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Advanced Vision System by Subtraction of Background Image for Patient's Movement during Treatment

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Abstract

According to the International Cancer Institute (IARC), the incidence of cancer in the world is rapidly increasing, and in the method of treating cancer, radiation therapy is 45% or more. As in the normal tissue in radiation therapy, to minimize radiation, it is important to maximize the exact dose to the tumor sites for local tumor control rates in intensive research (Local Tumor Rate). Therefore, at the beginning, therapist accuracy of detecting fatigue in the movement of the patient and therapist has been a problem that is weighted down directly. Also, by using a web camera, a difference value between the image to be updated to the reference image is calculated, and if the result exceeds the reference value, using the system for determining the motion has occurred. However, it is not possible in this system to quantitatively analyze the movement of the patient, as the background is changed when moving the treatment bed in the co-therapeutic device was not able to shift the patient. In this paper, using an alpha (α) filter index is an attempt to solve these limitation points, as it quantifies the movement of the patient by separating a background image of the patient and treatment environment, and it only senses movement of the patient during treatment, it was possible to reduce the problems due to patient movement.

Keywords: *Radiotherapy, vision tracking, background image*

1. Introduction

1.1. Background and the need for Research

According to the International Cancer Institute (IARC), and the increase in the elderly population, some of the incidence of cancer in the world to environmental factors is increasing rapidly. In the treatment of tumors, radiation is gaining even more significance. Minimizing radiation on normal tissue in radiation therapy in conjunction with this, it is important to focus treatment on the correct radiation site where the tumor occurs to maximize local tumor control rates [1]. However, movement of the patient during radiation therapy may risk the accuracy of the posture of the patient from the start to the end of the treatment. During treatment, the administrator should reduce the error range within 1.0 mm to track the movements of the patient, the amount of the generated motion is quantitatively analyzed, and it must leave the data. Therefore, until recently, based on the image processing at a plurality of locations, but by using a Web camera or a CCD camera is applied to a system for automatically detecting the amount of motion these systems, ROIs region in measuring the total pixel ratio moved percentage amount, and try to determine the extent of patient motion, a characteristic of the helical tomotherapy not able to know what part of the patient was a few mm movement therapy bed was a limit point to respond to changes in minute background which cannot be separated background image and patient movement which changes when moved together.

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1.2. Expected Effect of Research

In this paper, the time of radiation therapy using vision was measured by Reference difference mode (RDM) method and Sequential in the system for monitoring the movement of the patient. We have been using the difference mode (SDM) scheme and RDM scheme because it provides in addition to the movement of the patient in response to a change in fine movements of the wallpaper and tomotherapy equipment influence on the proportion of the motion (%), an error there is a probability to exiting [2]. In the SDM scheme, there is a disadvantage that it is difficult to detect continuous and slight movements of the patient. Therefore, in this paper, these RDM, by using a weight (alpha) filter index, tries to resolve the limitations possessed by SDM method to quantify the movement of the patient, to separate the background image of the patient and treatment environment, only by detecting movement of the patient during treatment, it is possible to reduce the problems due to patient movement. It was so. First to that end, an experiment to verify the reproducibility of the proposed system was conducted to get to know the speed of the experiment and the optimal treatment bed to know the value of the optimum of index weight (α). To obtain the optimal numerical value in the image of the real-time treatment bed during radiation therapy, a separate picture with the patient must be acquired to detect only the movement of the patient.

2. Related Research

2.1. Motion Detection Method According to the Edge Detection

Edge and an edge detection method for detecting the movement of a person or object, the brightness (pixel value) and a set point at which a change in numerical value to a small value from the interval or larger value is changed to a high value at a low value of the pixel. That is, binarization (Binary) of each pixel in the image pixel value by a dot in successive is expressed, distributed have not valued of the pixel values of the image adjacent to the boundary line between the both areas during representation of 0-255 It is. In this way, the process of detecting and defining a pixel is included in the edge of the edge detection or edge extraction. Methods that are calculated through the convolution operation of a method for detecting an edge are obtained by utilizing a differential value. Sobel operator, the horizontal one of the most generalized operators has been used, rather than a vertical edge, the diagonal edge, have a stronger property. This operator within the pixel and further emphasized that the center of the mask. Furthermore, by using the brightness of the rate of change between the pixels because it is effective to extract features of certain things, it is possible to obtain a result of further emphasizing the edge portion [3].

2.2. Motion Detection Method Using the Stereovision

An advantage of motion detection using the stereo vision using the distance information between the camera and the object obtained by using two images is that smaller than movement and human degree and the object size of the human or, or thing of being able to distinguish between the movement of large objects. This is the performance of conventional correlation method and 2D image matching; it has changed larger output data, which has received a lot of influence, such as the extent of the difference between the background noise and background. However, the stereovision system, by effectively using the characteristics of the object image from the three-dimensional point of view, makes it possible to greatly improve the separation performance of the target image. Thus recognizing the object as a method of distance can be used to identify, use left reference image and the current real-time, right, the pixels (pixel) region based algorithm between images input from two cameras to the left, right, position X of interest in the image of the two cameras, and extracts the Y coordinate. The camera shows a difference between the

extracted left and right cameras X, constant according to the Y coordinate distance while watching the same object. When calculating the difference value of a pixel for each distance, it is possible to know a formula can know the real-time distance will vary depending on the horizontal distance between the both cameras. Based on the position coordinates, that is, by controlling the stereo camera, so that the control main viewpoint and FOV of the target image (field of view) together. Then, the left, which is the current input, by utilizing the setting value and the fan or the tilt movement angle of the stereo camera that operates based on the coordinate values of the right camera image and calculates distance information to track video [4].

3. Methods

3.1. Overview

The system of three main parts, the operation is started and an image processing recognition portion of irradiation through communication with the tomotherapy equipment preparing a patient undergoing treatment. While monitoring the patient in real-time, based on the threshold (Threshold) set for patient motion, to determine whether the patient's movements.

3.2.1 Structure of the System

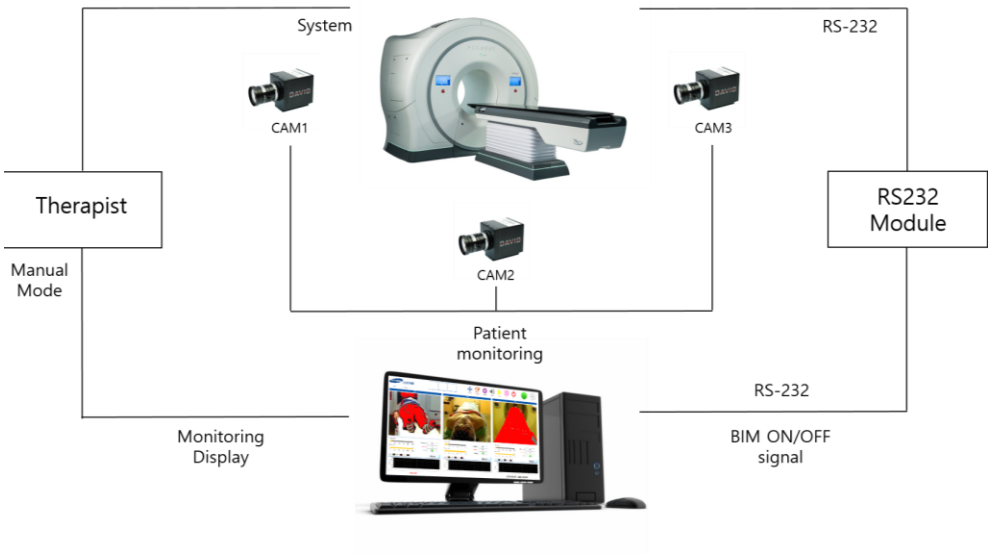

Figure 1. Figure Label

3.2.2 Part of Devices

The system focus lens in which one or more CMOS image sensor and automatic and manual mode are regulated, the Logitech HD power cam C920 webcam with a USB or Ethernet interface is used. This camera is compatible to USB3.0, 1500 million pixels, supports a resolution of 1920 * 1080, built-in microphone mounting, using a Carl Zeiss Lens, using a USB extension cable to the external power supply. It is connected to the outside of the image processing PC of the treatment chamber to provide a real-time video. While a CCD image sensor in a second, manually brightness of the light (exposure) adjustment and zoom function capable of adjusting the distance between the subject, the model of a CCD camera having an Ethernet interface, a Basler A640-80gm, 29mm * 29mm * 42mm of the outer shape and 30frame / sec shooting speed of, with a 640 * 480

Progressive Scan resolution. The camera provides an image in real-time because it is connected to the outside of the image processing PC treatment chamber without using a USB extension cable, wherein another external power source is equipped to operate with the USB camera unlike Ethernet cable. Figure 2 shows the diagram for explaining the image acquiring unit of AVGPM the (Image acquisition part), which is designed so that it can be used to select the two kinds of image sensors described above.

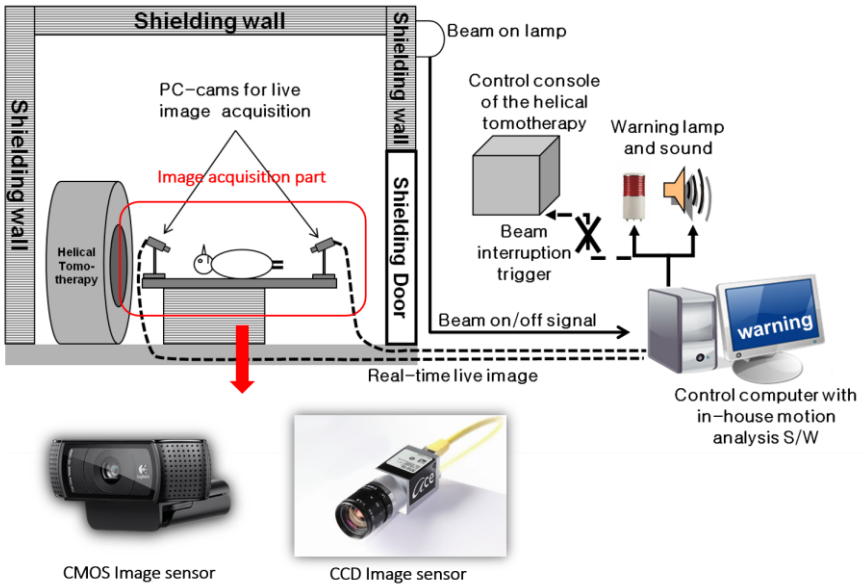

Figure 2. The Parts of a Device

3.3. Algorithm of Alpha

We developed an exponential algorithm method of applying an algorithm that uses an exponential weight (alpha), which can distinguish the background image and the patient's image. First, with the existing method, the motion information of the patient, the reference image Iref generated in the previous sequence (t), auto contrast obtained in the current sequence image IINPUT (t) of the video Idiff_abs_reference of (t) pixel exceeds the threshold δmotion for each pixel value can be obtained by detecting the motion of. Results motion video Imoving (t) are the following formula can be represented [5].

$$I_{moving}(x,t) = \begin{cases} 1, & if \quad \left| I_{input}(x,t) - I_{ref}(x,t) \right| > \delta_{motion} \\ 0, & if \quad \left| I_{input}(x,t) - I_{ref}(x,t) \right| < \delta_{motion} \end{cases} \quad (1)$$

After detecting the threshold (Threshold) or more pixel locations in describing the weight (alpha) algorithm schematized index under the next video, and it updates the pixel value of the detected position.

When α is 0.9, the pixel value of the detected position, prior to the pixel value of 90% of the background image in the sequence is a value obtained by combining the 10% pixel value of the image of the current sequence. Pixel values that have not been detected to leave without updating, when the background image is completed, are used as a reference image for detecting the difference in the background of the next sequence [6]. Reference image Iref (t), the teeth of the difference of each pixel is generated in the previous sequence Iinput (t-1) and Iinput (t-2) differences in both of the previous video picture Idiff_ abs_input (t-1) threshold (threshold) δbinary to detect the pixels exceed identify the

movement area, Fig only the pixels of no motion area existing reference image Iref (t-1) and the input video Iinput the (t-1) as an argument. Is an image generated by applying the three.

Reference image generated by using an exponential weight (alpha) filter has the character of moderate reference images used in RDM method and SDM method described above. α in results car video using the reference image by controlling the update speed of the reference image update rate, a function of adjusting the sensitivity to small movements and changes. Thus the results of RDM show how the value of α approaches 1, will have the results of the nature of SDM method close to zero. Applying the value of the appropriate alpha generated reference image, by reflecting the image by reference to motion of the Gantry due to acquire images in tomotherapy treatment bed of movement during treatment, the patient's breathing, movement only it can be extracted.

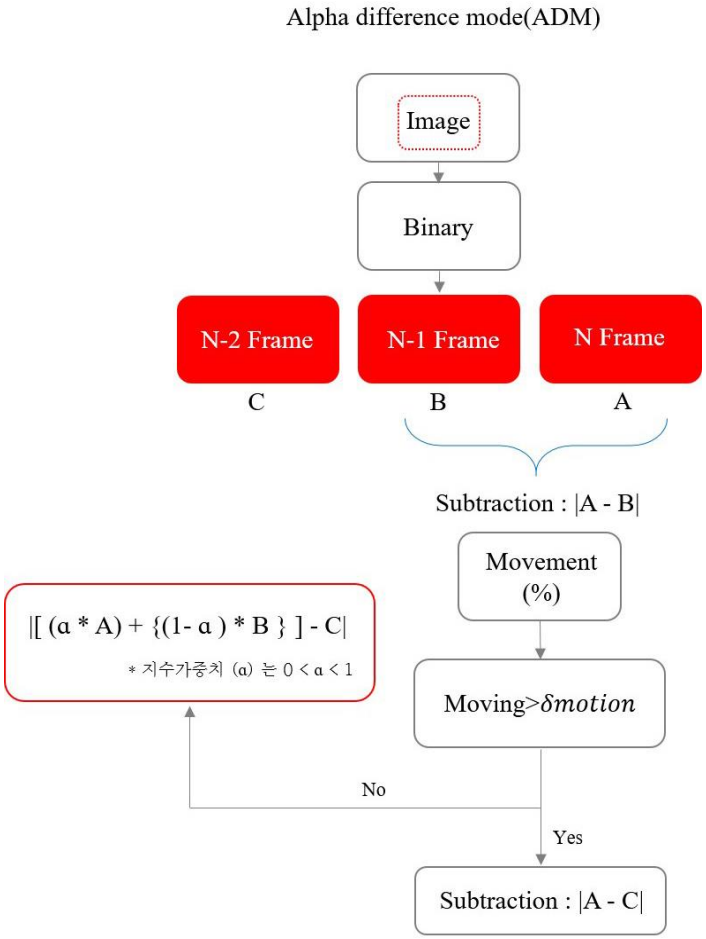

Figure 3. Alpha Difference Mode Algorithm

The generated reference image Iref (t) is used as a reference image in the following sequence, initialization of the reference picture is performed by the image acquired at the time of irradiation from Control board receives a valid signal. Using threshold (threshold) is δmotion is defined as a value obtained by adding a slight margin to the maximum value of jitter noise generated by the camera's sensor. Furthermore, before it was used for difference operation and to minimize the effect of the difference image by the jitter noise in the input image after applying the Gaussian Blurring [7]. Thus the results obtained video Imoving (t) is false (0) if no true (255) pixel and the motion in motion is divided into pixels. Whether valid motion, calculates the ratio of pixels with the number and value

of one pixel in the whole region or region of interest of the image, with regard to the situation above the threshold (Threshold) generates an alarm.

4. Experiments and Evaluation

4.1. Experiments

The value of the research and performance evaluation of the appropriate index weights of the proposed system (α) is Fig voluntary production moving phantom. Figure 4 shows the actual appearance diagram of the moving phantom.

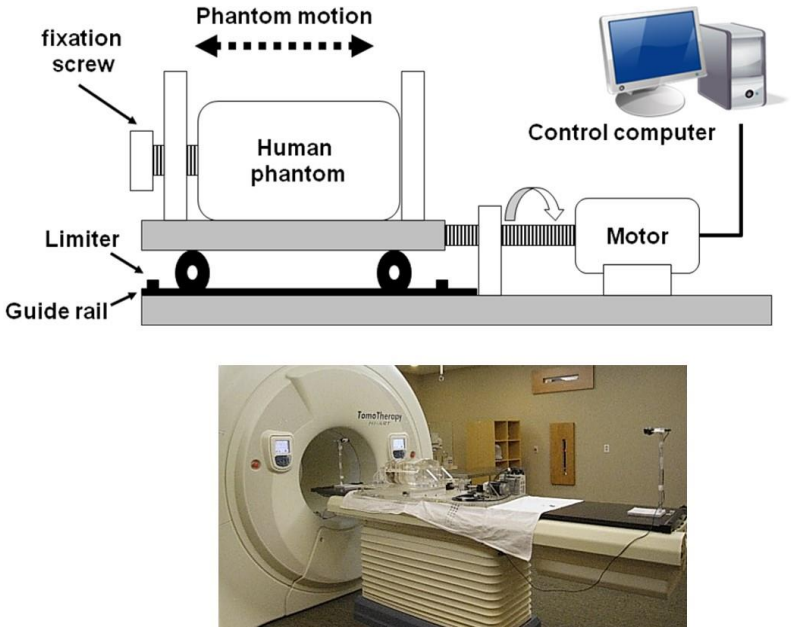

Figure 4. Components of the Experimental Moving Phantom

Moving phantom, phantom and a servo motor (CSM-1012, Rockwell Samsung, USA) wagon, which is controlled by having a human body in the chest outline, PC to control the servo motor (i5CPU, 8G Ram, SDD) and software (LabVIEW, National Instrument, USA) and is constituted by a motor driver, it is possible to reproduce the movement of a given model by user [8].

4.2. Scenario

1) The phantom moves by the speed with moving phantom human breast concept, the system obtains data taken with each mode.

2) First, it is necessary to verify the reproducibility of the system; mode operates 10 times with RDM method using a USB camera marked with CMOS image sensors by operating the moving phantom at the same rate to get the data. (However, a prerequisite for the second scenario, operation and control of the moving pattern motor is the assumed to be operating regularly within the maximum allowable value criteria.)

3) If the verification of the reproducibility of an image acquisition unit of the system through the second experiment was to experimentally as follows.

4) Five operating the moving phantom at a rate, in each mode (RDM, SDM, ADM) system of the present system monitors the movement of the patient, whether it together with the alarm to give a ratio of motion (%) also recorded. If a second round of experiments when the reproducibility has not been verified to play a verification of the software.

5) Confirmation when the change of the background image moves faster from when the speed of the moving phantom moves slow large RDM, SDM, the more accurately speed and algorithm of optimal sensed only the movement of the patient of the ADM system in the data to.

6) For verification of ADM algorithm by operating the empty treatment bed in the actual maximum speed moving at the time of radiation therapy, to apply the value of the different α (0 <α <1), of the entire image pixel data of the number of motion pixels to generate the number. The value of α is to evaluate the effects on detection performance patient motion, in situations where the therapeutic bed is fixed, the value of another α detects a change in the image by moving the phantom with motion it is possible whether to experiment

7) Prior to the experiment, to apply to the ADM algorithm to find the speed of the treatment bed and the α value of the optimum.

4.3. Evaluation

Threshold for binarization the difference image (Binary) (Threshold), the difference between a situation where tomotherapy treatment unit is not running, for a predetermined time (about 1 minute) input frame and the previous frame generates an image can be set by the value obtained by adding a slight margin to the maximum variable luminance value with each pixel on the generated every pixel. Was obtained through experiments threshold (Threshold) as approximately 6% of the maximum variable can have each pixel (0-255), negligible noise can have is this treatment device image sensor in an environment is the value. For the radiation therapy room, all faces are shielded with concrete, since the state of the illumination and the temperature is maintained constant; changes in the external environment are excluded in Korea University. Without detecting changes such as enlargement / reduction of the video in the gantry to be generated by the movement of treatment bed, the patient's breathing, appropriate setting of a reference image generation element to sensitively detect the motion α is very important it is. To obtain the α value when change is not detected in the image in the gantry generated by the movement of treatment bed, by applying different values of α in the system to provide a situation where an empty treatment bed is moved, the entire image the number of motion pixels that occurs when the number of pixels, as a result of collection, were analyzed. At this time, the moving speed of the treatment bed is the moving speed of the fastest treatment bed in the range used in the clinic. The value of α is, to evaluate the effects on detection performance patient motion, in situations where the therapeutic bed is fixed, the value of another α is to sense changes in image according phantom with motion It was to evaluate the performance issue [9]. Finally, based on the results obtained in the above two experiments, by setting the optimal value of alpha, in applying the actual patient treatment plan circumstances, the motion extraction result of moving the phantom of various movements was confirmed. For the setting of appropriate parameter values, movement in and confirm that there is no abnormality by applying the present system to tomotherapy treatment room environment for two months in Samsung hospital, the actual patient's room appropriate treatment environment observe the fraction of pixels, based on this result, setting the values of all time arguments. First, an experiment was conducted to verify the data input part of the vision camera repeatability of the system. Therefore, the proportion motion RDM way while the speed of the moving phantom is operated constant at 0.5 cm / s (percent) was measured 10 times, the standard deviation for this average was calculated error rate.

Table 1. The Verification of Input Section Data

	1	2	3	4	5	6	7	8	9	10	STD	Mean	Error
RDM Moving (%)	9.78	9.77	9.76	9.78	9.79	9.77	9.76	9.78	9.79	9.77	0.010657	9.775	0.03%

As shown in Table 1, in a hardware manner equipment constant environment, when repeating the same operation, it can be confirmed that the software of the system, the standard deviation 0.01 has a very good reproducibility with average error 0.03%. Thus it is obtained by securing the prerequisites for the second experiment. Second, to drive the tomotherapy treatment bed in order to find the appropriate value of α at a constant speed, to confirm the percentage of the movement are doing to change the value to 0.8 to 1 α (%). Figure 5 is provided with the same speed of the treatment bed, as a graph showing the ratio of motion (%) due to the change in the value of alpha. Moving speed threshold was set to the maximum speed used in the clinic. Figure 5, if α has a value of 1, as compared to continuous motion pixels is increased, if it has a value smaller than 1, that the amount of motion detected for the same movement is reduced show. The extracted results, when the value of α has a value of 0.90 or less, it is found that does not detect the change in the image due to the movement of treatment bed. However, low α value is insensitive to detect a change in the image due to movement of the threshold.

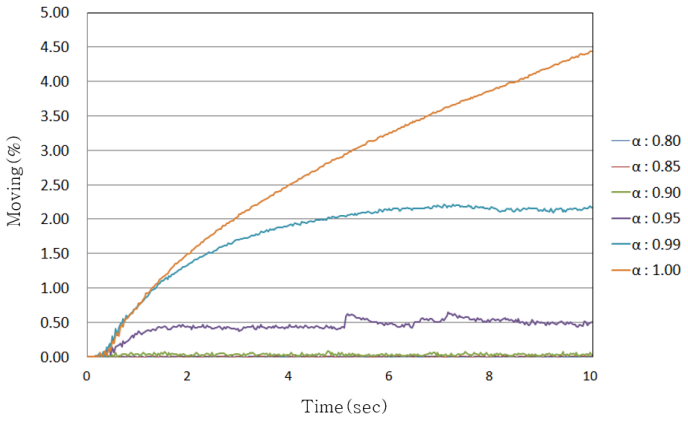

Figure 5. Components of the Experimental Moving Phantom

This means that you are able to decrease the ability to detect changes in the video quickly at the same time as the patient's movement. The detected result of the value during the experiment to remove noise using a low-frequency filter exhibited an average value of the peak value on the detection results displayed in a periodic manner. Motion as a result, it is possible to confirm that the detection rate is decreased as the value of alpha decreases, alpha value of the system proposed in guessing the present study from the results of the above experiments, due to the movement of treatment bed it can be seen that is possible to use the maximum of α value that can be eliminated only with the best performance. The value of α based on the above experiments, it can be known that the value between 0.85-0.90 are suitable. Third, the rate of movement looks to change the moving distance the tomotherapy treatment bed to apply the value of α in order to find the speed of the appropriate treatment bed constant at 0.9 to per second 0.2cm ~ 1cm (percent) was confirmed. Figure 7, compared to the same α value is a graph showing the proportion of the motion (%) due to the change in velocity of the treatment bed. The value of α in the first experiment was to apply the values of the optimal environment won. Figure 6, the speed of the treatment bed has the following values 0.3 cm / s is the area of

the Limit the moving distance per second is set to stable monitored than if you have more speed 0.3 cm (%) that coming into it can be confirmed. This, when the per second rate of the therapeutic bed has the following values 0.3 cm / s, it can be seen not detect a change in image due to the movement of treatment bed.

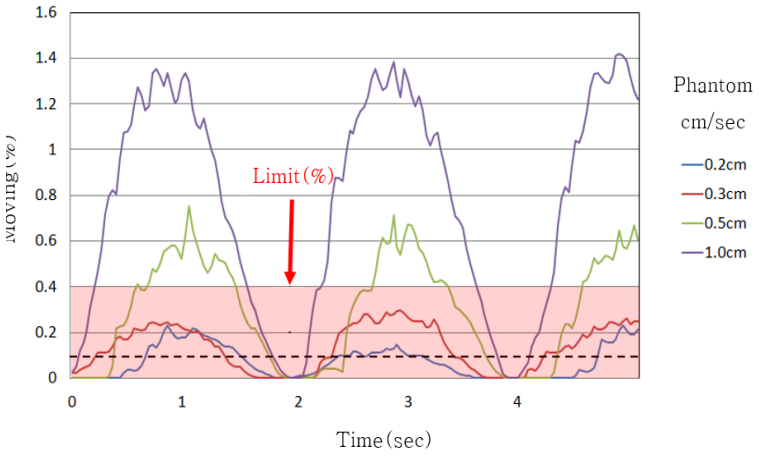

Figure 6. Moving Rate by the Speed of Therapeutic Bandages (%)

However, 0.3 cm / s or faster is insensitive in detecting a change in the image due to movement of the threshold. This means that you are able to decrease the ability to detect changes in the video by quickly at the same time the patient's movement. As in the previous experiments, the value of the result detected during the experiment to remove noise using a low-frequency filter exhibited an average value of the peak value on the detection results displayed in a periodic manner. As a result, it is possible to detect the rate as the speed value of the treatment bed is decreased to confirm that decreases in the velocity values of the treatment bed system proposed by guessing the present study from the results of the above experiments, patient movement can be seen that the use of following speed value 0.3 cm / s, which can be eliminated only with the best performance.

Through a system proposed, the results of monitoring the therapeutic situation of a patient, typically a patient is in the respiratory, cranial 0.8%, caused the greatest motion pixels of the foot-side 0.25% to 0.3%. This is a slightly above the level of the ratio of movement pixels that occur in the context of 0.3cm movement of the phantom, this was applied to the clinical trial a little bit of a head side 0.85% foot side 0.35% plus a margin.

5. Conclusion

Monitoring of patient movement during treatment using video has already been made through the treatment chamber CCTV. The treatment room of Samsung hospital was the site of a clinical trial conducted of the system proposed in the three CCTV, which monitors the patient. However, the monitoring of these patients, since the use of CCTVs adhering to the walls of the treatment chamber as co-therapeutic device environment, if the patient is positioned inside the treatment unit, occlusion region by the treatment device has occurred, and the patient it is difficult to monitor the systemic. Also, if you apply a restraint, for the treatment of head and neck in a patient, intensive monitoring of the head of the patient is needed and wrapped by restraint ward, a lot of monitoring therapist is able to grasp the movement require the concentration of.

Therefore, the burden of the therapist, automated system monitoring for performing continuous monitoring, RDM method and SDM scheme, a bar proposed in this paper, and as an Allign RT, another product through the device is already commercially available. However, these methods are like tomotherapy, moving the patient's body when located in

the interior of the treatment unit may be difficult to perform. The proposed system is that cameras should be positioned for patient monitoring in the treatment bed, where it is possible to monitor the movement of a patient in a closer position, with the field of view of the camera according to the treatment unit not hindered. Furthermore, by applying the exponential weights (alpha) algorithm that reflects the neighborhood of the motion, to remove the motion due to changes in the input image in the gantry caused by the movement of treatment bed, by detecting only the motion of the patient, conventionally proposed it overcomes the weakness of the system. AVGPM system, in order to use, as in the conventional CCTV, without the need for a separate installation work, camera, software, requires only a simple package consisting of a control board, its introduction is very simple and is also cost-efficient.

However, as the problem of this system, first, there was inconvenience and potential danger of the operation of the treatment bed generated by the camera fixation device. In order not to disturb the space the patient lying down, if that impedes the operation in adjusting the position of the x-axis of the treatment bed by the arrangement of support in tight contact against the possible head / foot occurs. In addition, the gantry protection and camera by the support base of the height (or support) there is a possibility that a very serious medical accident may occur when there is collision.

If clinical trials in such cases, the possibility of measures did not occur, a further study matters. In addition, the wiring of the USB extension cable was used to connect the camera to a PC, where there is a possibility to become a scratch the comfort of the patient in the treatment room environment that must be considered top priority, in extreme cases, wiring treatment can possibly give a fatal effect on the equipment entered in the interior of the vessel. The improvements or a bug previously described, the improvement of the camera built-in (built-in) method of the therapeutic bed fabrication and the camera-fixing device is expected to be solved by a method such as wireless data transmission. We may use a common Web camera and a CCD camera using a CMOS image sensor and a CCD image sensor, which has developed a microprocessor, the video-based patient monitoring system that combines software. Using real-time two-way communication in synchronization with the beam condition of tomotherapy treatment device was developed ADM Systems with exponential weights (alpha) filter Focusing on the algorithm of the existing RDM method and SDM scheme. Thus, it makes more accurate patient monitoring for fine movement of the patient through the separation of the picture, other than the tumor that may be caused by neglecting patient monitoring in radiation therapy in such automated systems the work burden of radiation exposure failure and radiation therapist was able to reduce. The system does not require such structural changes of the therapeutic chamber that can be provided with a system at a low cost. This system, received verification in the medical environment through an actual clinical trial.

References

[1] G. J. Kim, J. Y. Hong and S. H. Han, "Analysis of Correlation Coefficient Between Movements of Thoracoabdominal Tumors and External Respiration Using Image Guided Radiotherapy(IGRT)", JKCA, vol. 14, **(2014)**, pp. 362-370.
[2] S. Webb "Optimization of conformal radiotherapy dose distribution by simulated annealing, Physics in Medicine and Biology", vol. 34, no. 10, **(1989)**, pp. 13-49.
[3] J. S. Kim, M. K. Cho, Y. B. Cho, H. B. Youn, H. K. Kim, M. Shin, D. Lee, S. Lee, R.N. and S. Y. Park, "Geometric calibration of cone-beam CT system for image guided proton therapy", Korean Journal of Medical Physics, vol. 19, no. 4, **(2008)**, pp. 209-218.
[4] Y. J. Kim, Y. I. Jang., Y. S. Ji, J. B. Han, N. G. Choi and S. J. Jang, "Evaluation on Usefulness of Applying Body-fix to Four Dimensional Radiation Therapy", The Journal of the Korea Contents Association, vol. 13, no. 10, **(2013)**, pp. 419-426.
[5] A. M. Berson, R. Emery, L. Rodriguez, G. M. Richards, T. Ng, S. Sanghavi, and J. Barsa, "Clinical experience using respiratory gated radiation therapy comparison of free-breathing and breath-hold techniques", International Journal of Radiation Oncology* Biology* Physics, vol. 60, no. 2, **(2004)**, pp. 419-426.
[6] P. J. Keall, S. Joshi, S. S Vedam, J. V. Siebers, V. R. Kini, and R. Mohan, "Four-dimensional radiotherapy

planning for DMLC-based respiratory motion tracking", Medical physics, vol. 32, no. 4, pp. 942-951.
[7] G. Medioni, J. M. Choi, M. Labeau, J. T Leksut and L, Meng, Member, KIICE. "3D Facial Landmark Tracking and Facial Expression Recognition", Journal of information and communication convergence engineering, vol. 11, no. 3, **(2013)**, pp. 207-215.
[8] K. B. Kim, D. H. Song and Y. W. Woo, "Real-Time Recognition of Finger-Language Using Color Information and Fuzzy Clustering Algorithm", Journal of information and communication convergence engineering, vol. 8, no. 1, **(2010)**, pp. 19-22.
[9] K. Sharma, S. lah and I. K. Moon, "GPU-Based Optimization of Self-Organizing Map Feature Matching for Real-Time Stereo Vision", Journal of information and communication convergence engineering, vol. 12, no. 2, **(2014)**, pp. 128-134.

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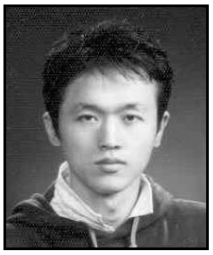

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