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Initial characterization of the Seracam:
a small-footprint gamma-optical camera, with fully automated collimator changing capabilities

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SERAC | Imaging Systems | SERACAM

Introduction

The Seracam is a highly portable, high-resolution gamma-optical camera, developed by Serac Imaging Systems. This device miniaturises the planar functionality of current clinical large field of view (FOV) gamma cameras, offering the potential to integrate scintigraphy within clinical pathways outside of the nuclear medicine department [1].

The Seracam features a pinhole-collimated, microcolumnar-CsI(Tl) gamma sensor and an optical sensor with a matched FOV. An automated collimator changing system allows rapid (~1 s) switching between internally housed collimators.

The gamma-imaging performance of the initial Seracam prototype has been characterised at Loughborough University following a modified NEMA protocol, with alterations made to be more suitable for small FOV gamma camera assessment [2,3].

Method

Count rate capability: Detected and incident counts were compared for a ~36 hour decay image to determine the 20 % deviation and maximum count rate values.

System uniformity: Useful FOV coefficient of variation and differential uniformity values were calculated for flat field corrected flood imaging containing ~63M counts.

Spatial linearity: Difference between Gaussian centroid fit positions and physical phantom bar spacing was calculated, for a ~18 hour bar phantom image.

System spatial resolution and sensitivity: FWHM values were calculated using a modified point spread function fit [4], for imaging at 0 – 350 mm. Sensitivity values were calculated using the region of interest counts, and the known source information.

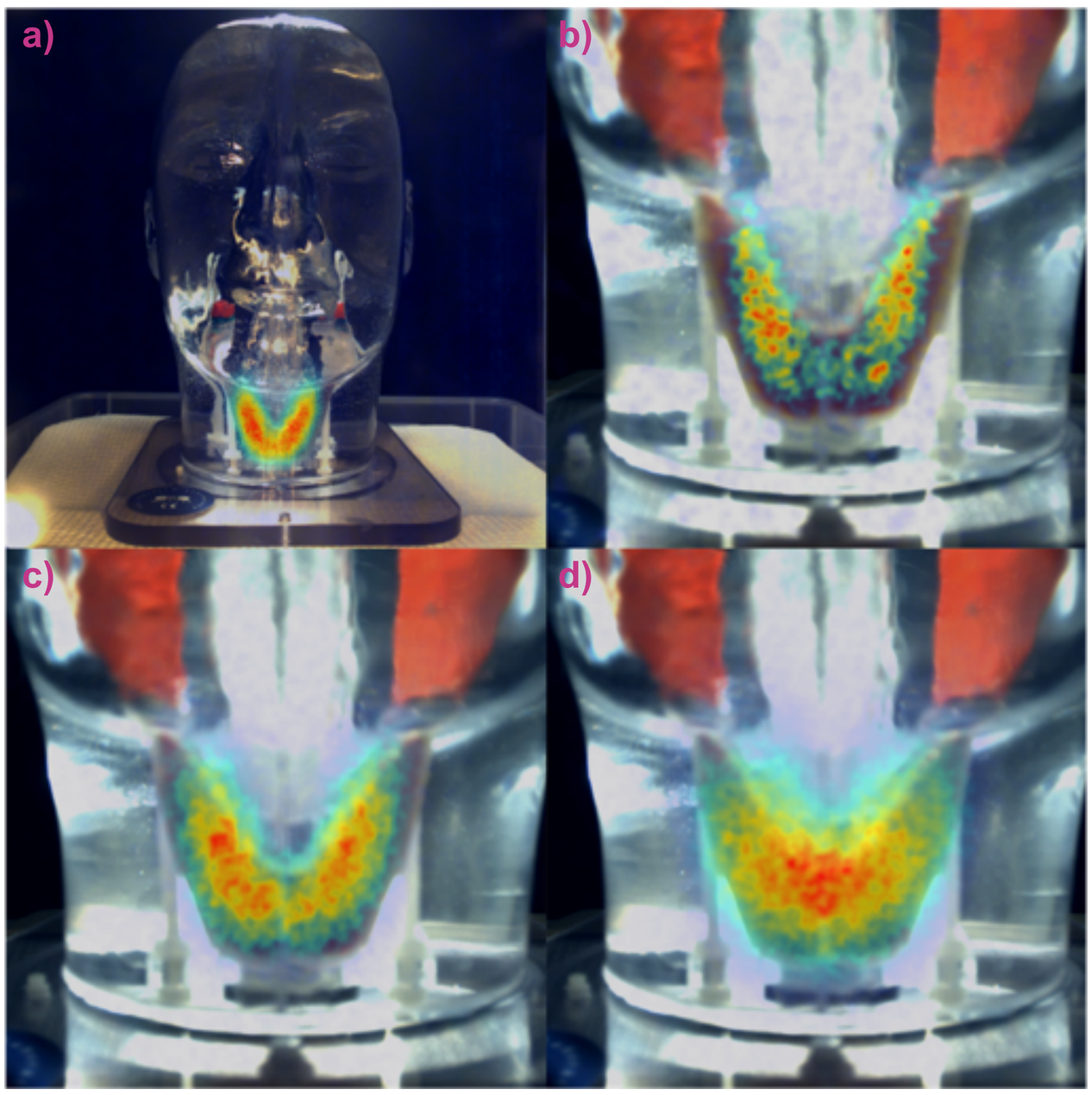

Fig 1. Preliminary simulated Seracam thyroid imaging, using clinically-appropriate ~12 – 16 MBq ^{99m}Tc activities. Extensive additional imaging over 5 – 10 minute durations has demonstrated the clinical potential of the Seracam.
a)1 mm pinhole, full phantom, long-exposure, raw image at 300 mm.
b)1 mm pinhole, 10 m raw image at 65 mm. **c)**3 mm pinhole, 10 m raw image at 65 mm.
d) 5 mm pinhole, 10 m raw image at 65 mm.

Fig 2. The Seracam gamma-optical imaging system, with active illumination ring. The green LEDs on the back of the device indicate which collimator is in situ.

Results

Parameter	^{99m}Tc Source Details	Measurement	Result
System spatial resolution (FWHM)	5 – 50 MBq point source at closest approach / 50 / 100 mm	1 mm pinhole response	3.8 / 4.7 / 5.6 mm
		3 mm pinhole response	7.1 / 12.0 / 16.9 mm
		5 mm pinhole response	11.8 / 20.3 / 28.7 mm
System sensitivity	5 – 50 MBq point source at closest approach / 50 / 100 mm	1 mm pinhole response	2.3 / 1.8 / 0.8 cps/MBq
		3 mm pinhole response	43.0 / 12.9 / 6.7 cps/MBq
		5 mm pinhole response	108.5 / 35.4 / 19.1 cps/MBq
Field of view	N/A	Imaging area	1347 / 6006 / 14019 mm^2
Uniformity	251 MBq flood source at 1 mm	Coefficient of variation	6.6 %
		Differential	3.5 %
Spatial linearity	200 MBq bar phantom at 6 mm	Absolute (full FOV)	64 µm
Count rate capability	297 MBq point source at 250 mm	20 % deviation from expected value	113 kcps (incident)
		Maximum measured count rate	21 kcps

Table 1. Seracam characterisation results of gamma imaging parameters. A 2 mm pinhole collimator is also available, but was not tested in this study.

Discussion and Conclusion

The Seracam characterisation results indicate that spatial resolution, spatial linearity and uniformity values exceed those of large FOV gamma cameras. Sensitivity and count rate capability are comparably lower, this was expected due to the smaller size of the device.

The comparison of the Seracam to other small FOV cameras is not straightforward due to differences in system geometries and characterisation methodologies [5,6]. The Seracam appears to display similar or improved spatial resolution and sensitivity for imaging distances which match the FOV of current devices, although this is highly dependant on the collimator used.

The characterisation results presented only investigate the gamma-imaging performance of the Seracam. The impact of the device's novel flexibility, mobility and hybrid-imaging capabilities are beyond the scope of this work and would be more appropriately assessed within a clinical environment.

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