A Correction Method of the Spatial Distortion in Planar Images from γ-Camera Systems

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Topics

- Problem Description
- The Correction Algorithm
- Application of the Method in Planar Images
- Effects in Tomographic Reconstruction (SPECT)

Distortions in Planar Imaging



Myung Hwan Jeong et al. PMB 49 (2004) 4961



M.M. Fernandez *et al.* NIM **A527** (2004) 92



R. Pani et al. NIM A477 (2002) 509



A. Bakkali *et al.* NIM **A545** (2005) 699

Small Field y-Camera System

The system is based on:

A Position Sensitive PhotoMultiplier Tube (PSPMT), Hamamatsu R2486

A resistive chain technique applied on the 32 crossed-wired anodes of the PSPMT



PSPMT Characteristics



- 3" Diameter Cylindrical Envelope PSPMT
- Bialkali photocathode
- 12 stage coarse mesh dynode structure
- 32 crossed wired anode outputs connected to a resistive current divider network

Position and energy reconstruction



$$X = (X_A - X_B) / (X_A + X_B)$$
$$Y = (Y_C - Y_D) / (Y_C + Y_D)$$
$$E = X_A + X_B + Y_C + Y_D$$

- X_A ~ (L-x)
 X_B ~ x



ADC on PCI-card



ANALOG OUTPUT SIGNAL (HAMAMATSU R2486)

- 4 A/D converters simultaneously sampling
- Up to 20 MHz sampling rate
- 12 bit analog input resolution



DIGITIZED SIGNAL (PCI-9812, AdLink)

Pixelated Scintillation Crystal used in the Measurements

Crystal CsI(TI)

- Diameter L = 44 mm
- Thickness d = 3 mm
- Pixel size a = 1.1 mm



Planar image using CsI(Tl) Crystal



Gamma-Camera Coordinate System(GCCS)



(u,v) coordinates



Correction Algorithm

- Calculation of the distances, du,dv of the nearest pixel center (uc(i),vc(i)).
- Calculation of R1 where R1=du/a, a= uc(i+1)-uc(i-1))
- Calculation of R2 where R2=dv/b, b= vc(i+1)-vc(i-1))



Correction Algorithm

- Finding of the coordinates (xci,yci) of the nearest center
- dx=R1* c , c= (xc(i+1)-xc(i-1))
- dy=R2*d , d= (xc(i+1)-xc(i-1))
- x(i)=xc(i)+dx, y(i)=yc(i)+dy



Comments

- It is not necessary to extract the centers of all the pixels in the crystal (~16 columns).
- Columns near the edge of the crystal are more significant since the spatial distortion is more obvious at the edges of the planar images of the GCCS.
- Distances in corrected images are measured in mm.

Application of the correction method in experimental data – use of ⁶⁰Co source

- Uncorrected planar image
- Corrected planar image





Application in a SPECT experiment

- Phantom : 4 capillaries (1.2mm) filled with ^{99m}Tc solution.
- Planar images were obtained from 0° to 180° by step of 15°.
- Tomographic images were reconstructed using the MLEM reconstruction technique.

Geometry of the experimental setup

Application in a SPECT experiment











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Reconstructed Images

uncorrected

corrected



h = 20 mm

Reconstructed Images

uncorrected

corrected



h = 15 mm

Reconstructed Images

uncorrected

corrected



h = 00 mm



After Correction



3-D reconstruction



Conclusion & Future Plans

- Correction technique applied to planar distortion gives promising results.
- Examine correction in SPECT with more complicated phantoms.
- Automatization of the procedure (input coordinates of pixel-centers - calculation of the correction matrix).