Improvement of Pulse-mode Photographic Images in MDS Computer Systems

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Users of scintigraphic computer systems manufactured by Medical Data Systems (MDS) frequently experience textured distortion of oscilloscope images when scans are produced by Z-axis modulation. The source of this malfunction has been identified and a way to eliminate the problem is described. The modification is simple and inexpensive. The availability of Z-axis modulation significantly enhances the capabilities of MDS systems.

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Users of scintigraphic computer systems manufactured by Medical Data Systems (MDS), Ann Arbor, Michigan, frequently experience a textured distortion of images when these images are formatted with pulse-mode photography software and transferred to film for diagnostic or record purposes. This distortion makes the photograph appear to be a photomicrograph of an undulating surface with periodic maxima. The degree of distortion is usually fairly random in nature. The image is "wiped on" in a line-by-line mode by the pulse-mode photography program; consequently, no static image is available to predict the extent of the distortion. The use of pulse-mode photography requires the operator to complete an image before any distortion can be evaluated. These factors tend to make pulse-mode photographic imaging unreliable and, therefore, undesirable for diagnostic purposes.

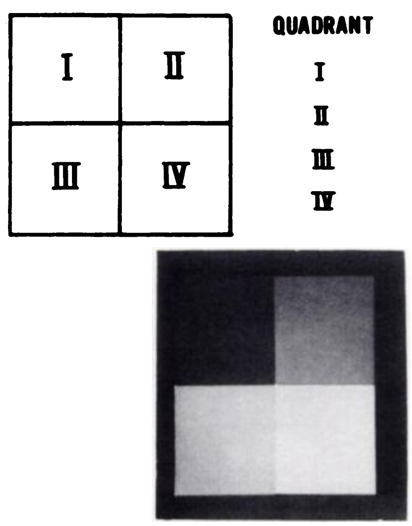
The problem has been recognized by MDS users for quite some time, although recently manufactured MDS systems are reported to be greatly improved in this regard. Various causes and solutions have been postulated by both users and the manufacturer, but until now all of these solutions have been either unsuccessful or very time-consuming.

We have determined that the display distortion is caused by conducted noise on the power-supply lines that deliver power to the digital-to-analog (D/A) converters in the display controller. The exact cause of the noise has not been firmly established. Two reasonable possibilities will be discussed later. No matter what the cause, the modification to be described has satisfactorily corrected the problem.

MATERIALS AND METHODS

Some sort of control is required to permit pre- and postmodification comparisons. We describe one here that other users may find helpful.

Our control consists of a matrix on disk that may be displayed by a pulse-mode program (DPIX or equivalent). This matrix is divided into four equal quadrants. The number of counts per cell in each quadrant is uniform, but each quadrant contains a different number of counts per cell. An illustration of the test matrix and the distribution of counts per cell is given in Fig. 1.



QUADRANT	COUNTS PER CELL
I	400
II	800
III	1200
IV	1600

FIG. 1. Control matrix is composed of four quadrants, each containing indicated number of counts per cell. Matrix permits evaluation of effectiveness of modification.

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Such a matrix provides four different intensities, thus permitting a worst-case analysis.

Before the modification, a photographic record of the displayed control matrix was made, and the intensity setting of the display was recorded. This photograph is the premodification control.

The solution to the problem is the complete isolation of the power-supply lines to the Z-axis D/A converter from the rest of the system. This is done most simply by installing a small modular power supply that provides ±15-Vdc power only to the Z-axis D/A converter and its associated voltage followers. The power supply used by us was an Analog Devices Model 902, which provides ±15 Vdc at up to 100 mA per side, but any well-regulated and well-filtered power supply with this current rating would be adequate. As an extra precaution, both the +15- and the -15-Vdc outputs were bypassed to the power supply common with 0.1 μF solid tantalum capacitors. A schematic diagram of the modification is shown in Fig. 2.

Exact details of construction for this modification are not possible because each MDS system usually has features that are unique to that installation. However, the following general guidelines should apply.

1. Mount the power supply as close as possible to the Z-axis D/A converter. We were able to mount our power supply on perforated board in space previously unused and immediately adjacent to the Z-axis converter.
2. Keep the ±15-Vdc power-supply leads as short as possible. This not only reduces the possibility of catching these leads when the display-controller tray is moved, but it also reduces the possibility of noise pick-up from any source. If the physical arrangement of a particular system requires longer leads (>6–8 in.), it is recommended that additional bypass capacitors (e.g., 0.1-μF ceramic discs) be installed at the power-supply pins of the Z-axis D/A converter.
3. Keep the 120-V ac power leads well removed from the ±15-Vdc output leads.
4. Connect the power-supply's common line to the display driver circuit at only one point, preferably at the Z-axis D/A converter ground pin.

At the completion of this modification, our control matrix was photographed at the display intensity level used before the modification. This postmodification record was used to gauge the success of the modification.

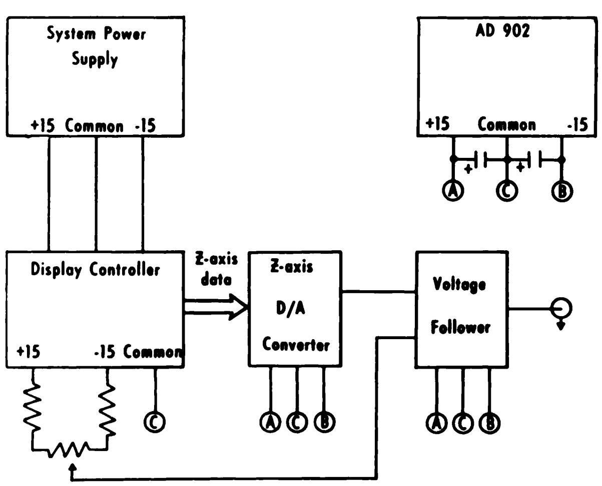

FIG. 2. Schematic of modification. Accessory power supply and its connection to existing circuitry are indicated.

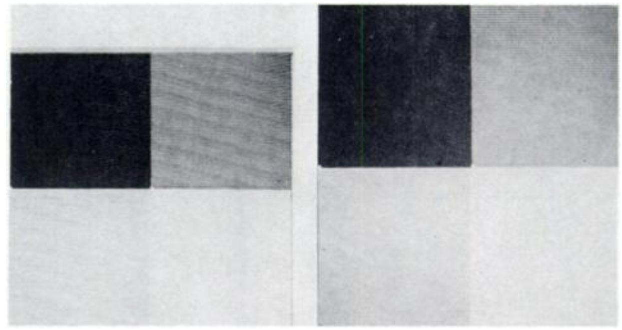

FIG. 3. Comparison of premodification performance (left) with postmodification performance (right). Striations are now minimal or absent.

RESULTS

The results were most satisfactory. The premodification waviness was absent from the postmodification record, and the Nuclear Medicine staff considers the current performance to be satisfactory. The effectiveness of the modification is shown in Figure 3, with the premodification record at the left and the postmodification at the right.

DISCUSSION

Beyond doubt, the textured distortion in the unmodified display is caused by conducted noise on the ±15-Vdc power supply leads of the Z-axis D/A converter. This has been demonstrated most convincingly by the success of the modification. The source of this conducted noise however, has not been definitely established. Two possible sources have been suggested, and these are mentioned here to illustrate some of the more subtle pitfalls in display-controller design.

The first possibility is 60-Hz noise on the ±15-Vdc power-supply leads. Although this is attractive to explain the apparent periodicity of the distortion pattern, we cannot believe it is the sole source of the distortion. In our earliest attempts to correct the display distortion, the ±15-Vdc power-supply lines to the Z-axis D/A converter were heavily bypassed. Additional bypass capacitors were installed at the system's power-supply outputs. This did not eliminate the observed striations, although it did change their slope. Thus, although 60-Hz noise may be a contributing factor it is unlikely that it is the sole cause of the problem.

The second possible source of conducted noise is the Z-axis D/A converter itself. In pulse-mode operation, the amplitude of the Z-axis converter output is held constant, but the dot is pulsed a varying number of times to produce the desired intensity. Because the X-, Y-, and Z-axis D/A converters normally have all power-supply lines in common, it is possible that the very small and rapid transients accompanying the pulsing of the Z-axis converter may couple through the ±15-Vdc power-supply lines to cause minute shifts in X and Y coordinate positions. The cumulative effect of many transients may be sufficient to cause a very small net displacement of each dot that is not easily measurable but could nevertheless be integrated visually to yield the observed distortion pattern.

These suggestions must be regarded as speculative. The urge to establish the cause(s) conclusively has not been strong enough to justify the system down time necessary to make the determination.

Whatever the noise source, it is clear that high-quality, noise-free power to the Z-axis D/A converter is essential to quality pulse-mode imaging.