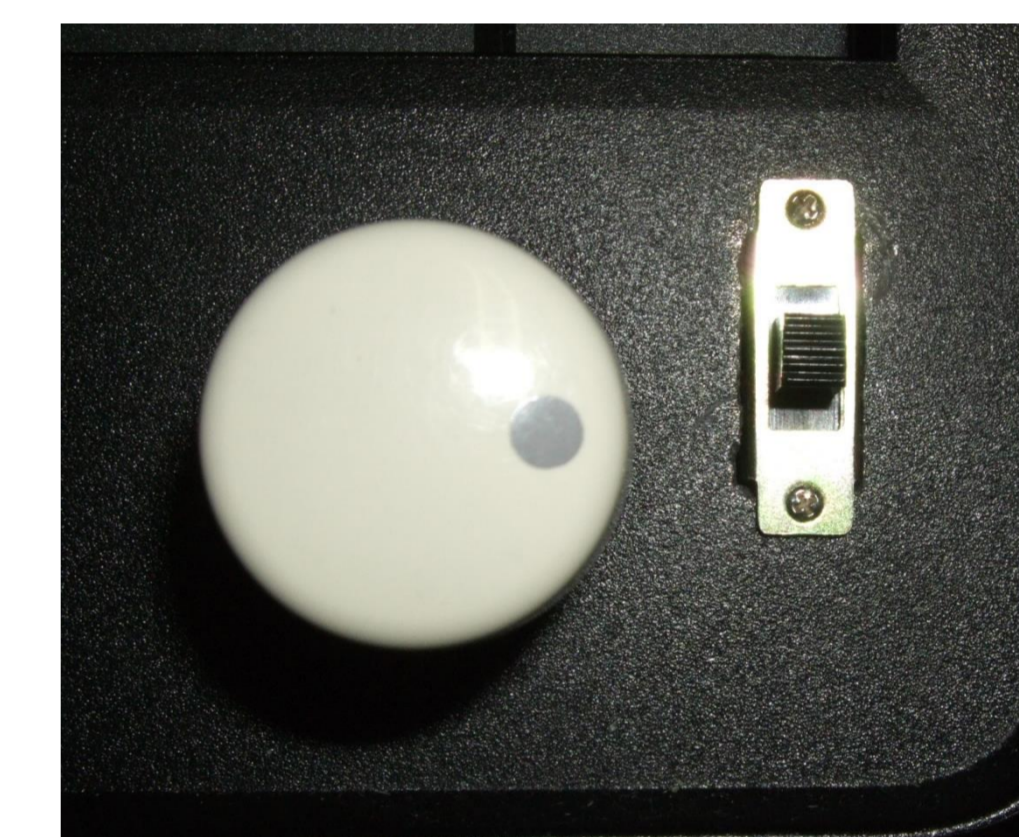
Figure 1. Measuring instrument of EVP

Calibration of EVP

Speed controller switch to alternate forward and backward motion

【Results】

Student who had a score of 0.03 of visual acuity were excluded due to the necessities over 37D of EVP. Another 9 students who had corrected visual acuity between 0.04 and 0.4 were compared when using the instrument and reading chart. 7 students have differences below 2D, 2 students whose visual acuity have 0.06 and 0.04 have 5D and 20D respectively. As a result, there were no significant differences with the t-test (p>0.05). Bland-Altman plot is as follows. The mean difference between the values of the (A) and (B) is 2.06D (Figure 2). The 95% limits of agreement for the difference is ±13.82, meaning that on average there is 95% confidence that the difference is within 15.88 and -11.76 (Figure 3).

	Dicimal Visual acuity	Reading Chart [D] (A)	EVP meter [D] (B)	(A+B)/2	A−B
A	0.03	100			
B	0.04	50.0	30.0	40.0	20.0
C	0.06	25.0	20.0	22.5	5.0
D	0.06	28.0	28.0	28.0	0.0
E	0.06	33.0	34.0	33.5	−1.0
F	0.15	13.3	14.8	14.1	−1.5
G	0.15	13.3	13.0	13.2	0.3
H	0.2	9.5	11.0	10.3	−1.5
I	0.3	10.0	12.0	11.0	−2.0
J	0.4	10.0	10.8	10.4	−0.8
Average		21.34	19.29	20.32	2.06
Standard deviation		13.75	9.09	11.19	7.05

Figure 2. Decimal visual acuity , diopter measured by reading chart and EVP meter
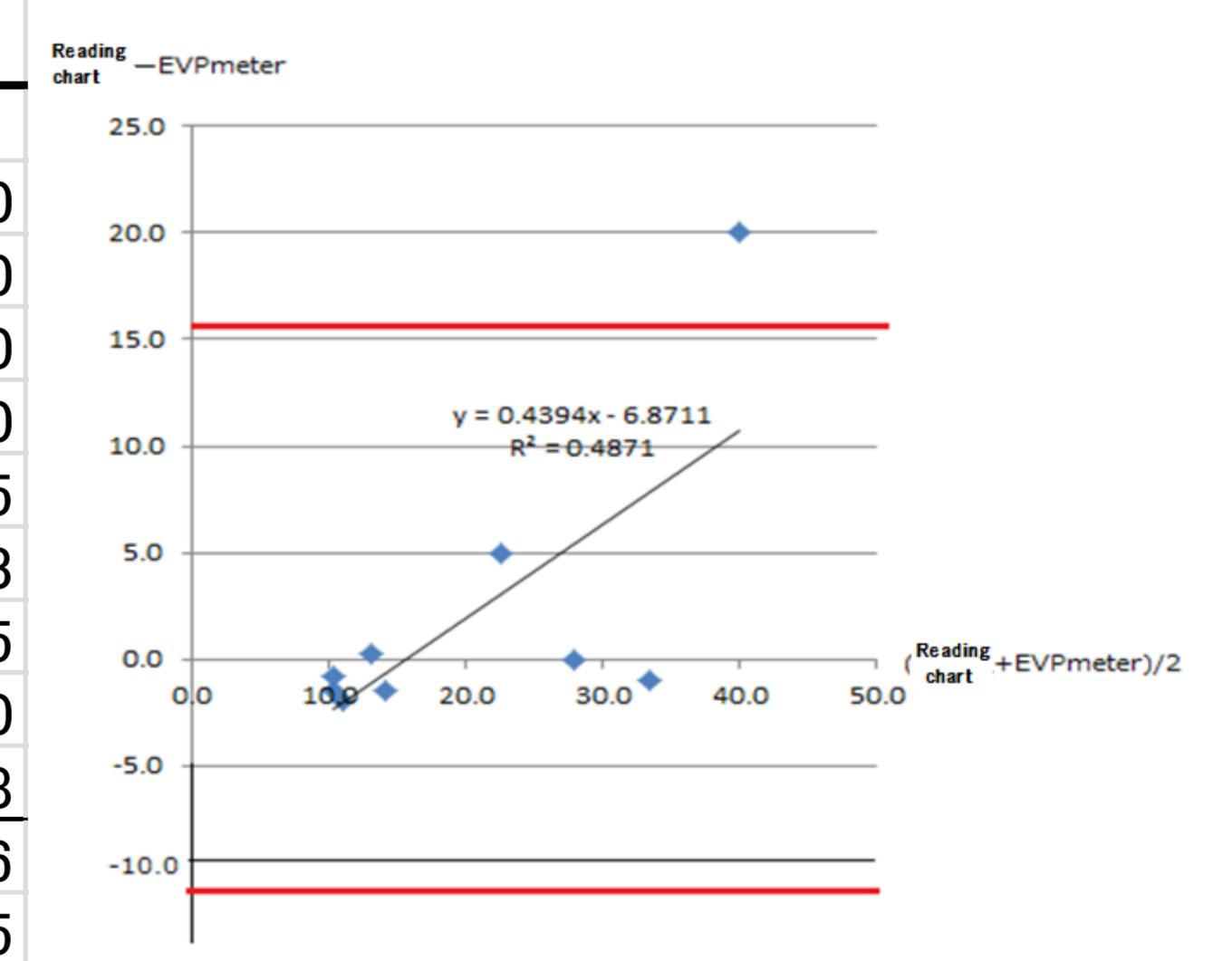＊ Yellow backgrounds are sighted persons with simulation lens of low vision.

Figure 3. Bland-Altman plot

【Discussion】

In practice, we might expect that vision impaired people are not able to determine working distances precisely because their tolerance to defocused image may be increased. If we accept that a person with visual acuity of 0.1 (6/60 or 20/200 or logMAR1.0) is tolerant to ±1.0D of defocus, there will be a variation of EVP if the distance between auto-focus telescope and the target letters are imprecise.

【Conclusion】

Measuring of the EVP instrument for magnification, successfully estimated the EVP without calculation. The prototype instrument was effective in its intended purpose.