Automatic CT Air Bubble Artifact Detection in Routine Quality Control Images

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OBJECTIVE

- To design an algorithm capable of detecting image artifacts caused by air bubbles in CT scanner cooling oil.

METHODS

- Water images appear uniform when viewed at standard window but display concentric light and dark circles when the window width is narrowed.

- Since the air bubble artifacts cause dark streaks across images, the **air bubble artifact identification algorithm (ABAIA)** was designed to detect dark spots in these concentric circles.

- An image is divided into annular sections forming a bull's-eye pattern, and each section is divided into radial trapezoids.

- The mean of voxel values in each section is compared to the mean of voxel values of each trapezoid within a section.

- Trapezoids that are more than 0.7 Hounsfield Units darker than the section to which they belong are labelled as containing artifacts.

RESULTS

- ABAIA was tested on a novel dataset containing 66 images with artifacts and 14 without.

- ABAIA correctly identified 14/14 (100%) images without artifacts and correctly identified 60/66 (91%) of the images with artifacts. ABAIA achieved 92.5% overall accuracy on the novel dataset.

CONCLUSIONS

- ABAIA can be integrated into automated quality control procedures so technical staff can be alerted if a scanner's images are compromised by air bubble artifacts.

REFERENCES

1. Hedrick et al. J Comput Assist Tomogr 2016; 40: 67-70
2. McVey et al. Clin Radiol 2016; 71: 1059–65
3. Wong et al. Jpn J Radiol 2018; 39: 90-5
4. Barrett & Keat. RadioGraphics 2004; 24: 1679–1691

Air bubbles in CT scanner cooling systems can cause **streaking artifacts** in images.

An **automated test** for these artifacts was designed by assessing **circular uniformity** of routine quality control images.

Scan with phone camera to download the full paper, or go to myaqs.com/abaia
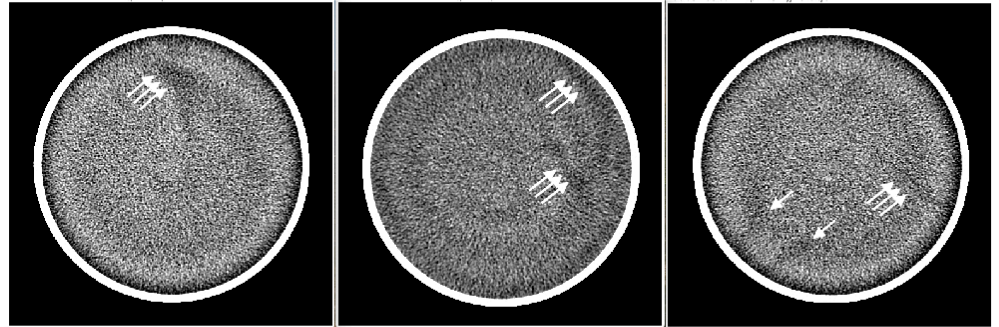
AIR BUBBLE ARTIFACT

Fig 1. Water phantom images showing different instances of the air bubble artifact.

ARTIFACTS ARE NOT DETECTED BY ROUTINE QUALITY CONTROL

(Values in HU)	Centre (mean)	Centre (stdev)	12 o'clock (mean)	3 o'clock (mean)	Abs (12 o'clock – centre)	Abs (3 o'clock – centre)
artifact present	1.63	4.31	0.45	0.12	1.18	1.51
Air bubbles removed	1.47	4.58	1.13	0.35	0.34	1.12
QC limits	+/- 4	4 – 5	Na	Na	< 2.29	< 2.85

Table 1. Standard QC test results all pass when air bubble artifact is present. Standard deviation (stdev); Absolute value operation (Abs)

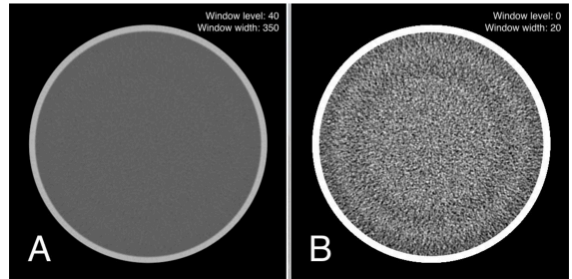## NON-UNIFORMITY IN WATER IMAGES

Fig 2. A water image viewed at a wide and narrow window width to show noise and macro non-uniformity
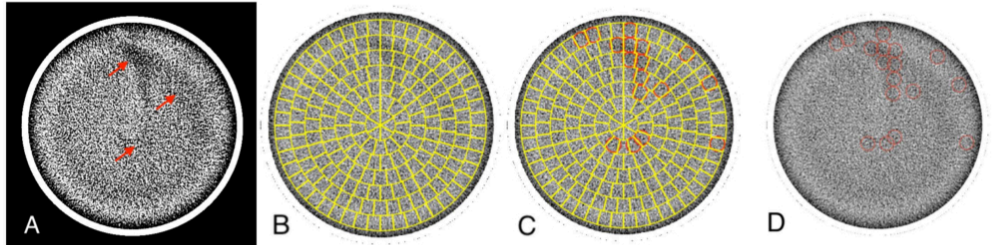
ASSESSMENT OF AN IMAGE

Fig 3. Manually identified image artifacts from the training (A), the image is divided into annular sections and trapezoids (B), trapezoids that deviate from the section mean are circled in red (C), the dividing lines are removed