International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 07 July 2024, pp: 775-778 www.ijaem.net ISSN: 2395-5252

Using medical endoscope field of view characteristics (FOV) and viewing direction (DOV) for a simplified endoscopic detection approach through analytics

Fadwa Joma Abuhbail

Date of Submission: 15-07-2024 Date of Acceptance: 25-07-2024

ABSTRACT: This work has enhanced the conventional testing approach by rotating the testing target, in accordance with endoscope Field of View (FOV) and Direction of View (DOV) properties. A theoretical foundation for the streamlined endoscopic detection approach was provided by the paper's analysis of the theories of vertex field angle and object pupil field angle, as well as their reciprocal transformation relationship.
Key Words: Field of View, Direction of View, vertex field angle, object pupil field angle

I. INTRODUCTION

A medical equipment with an observation function is a medical endoscope. It can enter the body through natural openings or through a surgical procedure performed for testing, diagnosis, or therapy. The field of view and direction of view requirements for a medical endoscope vary depending on the part of the human body they are used on. The range of observation is determined by the field of view. The observation position of things is determined by the Direction of View. These are two critical endoscope parameters. Its ability to precisely locate the lesion is directly correlated with the precision of these two metrics.

II. DEFINITIONS OF FIELD OF VIEW

The object FOV can be described as the object pupil field angle and the vertex field angle, using the classification of YY 0068.1-2008 [2]. The maximum object pupil field angle is the maximum field height angle from the entry pupil centre in the endoscope imaging system to the object (see Figure 1). The maximum vertex field angle is the maximum field height angle from the endoscope terminating centre to the object (see Figure 1)[2].

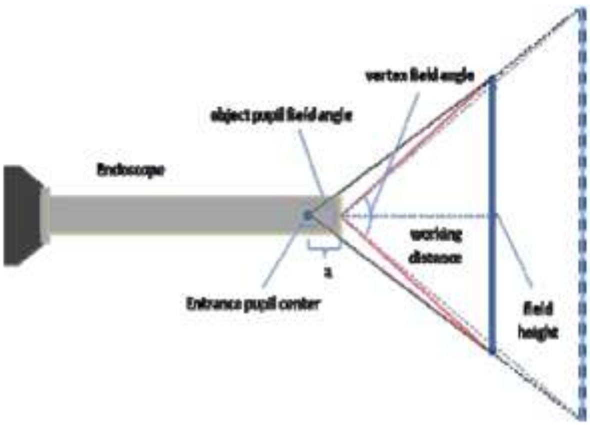

Fig 1. Field of View

The object pupil field angle is fixed with respect to working distance because the entrance pupil centre point denotes the upper bound of FOV. However, the vertex field angle and object pupil field angle have the same field height; the value is greater than the object pupil field angle, which eventually approaches the object pupil field angle as the working distance increases[4][5].

III. THE TESTING OF FOV AND DOV

The paper used a fixed Direction of View testing target [1][3], with the endoscope rotating around Direction of View. This is a straightforward method that can be used to finish both Direction of View and Field of View testing, in accordance with GB 11244-2005 testing procedure. However, during the test, you will need to adjust the endoscope. In addition, the endoscopic eyepiece end will connect to the camera, spectral measurement system equipment, and so on. This will require a lot of work to adjust; for instance, if the endoscope is long and the eyepiece connects to a heavy camera, each factory has a different type of camera that rotates during the adjustment process, increasing the risk of damage and endoscopic optical axis bending.

We enhanced it in this paper using a conventional testing apparatus as a guide. Rotate the testing target after fixing the endoscope. As illustrated in Figure 3.The problems and danger of the eyepiece rotating are eliminated by this solution. In the meantime, the endoscope's tip might conform to the testing target's rotational centre, preventing a position offset during rotation.

Testing target fixed equipment can be adjusted in four dimensions, and when the necessary working distance and direction of view are met, the field centre will coincide with the testing target centre. Using electric control, one may modify the zero position of a specific system's working distance and direction of view during the process. This leads to the realization that the position can be displayed in real time during testing, which increases the automation and efficiency of the testing process.

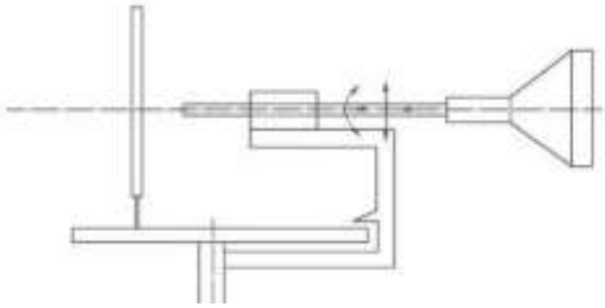

Fig 2. The traditional testing device for FOV and DOV in GB 11244-2005

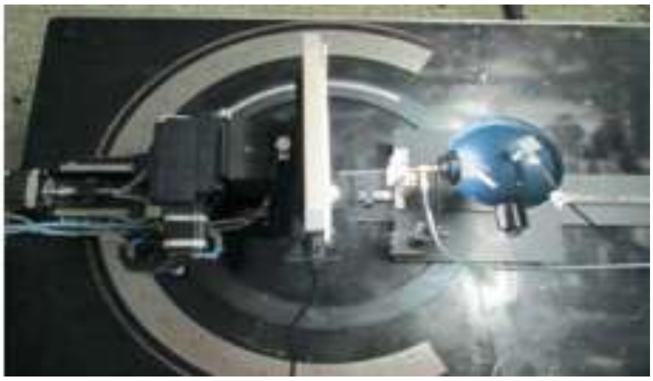

Fig 3. The optimizing testing device

IV. FOV TESTING TARGET AND CALCULATION

To complete the test of object pupil field angle and vertex field angle, two testing targets are required: double circle testing target and concentric circles testing target. All of these require light-weight, high-intensity material. Using Light box lighting with uniform illumination on the rear to lessen light reflection on the testing target surface. At the same time, meet the 500lx minimum required level of illumination intensity. To measure the vertex field angle, utilize a testing target with concentric circles.As a reference, a 50 mm working distance for engraved lines with a 2 ° groove and a concentric diameter L is:

$L = 2\times50\times\tan(A/2)$ $(A=0,2,4\ldots\ldots,128,130)$(1)

where A is the vertex field angle at a working distance of 50 mm and L is the concentric diameter. At a working distance of 50 mm, the vertex field

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 07 July 2024, pp: 775-778 www.ijaem.net ISSN: 2395-5252

angle can be read directly. If the working distance is less than 50 mm, convert using formula (2).
2W= 2arctan((50* tan A/2)/d)(2)
where 2W is the actual vertex field angle and d is the working distance of the vertex field angle.
Object pupil field angle is measured using a double circle testing target. The two circles have diameters of 25 and 50 mm, respectively, in accordance with the YY 0068.1-2008 testing technique. Object pupil field angle can be calculated using

WP =arctan($\frac{12.5}{d2-d1}$) (3)
a = $d2 - 2d1$(4)

Where Wp is object pupil field angle;
d1is the diameter of small circles;
d2is the diameter of big circles;
The distance a is from the object pupil to the vertex.
Figure 1 shows that the vertex field angle at a random working distance may be calculated using the following formula if the object pupil field angle and are both known:
As follows:
2W= 2arctan ((d+a)* tan (WP/2)/d)

Where 2W is vertex field angle; d is the working distance of vertex field angle;
a is the distance between object pupil to vertex;
Wp is object pupil field angle.

The distance a between object pupil to vertex that is the necessary testing parameter that realize endoscope function test. If you can finish this parameter test, you could get the object pupil field angle Wp, according to formula 5, you can get the vertex field angle. Consequently, you do not need test vertex field angle. So this could simplify testing steps, equipment and improve the work efficiency.

V. RESULT

The first portion compares the Field Angle and Direction of View results obtained from traditional testing equipment with those obtained from an optimising testing equipment. The second part compares the vertex field angle calculated from object pupil field angle with the vertex field angle obtained from actual testing.Test each of the ten samples independently; the findings are as follows:

Table1. The comparing results between traditional testing device and optimizing testing device

samples	Traditional testing device	Optimizing testing device	Deviation
1	DOV: 0° FOV: 50°	DOV: 0° FOV: 50°	0%
2	DOV: 0° FOV: 65°	DOV: 0° FOV: 65°	0%
3	DOV: 0° FOV: 85°	DOV: 0° FOV: 85°	0%
4	DOV: 30° FOV: 50°	DOV: 30° FOV: 50°	0%
5	DOV: 30° FOV: 65°	DOV: 30° FOV: 65°	0%
6	DOV: 30° FOV: 85°	DOV: 30° FOV: 85°	0%
7	DOV: 70° FOV: 50°	DOV: 70° FOV: 50°	0%
8	DOV: 70° FOV: 65°	DOV: 70° FOV: 65°	0%
9	DOV: 70° FOV: 65°	DOV: 70° FOV: 65°	0%
10	DOV: 12° FOV: 65°	DOV: 12° FOV: 65°	0%

The results show that the optimizing testing device's results are identical to those of the traditional device, meaning that it can be used in place of the traditional equipment for measurement.

Table2. The comparing results between calculation and measurement of vertex field angle

samples	measurement results (°)	calculation results (°)	Deviation
1	66.7	67.9	1.8%
2	93.5	94.4	1.0%
3	74.8	75.2	0.5%
4	51.4	50.8	-1.2%
5	55.4	55.3	-0.2%
6	47.3	46.5	-1.7%
7	67.6	66.3	-1.9%
8	78.1	77.6	-0.6%
9	80.2	79.5	-0.9%
10	51.8	50.9	-1.7%

The result indicates that the maximum error is -1.9%. The precision testing target utilised is 1°; at 50 mm distance, the reading error in the 50 ° Field Angle is± 2%, and in the 80 ° Field Angle, it is ±1.25%. In addition, the result falls within a predictable error range when the scribed line edge blur is added to the value measuring error.

VI. CONCLUSION

This research examines the issues related to the field of view and direction of view of medical endoscopes in real-world testing, leading to the optimisation of the testing apparatus. We also examined the link between the object pupil field angle and the vertex field angle at the same time, in conjunction with the theoretical calculation. It demonstrates that testing device optimisation is accurate and feasible for real testing. In the meantime, it was demonstrated that theoretical conversion could replicate the real testing by contrasting the theoretical conversion with the vertex field angle and object pupil field angle testing.

The National Science and Technology Infrastructure Program's research fund (Quality evaluation and security of active medical device, 2012BAI22B04) and the National Institute for Food and Drug Control's Young and Middle-Aged Fund (Research of simulated eye for detection of optical coherence tomography, 2011C1) and Young and Middle-Aged Fund (The Measurement Research of Rigid Endoscope, 2012B14) provided funding for this work.

REFERENCES

[1]. GB 11244-2005 General requirements for the medical endoscope and endoscope accessories,Standards Press of China 喋 Beijing,China,2005.
[2]. YY 0068.1-2008 Medical Endoscopes-Rigid Endoscopes-Part1:Optical properties and test methods, Standards Press of China,Beijing,China,2008.
[3]. YY 0068.2-2008 Medical Endoscopes-Rigid Endoscopes-Part2:Mechanical properties and test methods , Standards Press of China ,Beijing, China, 2008.
[4]. Xiao hang jia, Evaluation Method of Medical Rigid Endoscope's Relative Effect of Edge Light Luminosity, ActaPhotonica Sinica,Vol.37,NO.9,1869-1873,2008.
[5]. Liu Yan zhen, The Research of Influencing Factors for Edge Illuminance Measurement of Medical Rigid Endoscope[J], Advances in Information Sciences and Service Sciences, Vol.5,NO.5,1048-1056,2013.