Prototype Development of an Image Capturing Device for Field Use

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Summary

Real-time ultrasound technology is now being used by many researchers and technicians for evaluating livestock composition, especially in beef and swine. The digitally captured ultrasound images are analyzed for fat thickness, ribeye cross-sectional area, and percentage intramuscular fat (IMFAT). ISU researchers and ultrasound technicians have realized that the current method of capturing images using a regular portable PC has many problems including frequent failures in the field. ISU has developed a prototype device, called "*BlackBox*", that allows one to capture and store images in the field without frequent problems encountered with the regular PC. The primary goals of the design were to use minimal components and an easy to use software to capture images in the field. For field use, the *BlackBox* is a rugged unit with easy push-button operation. It will meet the demands of seedstock ultrasound scanning for later analysis by the technician or by a centralized processing center. It should also prove to be a useful tool for feedlot chute-side application.

Introduction

Real-time ultrasound technology is now being used by many researchers and technicians for evaluating livestock composition, especially in beef and swine. Ultrasound images from live animals are captured and stored digitally using a personal computer equipped with a frame-grabber. The images of *Longissimus dorsi* are later analyzed for fat thickness, ribeye cross-sectional area, and percentage of intramuscular fat (IMFAT). Iowa State University has developed the technology for predicting the IMFAT from a longitudinal image of the LD muscle across the 11th, 12th, and 13th ribs.

Iowa State University researchers and ultrasound technicians certified by the Beef Improvement Federation have realized that the current method of capturing images using a regular portable PC has many problems, including:

(1) Most computers are not designed for the harsh environmental conditions (extreme temperature, humidity and dust) encountered during livestock scanning.
(2) Vibration and shock of travel and handling often cause system components to fail.
(3) Electronic and radio-frequency interference causes frequent problems with portable computers, especially those equipped with a liquid-crystal-display (LCD) screen. Such interference, if captured as a part of the image, either makes the image useless for IMFAT prediction or severely affects the accuracy of the prediction.
(4) The system and software problems are sometimes not easy to diagnose and correct in the field.
(5) There are a few commercially available portable rugged computers that could provide solutions to many problems, but such systems are prohibitively expensive. Also, many of the components are either proprietary or not widely available, which makes system repair unacceptably time-consuming and expensive.

ISU researchers have developed a prototype device that allows one to capture and store images in the field without frequent problems encountered with the regular PC. This report describes the first prototype, called "*BlackBox*".

Prototype Design

The primary goals of the design were to use minimal components and an easy to use software to capture images in the field.

The *BlackBox* prototype is developed around a popular and inexpensive IBM-compatible computer platform. However, the *BlackBox* does not look or function like a typical computer. The keyboard, monitor, and mouse are removed from the system, and minimal components are housed in an enclosure with positive pressure filtered air-flow for cooling and protection from weather extremes. A small hand-held control pendant allows a user to interact with the system for image capturing. The control pendant has a switch for capturing the image, a switch for displaying (on external monitor) the last captured image, a status light to indicate when the system is ready to capture, and a status light to indicate low storage capacity. The standard configuration stores up to 4,000 images (248 kilobytes per image). When

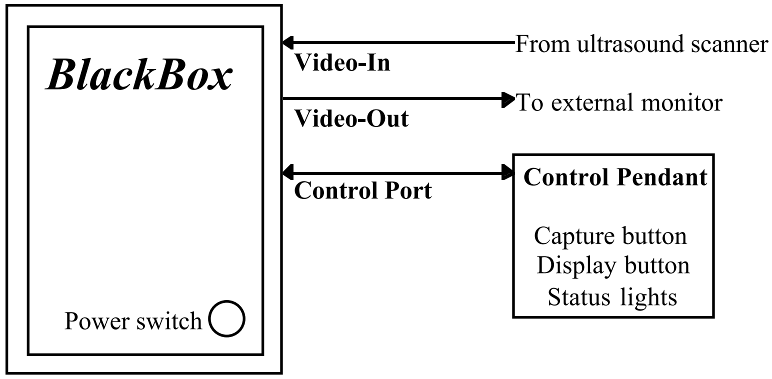

Figure 1: Block diagram of the *BlackBox* illustrating design and operation for field image capture.

connected to a processing PC using a data-transfer cable, the user can transfer the image files for further analysis and backup.

The prototype was built using readily available off-the-shelf computer components. The aluminum enclosure was made and assembled at a local machine shop. The control pendant was designed and developed by ISU researchers. The components used in the prototype are listed below:

(1) Computer board (Intel 486/33mhz processor)
(2) Hard disk (1.6 gigabyte capacity)
(3) Power supply (230 watt) with exhaust fan
(4) Frame grabber (Cortex100 from ImageNation Corporation, Beaverton, OR, USA)
(5) Enclosure case (aluminum case, fan, and filter)
(6) Control pendant (two push-button switches and four dual-color LED lights housed in a 4 by 2.5 inches plastic enclosure, with 6 foot cable)
(7) Data-transfer cable (bi-directional parallel)
(8) Video cables

The scanning software was developed using a utility program (grabit.exe) supplied with the frame-grabber. The hand-held pendant was controlled using a parallel port. For scanning, the software cycles through the following steps: configure the frame-grabber for continuous acquisition mode; turn the Ready-to-capture light to green and wait for the user to push the Capture button; acquire the frame when Capture button is pressed; turn the Ready-to-capture light to red (indicating system busy status); display the acquired frame on external monitor; save the image using a unique file name based on the system time (hour, minute and second); configure the frame-grabber again for the continuous acquisition mode; turn the Ready-to-capture light to green and wait for the user to push the Capture button. The system also checks if the user presses the Display button when it displays the last image captured.

BlackBox Operation and Field Use

The *BlackBox* has been tested for field image capture using ISU research beef animals. The technician carries the *BlackBox* unit with its control pendant along with the ultrasound scanner (e.g., Aloka500V from Corometrics Medical Systems, Inc., Wallingford, CT, USA) and an inexpensive external nine-inch video monitor. The set-up of equipment for scanning is shown in Figure 1. The video output from the ultrasound scanner is connected to the Video-In on the *BlackBox*. The Video-Out on the *BlackBox* is connected to the external monitor, and the control pendant is connected to the designated port on the *BlackBox*. On power-up, the system runs basic diagnostics, automatically loads the software, and the Ready-to-capture light on the control pendant turns green.

The user performs the following steps to capture each image: type an animal ID on the ultrasound scanner console; position the transducer on the animal after clipping and applying oil; freeze an appropriate image on the ultrasound scanner, which is also displayed on the external monitor; press Capture button to save the image (if the user determines that image quality is acceptable). The system then gets ready for the next image as indicated by the status light. For confirmation, the user can press the Display button to display the last captured image on the external monitor.

The *BlackBox* has built-in basic diagnostic checks. For example, it indicates the busy status by turning the Capture light to red, and it indicates low storage capacity by flashing the appropriate light on the control pendant. Also, when finished, the user just has to turn the power switch off. Such a design makes data less prone to corruption on power failure or interruption.

Because the *BlackBox* is designed for image capture only; further analysis is done on a regular PC. The user can transfer image files from the *BlackBox* using a data-transfer cable and a software utility. The user can also delete scan sessions to allow storage of new images. The images are stored in the order of scanning and in binary format, which can be readily used by commercially available image analysis software. Isolating the image capturing process from analysis provides simplicity, ease of use, and reliability of field operation. It also provides flexibility of processing either by a technician using commercial software or by a centralized processing center. The *BlackBox* could also be used (with additional hardware and software) for feedlot chute-side scanning and evaluation application.

A hand-held keypad with text display has been considered as an optional user-interface device. The user could type the animal ID on the keypad that could be attached with the image file for later use during analysis and reporting.

Implications

The *BlackBox* is seen as a necessary tool for ultrasound technicians and researchers serving the beef industry. For field use, it is a rugged unit with easy push-button operation for capturing images reliably. It will meet the demands of seedstock ultrasound scanning for later distributed or centralized processing of images. It should also prove to be a useful tool for feedlot chute-side application.