Analysis of density and contrast in mammograms

S Meeson ¹, K C Young ¹, M L Ramsdale ¹, M G Wallis ² and J Cooke ³

¹ NCCPM, Royal Surrey County Hospital, Guildford. ² Warwickshire, Solihull & Coventry Breast Screening Centre. ³ Jarvis Breast Screening Centre, Guildford.

Introduction
The objective of this study is to develop tools for the NHSBSP to quantitatively assess image quality in clinical films. Using this data the ultimate aim is to optimise imaging procedures and improve cancer detection rates, by exploring the effects of changing exposure parameters. A methodology is presented, together with initial data, which allows the requirements of film contrast and latitude in screening mammography to be assessed.

Data Acquisition and Image Production
In this pilot study 120 Mammograms of 46 women recorded on a single day of screening on a mobile unit were used. The X-ray unit was an IGE 600 TS SENIX, the film / screen combination was Sterling Microvision C, and the films were processed using a Sterling T6 processor operating at 34°C.

Following film assessment, all the films were digitised (at 110 μm resolution) using a Lumisys 150HR laser digitiser. The films were digitised together with density calibration strips to facilitate the conversion from image pixel value to optical density units. In practice the stability of the digitiser was sufficient to allow a single calibration to be used for all film images. The maximum measurable density was limited by the operating range (0.3 to 3.6 optical density) of the digitiser. This was only an issue when measuring the maximum density near the skin edge, and was overcome by using a calibrated X-rite densitometer to measure this density.

Results
The pilot in figure 2 shows the large variation in contrast index (CI) from 0.72 to 3.22. Mammograms with a higher CI had a higher maximum density and a lower minimum density in the main breast region, with the average density remaining about 1.7.

Figure 2 : Variation of main breast densities in the sample of mammograms

The analysis was performed on each of the original images. Measurements included the maximum, minimum, mean and mode densities for each ROI. The minimum density was taken to be the lowest density value excluding calculations and small areas of film emulsion “pick-off”.

Region of Interest Analysis
For image analysis each breast image was divided into three mutually exclusive regions of interest (ROI), representing the pectoral muscle, skin edge, and the main breast region (see figure 1).

A semi-automatic method of selecting the ROI in this study was successful for the majority of films in the sample. To define the ROI the images were median filtered before a simple threshold technique was used to highlight the ROI. The threshold between the main breast and skin edge was defined as the density below which parts of the central breast tissue would be excluded from the main breast ROI.

The analysis was performed on each of the original images. Measurements included the maximum, minimum, mean and mode densities for each ROI. The contrast index (CI), defined in figure 1, was calculated for each film and represents the difference between the maximum and minimum optical densities in the main breast excluding calcifications.

Radiological Assessment of Mammograms
Two radiologists independently assessed each film. Breast composition was graded as either fatty, mixed or dense. The radiologists’ satisfaction with the OD of glandular tissue, adipose tissue, pectoral muscle and the skin edge were graded on a seven point scale from very high to very low with the mid-point (OK) representing the ideal. Image sharpness and noise were graded as satisfactory, unsatisfactory or poor. The overall diagnostic value of the films was graded as excellent (14% of all films), good (65%), satisfactory (17%), poor (4%) or inadequate (none).

CONCLUSIONS
• This pilot study has demonstrated that film optical density, contrast and latitude in clinical mammograms can be assessed quantitatively.
• The mean optical density in these clinical films was about 1.7, which appeared to be close to the optimum.

Acknowledgement: This research has been funded by...

Analysis of density and contrast in mammograms

S Meeson ¹, K C Young ¹, M L Ramsdale ¹, M G Wallis ² and J Cooke ³

¹ NCCPM, Royal Surrey County Hospital, Guildford. ² Warwickshire, Solihull & Coventry Breast Screening Centre. ³ Jarvis Breast Screening Centre, Guildford.

Introduction
The objective of this study is to develop tools for the NHSBSP to quantitatively assess image quality in clinical films. Using this data the ultimate aim is to optimise imaging procedures and improve cancer detection rates, by exploring the effects of changing exposure parameters. A methodology is presented, together with initial data, which allows the requirements of film contrast and latitude in screening mammography to be assessed.

Data Acquisition and Image Production
In this pilot study 120 Mammograms of 46 women recorded on a single day of screening on a mobile unit were used. The X-ray unit was an IGE 600 TS SENIX, the film / screen combination was Sterling Microvision C, and the films were processed using a Sterling T6 processor operating at 34°C on extended cycle.

Following film assessment, all the films were digitised (at 110 μm resolution) using a Lumisys 150HR laser digitiser. The films were digitised together with density calibration strips to facilitate the conversion from image pixel value to optical density units. In practice the stability of the digitiser was sufficient to allow a single calibration to be used for all film images. The maximum measurable density was limited by the operating range (0.3 to 3.6 optical density) of the digitiser. This was only an issue when measuring the maximum density near the skin edge, and was overcome by using a calibrated X-rite densitometer to measure this density.

Results
The pilot in figure 2 shows the large variation in contrast index (CI) from 0.72 to 3.22. Mammograms with a higher CI had a higher maximum density and a lower minimum density in the main breast region, with the average density remaining about 1.7.

Figure 2 : Variation of main breast densities in the sample of mammograms

The analysis was performed on each of the original images. Measurements included the maximum, minimum, mean and mode densities for each ROI. The minimum density was taken to be the lowest density value excluding calculations and small areas of film emulsion “pick-off”.

Region of Interest Analysis
For image analysis each breast image was divided into three mutually exclusive regions of interest (ROI), representing the pectoral muscle, skin edge, and the main breast region (see figure 1).

A semi-automatic method of selecting the ROI in this study was successful for the majority of films in the sample. To define the ROI the images were median filtered before a simple threshold technique was used to highlight the ROI. The threshold between the main breast and skin edge was defined as the density below which parts of the central breast tissue would be excluded from the main breast ROI.

The analysis was performed on each of the original images. Measurements included the maximum, minimum, mean and mode densities for each ROI. The minimum density was taken to be the lowest density value excluding calculations and small areas of film emulsion “pick-off”.

The contrast index (CI), defined in figure 1, was calculated for each film and represents the difference between the maximum and minimum optical densities in the main breast excluding calcifications.

Radiological Assessment of Mammograms
Two radiologists independently assessed each film. Breast composition was graded as either fatty, mixed or dense. The radiologists’ satisfaction with the OD of glandular tissue, adipose tissue, pectoral muscle and the skin edge were graded on a seven point scale from very high to very low with the mid-point (OK) representing the ideal. Image sharpness and noise were graded as satisfactory, unsatisfactory or poor. The overall diagnostic value of the films was graded as excellent (14% of all films), good (65%), satisfactory (17%), poor (4%) or inadequate (none).

CONCLUSIONS
• This pilot study has demonstrated that film optical density, contrast and latitude in clinical mammograms can be assessed quantitatively.
• The mean optical density in these clinical films was about 1.7, which appeared to be close to the optimum.

Acknowledgement: This research has been funded by...