Improvement of image quality with fusion in radiography of high and low intensity lateral head

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Abstract. Radiological examination of the head bone is an integral part in the management of patients suffering from head trauma. This is because X-ray of the head bone is still quite significant in diagnosing fractures of the head bone. X-ray examination of cases of injury to the facial bones required two times the examination of the lateral head of high and low intensity x-ray to produce different image information due to heterogeneity of the head bone. At this time there is no method to improve image quality by combining the two images, in this study a method of improving image quality with fusion on high-low lateral head bone radiographs is proposed. This research is an experimental study to compare two variables measured from unequal (free) samples, where the group that is compared is more than two, namely the quality of lateral images of high intensity head, low intensity and fusion. Image quality assessment is done using a histogram which is then analysed using the Friedman test. The results showed that the average gray level on the highest histogram was sequentially at high intensity, fusion and finally at low intensity. The statistical test results obtained p value 0.007 which means that there are differences in the quality of lateral head images at high intensities, low intensities and fusion. Fusion image quality obtained grey level values that are between high and low intensity images, this illustrates that using of image fusion is able to provide more complete image information.

1. Introduction
Head injury is a traumatic disorder of brain function that can cause deformity of deviations in the form or lines on the bones of the head bones and accompanied or without accompanied by internal bleeding in the substance of the brain without interruption of brain continuity. Head injury is one of the leading causes of death and disability due to trauma in many developing countries[1]. The incidence of head injuries worldwide in 2010 was around 2.5 million people, and has caused an estimated economic cost of nearly 76.5 billion US dollars. The incidence of head injuries in Indonesia is 27% of the total injuries suffered from traffic accidents. The incidence of severe brain injury in Indonesia is between 6 to 12% of all brain injury cases with mortality rates ranging from 25% to 37%[1]. Measuring the severity of trauma or prognosis models is a very important step in supporting appropriate clinical decision making, planning effective and efficient treatment strategies, saving time and costs and preventing disability and death of head injury patients. The diagnosis of head injury from a medical aspect is obtained from a radiological examination [2].
Radiological examination of the head bone is an integral part in the management of patients suffering from head trauma. There has been a revolution in radiology with the discovery of CT and MRI. Head fracture was first described as an X-ray finding in 1962. In developing countries, CT scan facilities are not widely available. Primary health centers and suburban hospitals still lack CT scan facilities in India. They rely heavily on X-rays for primary evaluation of head trauma, even when, CT scan facilities are available, head X-ray bones are still done routinely followed with CT scans. Of 42 head-bone X-rays, 20 (47.6%) showed fractures of the head bone; while during autopsy, fractures were found in 28 (66.7%). This shows X-ray of the head bone is still quite significant in diagnosing fractures of the head bone [3].

Bone is an organ that contains calcium phosphate compounds. Calcium phosphate consists of two phases, namely amorphous and crystalline. Amorphous and crystalline compounds in calcium phosphate have different combinations of compounds. This will cause differences in bone character. Bone character can be reviewed from quantitative analysis (composition), level of hardness and thermal influence. The composition of calcium phosphate compounds will be different if the compounds formed are different, as well as the level of hardness and thermal effect exerted on the bone [4]. Soft tissue / or organ that has a low density is made by reducing the exposure factor, mainly the X-ray tube voltage value (kV). Decrease in the value of the tube voltage ranges from 15-20 kV from the value for examination showing bone (bone X-ray). While other exposure variables such as the current value of the tube per second (mAs) are usually the same as bone examinations and the distance of the exposure to FFD (Focus to Film Distance) is fixed [5]. Cases of examination of the head bone which is bone with varying degrees of violence, with an increase in kVp will reduce the quality of the contrast from radiographic images [6].

Digital diagnostic tools such as Computed Radiography (CR) and Digital Radiography (DR) are one of the main modalities in performing initial diagnosis [7]. The medical image produced by the radiographic system is basically a mapping of the transmitted X-ray beam which is stated through the law of decreasing X-ray intensity. Over the past few years, with the development of computer acquisition technology, conventional diagnostic medical imaging modalities have been replaced by digital images. Computed radiography (CR) and Digital radiography (DR) is one of the technology acquisition of radiographic image processing computers. The results of radiographic images on CR and DR can be in the form of jpg or DICOM files [8].

Mathematically, the image is a function of continuing with the intensity of light in the two-dimensional plane. In order to be processed with a digital computer, an image must be presented numerically with discrete values. Representation of continuous functions into discrete values is called image digitization. Digital Image Processing is a scientific discipline that studies image processing techniques [9]. The image referred to here is a still image (photo) and a moving image (coming from a webcam). While digital here has the intention that the image processing / image is done digitally using a computer [10].

One of digital image processing is image fusion. Image fusion is an attempt to combine two or more different images in terms of resolution (especially spatial, spectral, temporal) or in terms of the system (optical, SAR) to produce new images that integrate the advantages of the original image [11].

Specifically in the case of a head injury a radiodiagnostic examination of the postero-anterior projection and lateral projection is required, but if the patient is also traumatized in the nose, an additional examination will be carried out, namely the lateral head with nasal concentrations using X-ray intensity parameters (kVp and mAs) conditions lower than the lateral head examination. because nasal bones have lower bone density.

The purpose of this study was to determine the improvement of the quality of image fusion on high and low intensity lateral radiographs.

2. Method
This type of research is a comparative experiment to compare two variables measured from unequal (free) samples, where groups are compared between three groups. The study was carried out on lateral head radiographs using high intensity (kVp 85 and mAs 25), lateral heads using low intensity (kVp 60 and mAs 10) and lateral fusion heads from low and low intensity. The population in this study was the lateral head X-ray. The sample size of this study were 5 head objects, each of which was performed twice head lateral position examination using high intensity (kVp 85 and mAs 25), and using low intensity (kVp 60 and mAs 10).
Quantitative data analysis is performed by calculating the mean grey level value of the histogram ROI on high intensity images, low intensities and image fusions. Then Friedman test was performed between the radiographs of the lateral head using high intensity (kVp 85 and mAs 25), the lateral head using low intensity (kVp 60 and mAs 10) and the lateral fusion head from the intensity of the tianggi and low.

3. Results and discussion
In this study the experiment was conducted using MATLAB software on the image to be processed. As a limitation, the image used is only the image with the DICOM format.

The study was conducted by measuring the average grey level values obtained from histograms on lateral head images of high intensity, low intensity and fusion. The results of the study are shown in figure 1.

The average grey level in the highest histogram is sequentially at high intensity, fusion and finally at low intensity. Statistical test results using the Friedman test obtained p value 0.007, which means that there are differences in the quality of lateral head images at high, low and fusion intensities.

The results showed that the use of fusion software obtained better lateral head image quality compared with high intensity and low intensity lateral head images. the results of image quality assessment using a histogram showed that the average grey level value in fusion images was between the average value of grey level low and high intensity images this means that with the use of fusion can provide image information previously on high and low intensity images not seen optimally.
Table 1. Average grey level histogram values

| Sample | High intensity | Low intensity | Fusion |
|--------|----------------|---------------|--------|
| 1      | 4313,167       | 5819,846      | 5264,824 |
| 2      | 4281,635       | 5896,886      | 5345,071 |
| 3      | 3575,701       | 5560,929      | 4631,908 |
| 4      | 3248,95        | 6437,684      | 4855,651 |
| 5      | 7090,587       | 8019,016      | 7578,561 |

Table 2. Friedman test results

| Variable     | Mean grey level | p-value |
|--------------|-----------------|---------|
| High intensity | 4502,01        | 0.007   |
| Low intensity  | 6346,87        |         |
| Fusion        | 5535,20        |         |

The main purpose of each image fusion algorithm is to unify all important visual information from several input images so that the resulting image contains information that is more accurate and complete than individual source images, without introducing artifacts[12].

In this research, the fusion category applied is multi view fusion, which means that the image to be combined is of the same modality and carried at the same time, but under different conditions and the main purpose of the fusion process in this category is to have everything complementary information under different conditions in one image. The difference in the grey level value of each pixel will be able to give a difference in the overall quality of an image.

The results of this research are the high intensity image of the lateral head examination which is applied to the nasal bone which shows the grey level value which leads to black while the low intensity shows that the pixel supporting the nasal bone shows a white grey level, then with fusion the grey level value is obtained. between high and low intensity images so that this illustrates that the use of image fusion is able to provide more complete image information. The results that provide more complete image information in research are expected to be able to provide more complete anatomical information so that it can help diagnose the abnormalities in the head bones.

4. Conclusions and suggestions
The conclusion is the application of image fusion in the lateral head image causes a difference in image quality compared to high and low intensity images. Based on the histogram shows that the average grey level in fusion shows the value between high and low intensity. this means that the use of fusion can display more image information from high and low intensity images.

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