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LEARNING APPLICATION MODEL OF HEAD CT SCAN IMAGE EVALUATION FOR HEALTH HUMAN RESOURCE CAPACITY BUILDING

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ABSTRACT

Background: CT image evaluation of head scan is one of the competencies in radiographic students including students in Radiographer education. Students must be able to analyze image quality, which includes anatomical criteria as well as diagnostic information of CT Scan images. This research is a pioneering effort to use AI in analyzing CT Scan images obtained retrospectively from Radiology Installations. Objective: the use of Artificial Intelligence as a learning application that can be utilized by radiography students in studying the accuracy of image intensity and automatic anatomical positioning in a head CT Scan Image analysis application. Method: The study used CT scan images that researchers collected and obtained retrospectively from the Radiology Installation. The use of Artificial Intelligence methods in accordance with the needs of research and development of Matlab Software is used in designing programs for applications. Results: In the aspect of object setting accuracy, the application can assess the accuracy of the position of the Head Object rotation or not and assess the intensity of the CT Scan image. The test accuracy value of this application is 97,78%, specificity is 100% and sensitivity is 94,45%. Conclusion: This application program can be used to increase the skills of radiographer students.

Keywords: *Head CT Scan, Educational Technology, Artificial Intelligence*

INTRODUCTION

Radiographers are health workers who are given duties, authorities and responsibilities by authorized officials to carry out Radiology Service activities in health service units. Radiographers are health workers who contribute to the field of Radiology in an effort to improve the quality of health services(1). Radiographers are more widely used in health service efforts, especially health services that use equipment / sources that emit ionizing and non-ionizing radiation. Radiographers apply their competence to Radiology Services (Radiodiagnostics and Radiotherapy) (2). One of the biggest challenges for radiology education institutions (Radiodiagnostics and Radiotherapy) in implementing the Competency-Based Curriculum in the Indonesian National Qualifications Framework (KKNI) is translating professional Competency Standards into educational and learning materials or themes (3).

Head CT scan examination technique is one of the competencies in radiographic students, including students in the Department of Radiodiagnostic Engineering and Radiotherapy, need to be equipped with skills in the management of head CT Scan radiographic examination (4). The management of radiographic examination includes the preparation, implementation and evaluation stages of radiograph examination results. At the CT Scan radiograph evaluation stage, students must be able to analyze image quality, which includes anatomical criteria as well as diagnostic information contained on the radiograph (5).

CT image evaluation of head scan is one of the competencies in radiographic students including students in radiographer education. At the CT Scan image evaluation stage, students must be able to analyze image quality, which includes anatomical criteria and diagnostic information of CT Scan images (6). The problem faced by lecturers / students / learning systems in evaluating CT Scan images is that there is no application system that facilitates the integration of image evaluation (7). There are several studies that use Artificial Intelligence (AI) to detect pathological abnormalities in CT scan images of the head. The research is certainly at an advanced level and large-scale (8-9).

This research is a pioneering effort to use AI in analyzing CT Scan images obtained retrospectively from Radiology Installations. The study used CT scan images that researchers collected from fellow radiographers. The use of Artificial Intelligence methods in accordance with the needs of this research will be designed and developed Matlab software is used in designing programs for this application. The hope of the researchers, this research can provide information about the use of Artificial Intelligence as a learning application that can be utilized by radiography students in studying the accuracy of image intensity and automatic anatomical positioning in an automatic CT Scan image analysis application.

MATERIALS AND METHODS

This research is a beginner research, with a software design design that can help student learning in analyzing CT Scan images of Axial cut heads. The study used CT Scan Head images obtained from several Radiology Installations of research partners. In the preparation and design of applications, researchers are assisted by partners who are experts in the design of the Mathlab application. Artificial Intelligence methods used are extreme machine learning and Asymmetry Detection. The samples used were 45 axial Head CT Scan images in DICOM format processed with Matlab. The application can already provide image quality assessments with under penetrate, normal and over penetrate categories[10]. In the aspect of accuracy of object positioning, the application can assess whether symmetrical or asymmetrical both right and left asymmetric (10-11).

RESULT AND DISCUSSION

Based on the results of the study, an application for evaluating the quality of the Axial Head CT Scan image has been produced, from the 45 images produced, the following data results were obtained :

		Actual Values
Predicted Values	**True Positive** 21	**False Positive** 0
	False Negative 1	**True Negative** 23

Accuracy

Accuracy describes how accurately the model can classify correctly (12-13). Thus, accuracy is the ratio of correct predictions (positive and negative) to the overall data. In other words, accuracy is the degree of proximity of the predicted value to the actual value.

$$= \frac{TP + TN}{TP + TN + FP + FN} \; x\; 100\%$$
$$= \frac{21 + 23}{21 + 23 + 0 + 1} \; x\; 100\%$$
$$= \frac{21 + 23}{21 + 23 + 0 + 1} \; x\; 100\%$$
$$= \frac{44}{45} \; x\; 100\%$$
$$= 0{,}97777\; x\; 100\%$$
$$= \mathbf{97,78}\%$$

Spesificity (Positive Predictive Value)

Specificity describes the level of accuracy between the requested data and the prediction results provided by the model. Thus, specificity is the ratio of positive true predictions compared to the overall positive predicted results (12-13). Of all the positive classes that had been correctly predicted, how many were truly positive.

$$= \frac{TP}{TP + FP} \; x\; 100\%$$
$$= \frac{21}{21 + 0} \; x\; 100\%$$
$$= \frac{21}{21} \; x\; 100\%$$
$$= 1\; x\; 100\%$$
$$= \mathbf{100}\%$$

Sensitivity (True Positive Rate)

Sensitivity describes the success of the model in retrieving information (12-13). Thus, sensitivity is the ratio of positive true predictions compared to overall positive true data.

$$= \frac{TP}{TP + FN} \; x\; 100\%$$
$$= \frac{21}{21 + 1} \; x\; 100\%$$
$$= \frac{21}{22} \; x\; 100\%$$
$$= 0{,}9545\; x\; 100\%$$
$$= \mathbf{95,45}\%$$

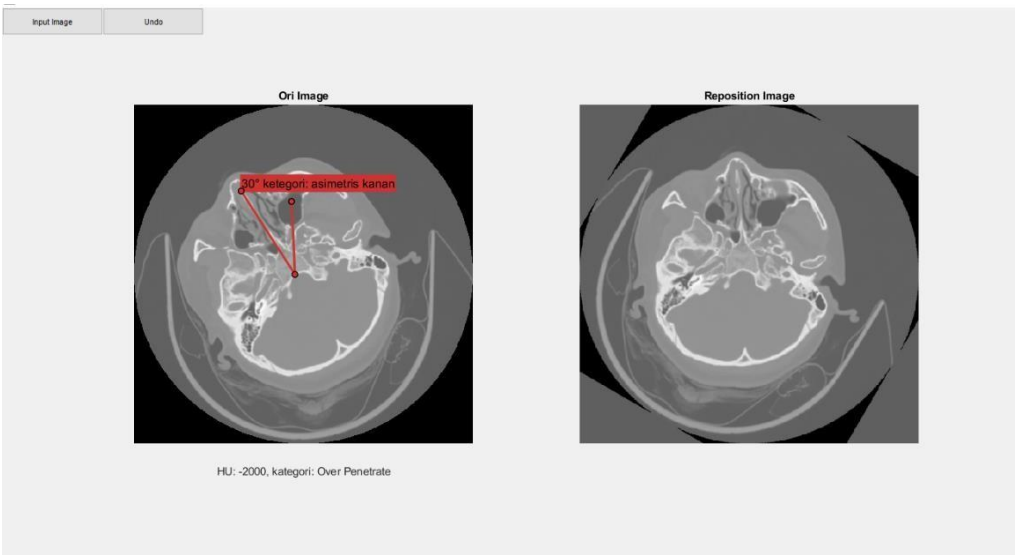

Figure 1. Examples of image test results with results: (1) over penetrating image quality, and (2) Right Asymmetrical image position.

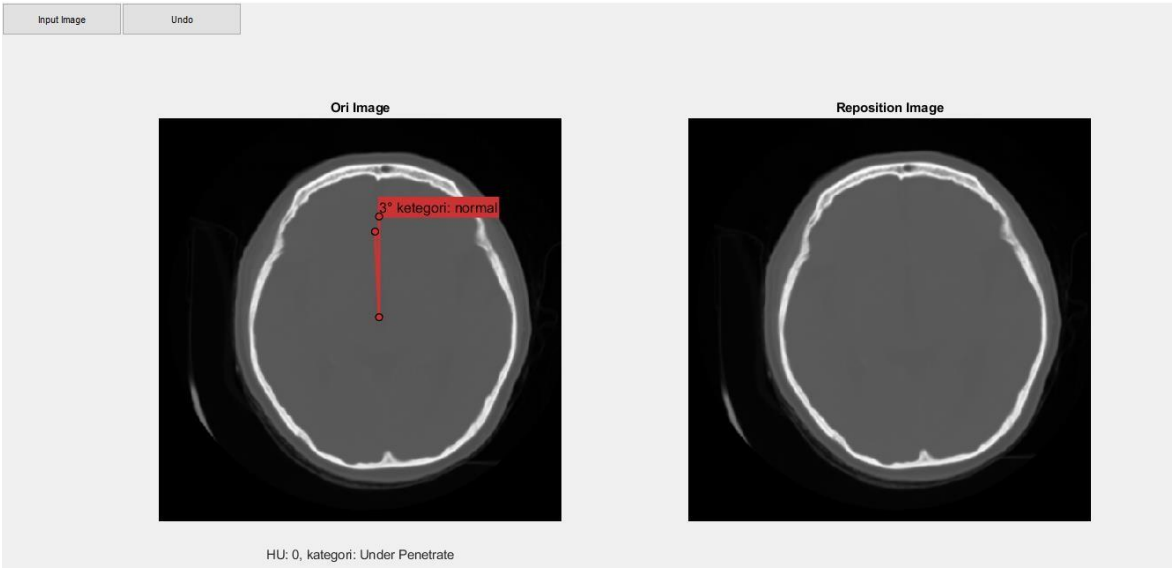

Figure 2. Examples of image test results with results: (1) image quality under penetrate, and (2) Symmetrical image position.

The use of artificial intelligence in the world of health has been very massive in this decade, considering all its convenience and speed (14). In radiology, AI algorithms are already being used in clinical practice for a range of imaging techniques and disease areas such as cancer, stroke, and fracture detection (15-16). Applications of AI in the radiology

world can be done from before image acquisition, during image acquisition and post processing (14). Artificial intelligence is a branch of computer science that is generating great expectations in medicine and particularly in radiology. Artificial intelligence will change not only the way we practice our profession, but also the way we teach it and learn it (17).

This research resulted in a machine learning application in the form of a program that can be used to detect the quality of the CT Scan image of the head and also the accuracy of the anatomical position. The limit of the standard deviation value used in determining the position of symmetrical or asymmetrical images based on the degree of rotation of the centerline of the Head CT Scan image is 3 degrees (9). From the test results show the accuracy value of this application is 97.78%, specificity is 100% and sensitivity is 94.45%. The results of this study show that the accuracy of the application has a value of 97.78%, this is inseparable from the limitations of the application, namely the lack of consistency of the application when used to test the extension DICOM image when saved with Windowing settings that are almost for Window Bone and Window Brain (18). This causes the results of image quality accuracy testing sometimes not in accordance with the reference that has been used so far (8,9,19). Current data indicate that AI will be able to offer students and residents educational content based on their needs (personalised precision education), achieving greater standardisation and harmonisation in the acquisition of interpretive skills (17).

CONCLUSION

Based on the results of the study, it can be concluded that the resulting application is effective in helping evaluate the quality of the Head CT Scan image so that it can be used as an alternative media in learning both in educational institutions for prospective radiographers and for learning for radiographers in hospitals. The limitation of this study is that there are still obstacles in the application, namely the lack of consistency of the application when used to test DICOM images that are extensions when saved with Windowing settings that are almost for Bone Window and Brain Window. This causes the results of image quality accuracy testing sometimes not in accordance with the theory that has been used. In the future, it is necessary to improve the method of detecting pixel value images automatically

and accurately. Then also when the image is less symmetrical sometimes it is still considered natural for some radiographers because it is still acceptable.

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REFERENCES

1. Kementerian Kesehatan RI. Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07/Menkes/316/2020 tentang Standar Profesi Radiografer. *Sustain*. 2020;14(2):1-4.

2. Sekretariat Konsil Tenaga Kesehatan Indonesia. Buku Banduan Standar Profesi Radiografer. 2022;1(1).

3. Menteri Pendidikan dan Kebudayaan Republik Indonesia. Salinan Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 3 Tahun 2020 tentang Standar Nasional Pendidikan Tinggi. Published online 2020.

4. Susiku E, Hewitt J, Akudjedu TN. Radiography Graduate competencies , employability and the transnational Radiography workforce shortage : A systematic literature review of current pre-registration Radiography education and training models. *Radiography*. 2024;30(2):457-467. doi:10.1016/j.radi.2024.01.001

5. Wilkinson E, Gill A, Hardy M. What do the revised UK standards of proficiency mean for diagnostic radiography training? A regional radiographer focus group study. *Radiography*. 2024;30(1):375-381. doi:10.1016/j.radi.2023.12.007

6. Castiglioni I, Rundo L, Codari M, et al. AI applications to medical images: From machine learning to deep learning. *Phys Medica*. 2021;83(March):9-24. doi:10.1016/j.ejmp.2021.02.006

7. Manco L, Maffei N, Strolin S, Vichi S, Bottazzi L, Strigari L. Basic of machine learning and deep learning in imaging for medical physicists. *Phys Medica*. 2021;83(December 2020):194-205. doi:10.1016/j.ejmp.2021.03.026

8. Vakli P, Weiss B, Szalma J, et al. Automatic brain MRI motion artifact detection based on end-to-end deep learning is similarly effective as traditional machine learning trained on image quality metrics. *Med Image Anal*. 2023;88(April). doi:10.1016/j.media.2023.102850

9. Herzog NJ, Magoulas GD. Brain asymmetry detection and machine learning classification for diagnosis of early dementia. *Sensors (Switzerland)*. 2021;21(3):1-17. doi:10.3390/s21030778

10. European Comission. European Guidelines on Quality Criteria for Computed Tomography European Guidelines on Quality Criteria. *Eur 16262 En*. Published online 1999:1-71.

11. Nayak S, Gupta C, Hebbar KD, Pandey AK. Morphometric analysis of the main brain sulci and clinical implications: Radiological and cadaveric study. *J Taibah Univ Med Sci*. 2023;18(4):676-686. doi:10.1016/j.jtumed.2023.01.004

12. Ibarra-Vazquez G, Ramírez-Montoya MS, Buenestado-Fernández M, Olague G. Predicting open education competency level: A machine learning approach. *Heliyon*. 2023;9(11):e20597. doi:10.1016/j.heliyon.2023.e20597

13. Theissler A, Thomas M, Burch M, Gerschner F. ConfusionVis: Comparative evaluation and selection of multi-class classifiers based on confusion matrices. *Knowledge-Based Syst*. 2022;247:108651. doi:10.1016/j.knosys.2022.108651

14. Pierre K, Haneberg AG, Kwak S, et al. Applications of Artificial Intelligence in the Radiology Roundtrip: Process Streamlining, Workflow Optimization, and Beyond. *Semin Roentgenol*. 2023;58(2):158-169. doi:10.1053/j.ro.2023.02.003

15. Vasey B, Novak A, Ather S, Ibrahim M, McCulloch P. DECIDE-AI: a new reporting guideline and its relevance to artificial intelligence studies in radiology. *Clin Radiol*. 2023;78(2):130-136. doi:10.1016/j.crad.2022.09.131

16. Atmakuri MK, Ganesh Ram A, Prasad VVKDV. Reliable image metrics-based brain tumor analysis using sensor deep learning technologies. *Meas Sensors*. 2023;29(January):100864. doi:10.1016/j.measen.2023.100864

17. Gorospe-Sarasúa L, Muñoz-Olmedo JM, Sendra-Portero F, de Luis-García R. Challenges of Radiology education in the era of artificial intelligence. *Radiol (English Ed*. 2022;64(1):54-59. doi:10.1016/j.rxeng.2020.10.012

18. Carmichael,J.H.E; Maccia.C; Moores BM. *European Guidelines on Quality Criteria for Diagnostic Radiographic Images*.; 1996.

19. Yamaoka T, Watanabe S. Artificial intelligence in coronary artery calcium measurement: Barriers and solutions for implementation into daily practice. *Eur J Radiol*. 2023;164(March):110855. doi:10.1016/j.ejrad.2023.110855