

## Propose Image Analysis Tools to Improve Radiology Interpretation

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### ABSTRACT

There are many image analysis tools and enhancement techniques that can improve image interpretation. In ports around the world, customs agencies use many x-ray machines to scan cars, trucks, luggages, and containers. Many of these systems use imaging adjustment techniques which are not being used in medical radiology departments. This paper is propose using of these image adjustment tools in the radiology field which may help in improving image recognition. As well, this paper will explain in details the uses of these image adjustment tools and what they can be used for in radiology departments. This paper will take rapiscan systems as an example of the companies that produces x-ray machines that used by customs agencies to scan cars, trucks, luggages, containers, etc. The tools and techniques that will be discussed in this paper including the following; pseudo color, quick enhancement (Q), crystal clear (CC), atomic number (Z), invert option (INT), energy option (HI and LO), histo-

gram option, edge enhancement (E and E2), and enhancement tools (log 1, 2, 3, and 4).

**Key words:** Image analysis; Pseudo color; Image enhancement; Radiology; Rapiscan

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### ANALYSIS TOOLS

In ports around the world, customs agencies use many x-ray machines to scan cars, trucks, luggages, and containers<sup>[1]</sup>. Many of these systems use imaging adjustment techniques which are not being used in medical radiology departments. The following is some of these tools

#### Pseudo color

It's a tool that calibrate between the low energy x-ray picture and high energy x-ray picture which generates a spectrum of colors ranging from the dark orange which means organic to dark blue which means non-organic. The spectrum has the following colors: yellow, orange, green, blue, and red. Pseudo color technique allows the user to visualize any small hidden entity. It has a similar look to infrared thermography which depends on the radiating infrared from any structure with a temperature higher than zero (temperature imaging), but pseudo color in ports are depend on the object's density that being scanned. With enhancement tools, it can improve the image visualization on pseudo color mode. As well, on a pseudo color image, the orange color means organic material, the blue color means metallic material, and the green color means aluminum. In MRI, pseudo color has been used which depends on the scanned tissue type and by analyzing the highest and lowest pixel values in the scan to calibrate between them to generate a pseudo color picture see (Figure 1). A published paper confirmed the usefulness of pseudo color in detecting lesions and identifying tumors at different regions<sup>[2]</sup>. The pseudo color can be done by using a clustering technique which basically works on humongous subgrouping of the data by

using a simple algorithm called K which means iterative algorithm.

**Quick enhancement (Q)**

It gives a fast enhancement to the picture and more brightness for a better viewing. It sets the scan on a standard value which will switch to directly without choosing any value.

**Crystal clear (CC)**

The letter Z clears the picture from any unwanted details that can obscure the picture. It sets the scan on a standard value which will switch to directly without choosing any value.

**Atomic number (Z, Z↑, and Z↓)**

It stands for the atomic number which analysis the atomic number of the scanned material in the picture. The option Z↑ which makes the material with high atomic number to appear in blue which means non-organic material, while Z↓ which makes the material with low atomic number to appear in orange which also means organic material. Any material with an average atomic number will appear in green. The scale for both Z↑ and Z↓ appears in different shades of the original colors from bright to dark which depends on the atomic number of the scanned material (i.e. the blue range from bright blue to dark blue and the orange range from dark yellow to dark brown).

**Invert option (INT)**

This option switches between the negative x-ray picture (dark) and positive x-ray (fluoroscopy) picture. Any unclear entity can be visualized by switching between both modes based on the wanted detail (i.e. contrast media is better to be visualized on the positive view, while the negative view is the best for visualizing bones or air).

**Energy options (HI and LO)**

The HI option which means high energy material and the LO option which means low energy material. The different energies will be distinguished in different colors.

**Histogram option**

This option fills the picture with a blue color gradually based on the material density unit. It covers the whole picture starting from the material with low density to be covered first to finish with high density material eventually.

**Edge enhancement (E and E<sup>2</sup>)**

This option is the edge enhancement which improve the edges of all the structures in the picture. The first option is (E) which can show any obscured edge that is not clear by un-wanted fuzziness or artifacts. There are two degrees of edge enhancement; the first one is (E) which shows the edges very clear, while the second one is (E<sup>2</sup>) which shows the edges and obscure all the other details in the scan.

**Enhancement tools (log 1, 2, 3, and 4)**

These are enhancement tools and these tools have 4 degrees of enhancement which are 25%, 50%, 75%, and 100% based on what you want to see. These enhancement tools help to increase the enhancement (see through) gradually based on which option has been chosen to visualize the structure. With increasing the enhancement, some structures with low density will disappear proportionally.

**GENERAL RULES**

The metallic materials appear in blue on the x-ray, while aluminum materials appear in green and the organic materials appear in

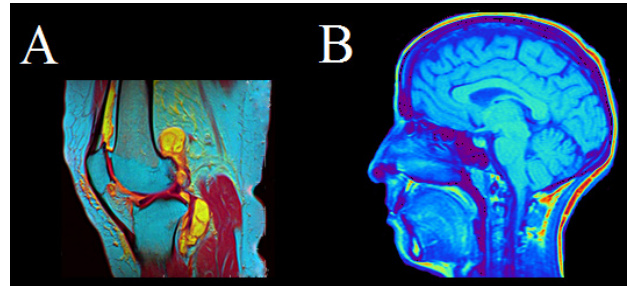


Figure 1 An MRI scan of the knee (A) and the brain (B) in pseudo colors.

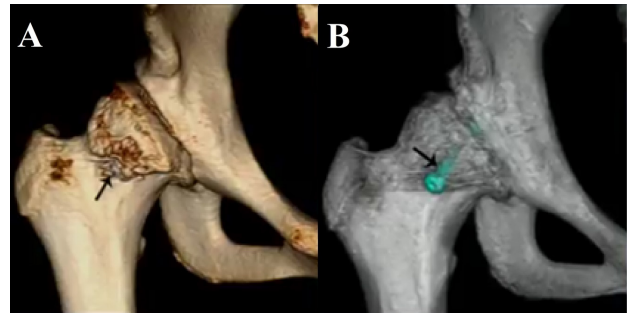


Figure 2 The image on the left (A) is SSD which has colors and the image on the right (B) is VRT which has a grey scale. See the obscured screw by the SSD, while with VRT is not obscuring any detail.

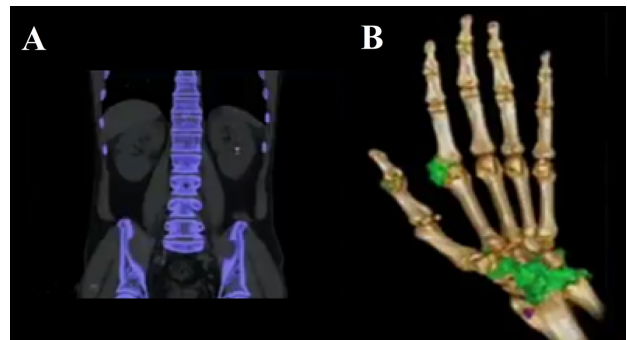
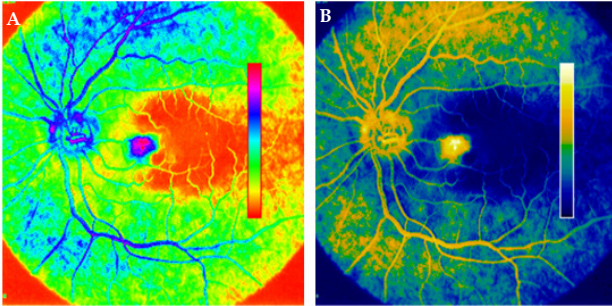


Figure 3 The image on the left (A) is a kidney ureter bladder (KUB) CT scan and the image on the right (B) is a hand CT scan. The image on the left is showing the bone with a bright blue color and the kidney stone in the left kidney with a bright red color based on the Hounsfield unit (i.e. Hounsfield unit can differentiate between a uric acid stone in the kidney and a bone). The image on the right is showing the hand bones in a normal color, while the goat disease in the wrist joint and the 2<sup>nd</sup> metatarsal phalangeal joint in green color.

orange. These colors can improve the x-ray pictures by adding these colors which can be helpful in a case of a foreign body. Many x-ray developers added colors to the x-ray and CT scan (i.e. volume rendering technique (VRT) in the CT scan has colors which makes the picture looks like a real human body in flesh and bone), but it can covers some important details and coloring is not important itself. The importance is in finding any details in the scan by using these image analyzing tools to improve radiology diagnoses. The colors could be used when machines start identifying abnormalities by machine learning [3]. Then the machine learning can highlight these abnormalities in different colors for each disease (for example; kidney stones appear in red, stenoses appear in blue, tumors appear in green, etc.) this will give colors a huge importance, otherwise the shaded surface display (SSD) and colors can hide details in some scans see (Figure 2).

The same principle that pseudo color technique is using different energies to define objects, dual source CT machines today are using the same principle by the scanning with a low energy and



**Figure 4** The image on the left (A) is representing a map with the rainbow color table, while the image on the right (B) is representing the same map with the SA pseudo color table.

a high energy kilovoltage peak (kVp) from each x-ray tube, then the difference in attenuation between both energies will help in identifying (the material decomposition). For example in kidney stones by differentiating uric acid from calcium then highlight the bone and the kidney stones in different colors which represent the material decomposition technique [blue for bones and red for kidney stones based on Hounsfield unit see (Figure 3)]. As well, it can differentiate goat disease from normal bone in musculoskeletal imaging based on Hounsfield unit with different colors based on the company who made the scanning machine see (Figure 3). Each company will have their own colors for each illness (i.e. Siemens maybe will use different colors than General Electric, Phillips, or Toshiba). As well, colors have different meaning in different image analysis tools as mentioned (i.e. the green color in pseudo color and in atomic number has different meanings between the two image analysis options).

The Human eye can differentiate in a monochromic grey picture around 30 shades of grey, but with colors, it can differentiate hundreds of colors' shades. Pseudo color tool can assign colors to any grey scale artificially. There are two ways of assigning colors to

a grey scale picture; intensity slicing and transformation of a grey level to colors (most used technique). The grey color feed three input colors which are red, green, and blue which known as (RGB color monitor). Modifying a map's colors has two approaches; auto-coloring procedure or color-map operation. Auto-coloring procedure is when a predefined color-map is replacing the existing color-map. Color map operation is when the existing color map's values are changed based on predefined algorithms. The auto-coloring has two schemes of mapping; positional mapping and data dependent scheme. Positional mapping is creating a map's values at any position on a map. These values are based on the function of the taken position (depend on the physical layout of the position not on the pixel value). Data dependent is generating a map's values based on the pixel value. There are two pseudo color tables; rainbow color-table and SA pseudo color-table which control the map's colors and how the map will look like after converting the values from a grey scale to a color table see (Figure 4).

## CONCLUSION

Using image analyzing tools can improve the image recognition by using the difference in kVp energy values, Hounsfield unit values, or pixel values can help in identifying the abnormal structure like a foreign body, a kidney stone, or an illness like goat disease.

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