



بسم الله الرحمن الرحيم

(إنما يخشى الله من عباده العلماء إن الله

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صدق الله العظيم ،،،

فاطر 28

Dedication:

***To my mother and father
who made me the persons I
am, with love***

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ABSTRACT

This study was designed to experiment the result of the indigenous phantom with associated algorithm and compares the result to the standard one. The phantom was designed according to the parameters recommended by NEMA, IAEA and some other researcher. A low cost material were used to simulate the 4-quadrant bar phantom, Slit phantom and Liquid flood phantom in order to achieve the gamma camera resolution, linearity and uniformity. A Perspex materials was used to fabricate the flood phantom and Perspex with a lead materials and silicon were used to simulate the bar phantom while a pure lead was used to fabricate the Slit phantom. IDL was used to develop a mathematical algorithm in order to analysis the result of indigenous phantom. The devolved phantom was experimented at Royal Care Hospital RCH and Radiation and Isotopes Center of Khartoum RICK. 1.3mCi of ^{99m}Tc and 1500ml water were used to prepare the flood phantom and then is centered at camera table with four quadrant bar phantom or Slit phantom perpendicular to it and image were acquired with optimum matrix size. Then the images were assessed using our developed IDL algorithm to measure the resolution, linearity and uniformity of those cameras. The results of the fabricated phantom showed that the resolution of two cameras increase as the objects size increased and the camera resolution decreased as the object frequencies increased with averaged resolution of 94% and 89.5% with comparison to standard NEMA phantom which represent resolution of 95.5% and 90.8% for RCH and RCIH respectively. The spatial linearity is calculated and was 0.631mm and 0.639mm for X and Y axis respectively for UFOV and the slanted phantom appear an absolute linearity of 0.70mm for both axis. The uniformity of the two cameras showed a 3.18% and 2.27% for I.U and D.U respectively for UFOV and the standard phantom shows uniformity of 2.0% and 1.5% for I.U and D.U for UFOV respectively. The developed phantom could be used with acceptable accuracy in the field of nuclear medicine to carry out the quality control tests of gamma camera SPECT, which is consider as general multi functional phantom as it could measures the resolution, linearity and flood field uniformity independency on type or manufactures of camera.

ملخص البحث

صممت هذه الدراسة لتجريب نتيجة مماثل (طيف) محلي مع الخوازية المرتبطة به ومقارنة النتيجة بالمعيار القياسي. وقد صمم الطيف حسب المعايير التي أوصت بها جمعية مصنعي المعدات الكهربائية وأجهزة التصوير الطبي ووكالة الطاقة الذرية الدولية وبعض الباحثين الآخرين. واستخدمت فيها مواد منخفضة تكلفة لمحاكاة طيف رباعي البار وشق الطيف وطيف الفيض السائل بغية تحقيق دقة كاميرا غاما وطابعها الخطي وتجانسها. استخدمت مادة البرسبكس Perspex لخلق فيض الطيف واستخدم البرسبكس مع مواد رصاصية مع السيلكون لتحفيز طيف البار بينما استخدمت الرصاص النقي لتخليق طيف الشق. واستخدمت لغة البيانات التفاعلية IDL لتطوير خوارزم رياضي من أجل تحليل نتيجة الطيف المحلي. وتم تجريب الطيف المطور في مستشفى رويال كير ومركز الأشعة والنظائر المشعة بالخرطوم RICK. واستخدم ماء بحجم 1500 ملي لتر و 99mTc لإعداد فيض الطيف ومن ثم يتم وضعه وسط طاولة الكاميرا مع طيف 4 رباعي بار أو طيف شق متعامداً عليه، وتم الحصول على الصورة مع حجم المصفوفة الأمثل. ومن ثم تم تقييم الصور باستخدام خوارزم لغة البيانات التفاعلية IDL المطور لقياس الدقة ومدى الخطية والتجانس لتلك الكاميرات. أظهرت نتائج الطيف المخلق أن دقة كمرتين قد زادت عندما زاد حجم الأجسام وتناقصت دقة الكاميرا ك لها زادت ترددات الأجسام بمتوسط دقة 94% و 89.5% بالمقارنة مع معيار الطيف لدى جمعية مصنعي المعدات الكهربائية وأجهزة التصوير الطبي التي تمثل دقة من 95.5% و 90.8% لمستشفى رويال كير و مركز الأشعة والنظائر المشعة بالخرطوم على التوالي. وتم حساب الخطية المكانية وكانت 0.631 و 0.639 ملم للمحور X والمحور Y على التوالي لحقل الرؤية المفيدة UFOV و أظهر الطيف القياسي اخطية مطلقة بقيمة 0.70 مم لكل محور. وأظهر التجانس لاثنين من الكاميرات 3.18% و 2.27% I.U و D.U على التوالي لحقل الرؤية المفيدة UFOV وأظهر الطيف القياسي تجانساً بمقدار 2.0% و 1.5% ل I.U و D.U لحقل الرؤية المفيدة UFOV على التوالي. يمكن استخدام الطيف المطور بدقة مقبولة في مجال الطب النووي للقيام باختبارات مراقبة الجودة لكاميرا غاما SPECT، والتي تعتبر طيفاً عاماً متعدد الوظائف كما أنه يمكن له أن يقيس الدقة والخطية ومقدار استقلال وتجانس الحقل الفيضي على نوع كامرات أو لمصنعيها

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List of Abbreviations

C.T	Computerized Tomography
3D	Three Dimension
AAPM	American Association of Physicist in Medicine
ADC	Analogue to digital Convertor
AQCP	Adaptive Quality Control Phantom
CCD	Charge Coupled Device
CFOV	Central Field of View
COR	Center of Rotation
CRT	Cathode Ray Tube
DQE	Detective Quantum Efficiency
DSP	Digital Signal Processing
DU	Differential Uniformity
FFT	Fats Fourier Transformation
FOV	Field of View
FWHM	Full Width at Half Maximum
FWTM	Full Width at Ten Maximum
GATE	Gent Application for Tomographic Emission
GBq	Gaga Becquerel
GEM	Gas Electron multiplayer
HEGP	High Energy General Purpose Collimator
IAEA	International Atomic Energy Agency
	International Committee of Radiation Protection
ICRP	
ICRP	Intrinsic Count ate Performance
IDL	Interactive Data Language
IEC	International Electrotechnical Commission
IER	Intrinsic Energy Resolution

IFFU	Intrinsic Flood Field Uniformity
ISL	Intrinsic Spatial Linearity
ISR	Intrinsic Spatial Resolution
IU	Integral Uniformity
KeV	Kilo electron Volt
LCP	Liquid Crystal Polymer
LEAP	Low Energy All Purpose
LFOV	Large Field Of View
LTF	Line Transfer Function
MB and NM	Molecular Biology and Nuclear Medicine center
MGRC	Mini Gamma Ray Camera
MRI	Magnetic Resonance Imaging
MTF	Modulation Transfer Function
MWSR	Multiple Windows Spatial Registration
NEMA	National Electrical Manufacture Association
NMQC	Nuclear Medicine Quality Control
NNPS	Normalized Noise Power Spectrum
PET	Positron Emission Tomography
PHA	Pulse Height Analyzer
PMT	Photo Multiplayer Tube
PSA	Pixilated scintillator array
PSF	Point Spread Function
PSPMTs	Plate Sensitive Photo Multiplayer Tube
QA	Quality Assurance
QC	Quality Control

QCP	Quality Control Program
RCIH	Royal Care International Hospital
RICK	Radiation and Isotopes Center of Khartoum
ROI	Region of Interest
SA	System alignments
SNR	Signal to Noise Ratio
SPECT	Single Photon Emission Computerized Tomography
SPS	System Planer Sensitivity
SSPR	System Spatial Resolution
SVS	System Volume Sensitivity
U of G	University of Gazira
UFOV	Useful Field of View
URA	Uniformity Redundant Array