Development iris collimator drive program for radiation therapy

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1. Introduction

In radiotherapy, it is important that the radiation should be irradiated according to the location and size of the tumor. When radiation is irradiated to normal cells during radiation therapy, complications such as destruction of normal cells and skin necrosis occur. In radiation therapy, cone-shaped lead shields have been used to minimize the radiation dose of normal cells [1.2]. However, since the size of the shield varies depending on the size of the tumor, the size of the irradiation field is varied and it is inconvenient to manually replace the shield. Small-sized tumors require more detailed and accurate radiotherapy, and the International Commission on Radiation Units (ICRU) recommends an accuracy of approximately ± 5% [3].

In this study, we developed an iris collimator which is optimized for small size tumors and can adjust the size of radiation field freely and developed a driving and evaluation program.

2. Methods and Results

2.1 Engineering design and manufacture of Iris collimator

Brass was used as the leaf material of the iris collimator to be fabricated. Brass is also used with shielding materials such as multi leaf collimators because of its excellent workability and shielding ability of radiation beam [4-6]. The collimator structure was designed to have a leaf thickness of 20mm and an inner diameter of 30degrees. Each leaf is driven by four fixed gears that perform a circular motion using a servo motor. The gears are connected by an elastic belt so that when the gear attached to the motor moves, the remaining three gears are also designed to move. The frame for fixing the motor was made of reinforced plastic and twelve leafs were interlocked and designed to produce a circular radiation field. Fig 1 shows the complete iris collimator.

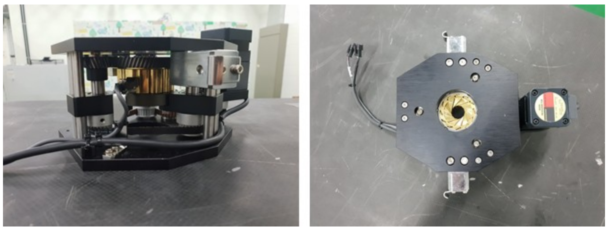

Figure 1. Appearance of manufactured iris collimator.

2.2 System operation and length measurement program development

We developed a motion program using LabView software to operate the complete iris collimator and conversion system. Device Ready button is a button for confirming that the functions are connected when they are first started. If there is a problem with the motor, the motor automatically stops and the SERVO OFF and Alarm lights up. The open and close buttons of the iris collimator are used to open and close the collimator field, and the numeric panel regulates the value of open and close field size. Fig 2 shows Iris collimator Motion Program

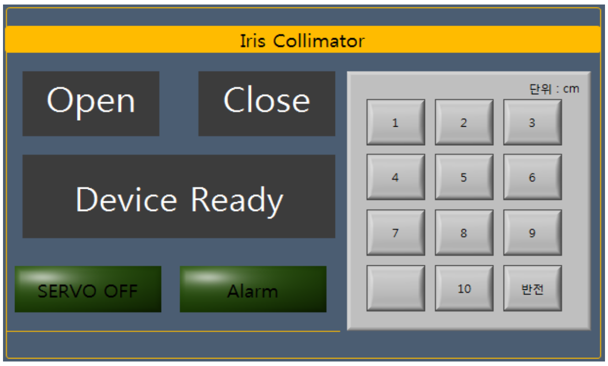

Figure 2. Iris Collimator Motion Program User Interface

2.3 Development of Iris Collimator Evaluation Program

To verify that the values entered in the numeric panel of the motion program are applied to the iris collimator, a measurement program was developed using LabView software. We used the functions of vision and motion categories such as Straight Edge and Caliper. For more precise measurements, we used the Morphology function to determine the boundary of the shadows. Since the result using the Caliper function is measured as a pixel value, it is necessary to convert it to cm as shown in the following equation.

$$1inch = 2.54cm$$

$$pixel = \frac{cm}{2.54} \times DPI,\ cm = \frac{(pixel \times 2.54)}{DPI}$$

The Iris collimator evaluation program GUI was constructed as shown in Fig 3. 1 is a function to retrieve the path of the image obtained by using the iris collimator and motion program. 2 is the function of judging whether there is an error. 3 is the function of displaying the converted image for the basic image and image measurement. The Fourth function is for stopping the program, and the fifth function is for inputting the DPI of the image. Function No.6 indicates the length information of both ends of the image. Fig 4 shows the flowchart of the evaluation program.

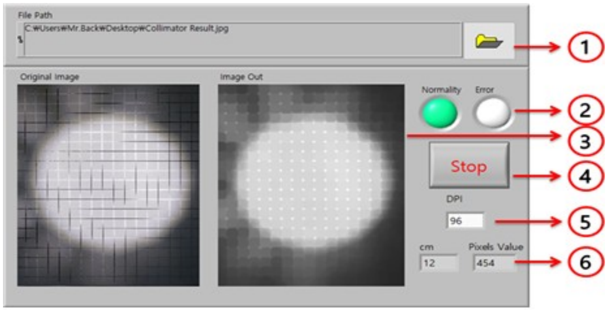

Figure 3. Iris Collimator and conversion system evaluation program User Interface

Figure 4. Evaluation program flowchart

2.4 Iris collimator experiment and results.

We measured the field size of each of the different sizes and conducted a total of 5 experiments. Both ends of the penumbra around the irradiated surface were measured. The average error of the measured values was 0.34 cm and the error rate was measured to be about 1.7%. The error value tended to increase from small circle to large circle. Fig 5 shows the experimental results.

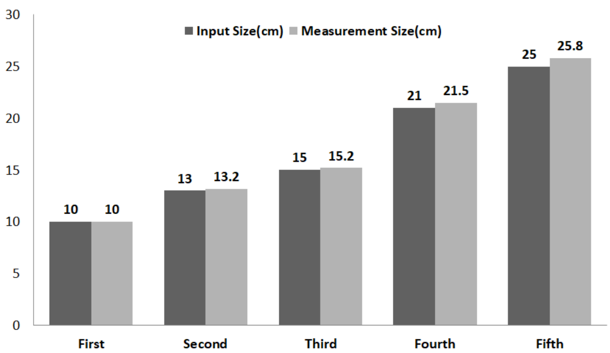

Figure 5. Iris Collimator field size measurement data

3. Conclusions

Before the radiotherapy, the position of the patient and the size of the lesion should be determined in advance, and the size of the irradiated surface is determined accordingly. We used an iris collimator to measure the size of the irradiated surface. We developed an evaluation program and compared the size of the radiation field with the size of the radiation field input from the program. An error value occurred in the process of measuring the irradiation surface. The error value tends to increase as the size of the irradiated surface increases. This seems to be due to the effect of penumbra that occurs when the light is shined to measure the radiation field. Except for these errors, the iris collimator operated normally. If this error is reduced, it is expected that it can be used in future radiotherapy equipment.

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