Scanner shown scanning a 14.25'' wide Mills Violano Virtuoso music roll

Wide-Format, "Any Roll" Music Roll Scanner

Overview and Specifications

Designed and built by:
Gene Gerety

General Description

The wide-format "any-roll" music roll scanner is designed to accept perforated (punched) music media of practically any type, converting the pattern of punched holes on the media into digital form. The stored information can then be used for any of a variety of purposes, including:

- Punch new rolls (or books, or whatever)
- Play back on any pneumatic piano (or other pneumatic instrument) equipped with the Gerety/Chase "E-Roll Player" system
- Play back electronically via a synthesizer, Disklavier®, or other MIDI-equipped musical instrument

The scanner is based on the RollSCAN-1 scanner controller board, and is capable of scanning any roll (or book) medium from 1 inch wide to over 20 inches wide. Both frontlighting and backlighting capability are provided. Rolls can be scanned face-up or face-down, head-first or tail-first. The motors on both the takeup and supply spools are reversible so that media can be fed either from the top or the bottom of the supply spool. A special feature of the spool motor design is automatic, motorized rewind, with precisely controlled paper back-tension throughout the entire rewind process.

Paper tension during capstan-driven scanning is automatically maintained by a specially designed spool motor controller, and is programmable for each different type of music medium. Literally thousands of different media types can be defined and scanned, each one having a different hole layout, width, rewind speed, supply and takeup tension specification, etc..

The scanner is a three-piece design, comprising a scanner body, a supply spool assembly and a takeup spool assembly. The spool assemblies "dock" with the scanner body for scanning, but can be quickly separated for ease of transport.

Scanner Body

Supply Spool Assy.

Takeup Spool Assy

The Scanner Body

The scanner body is the "engine" of the scanner, and performs most of the critical scanning tasks. Based on the highly-integrated RollSCAN-1 controller, it uses two 12-inch long Contact Image Sensor (CIS) modules in a staggered, offset configuration to scan a 22" wide path. The two CIS modules are visible through the scanning window in the photo on the previous page. The scanner software combines and "seams" the images captured by the two sensors into a single image.
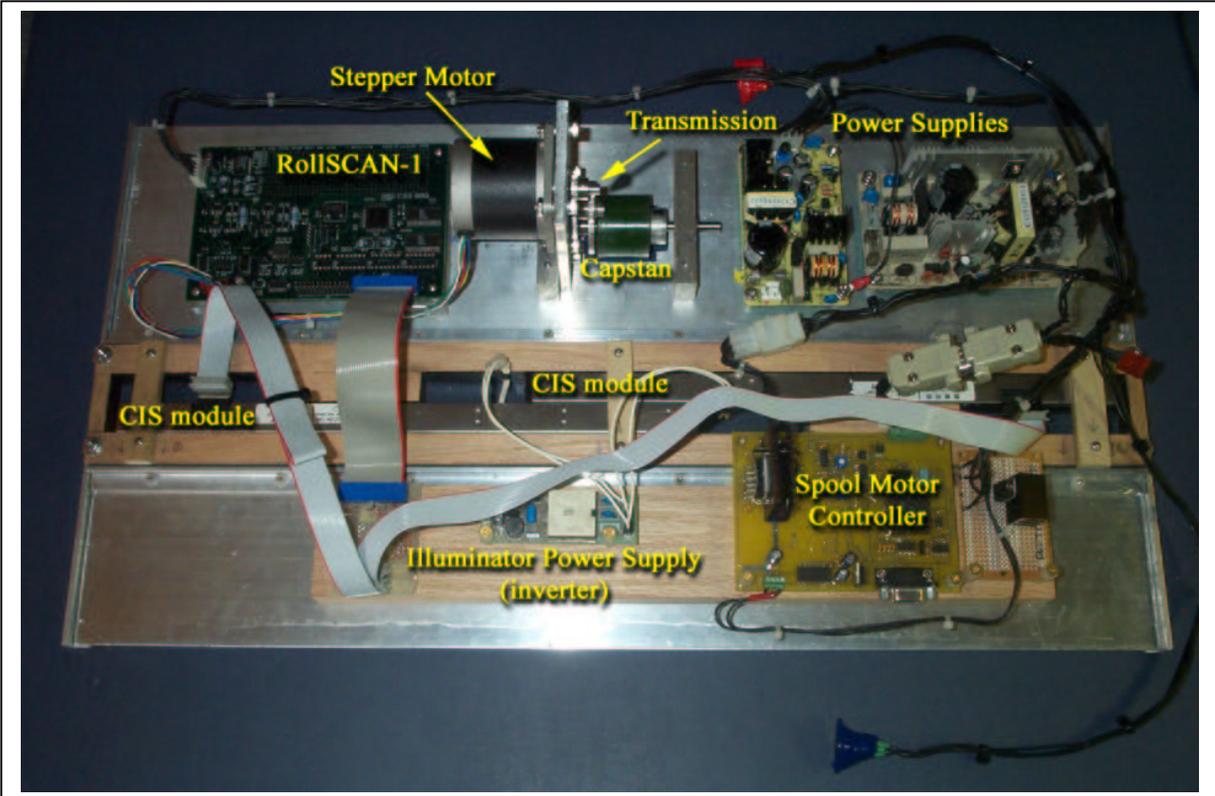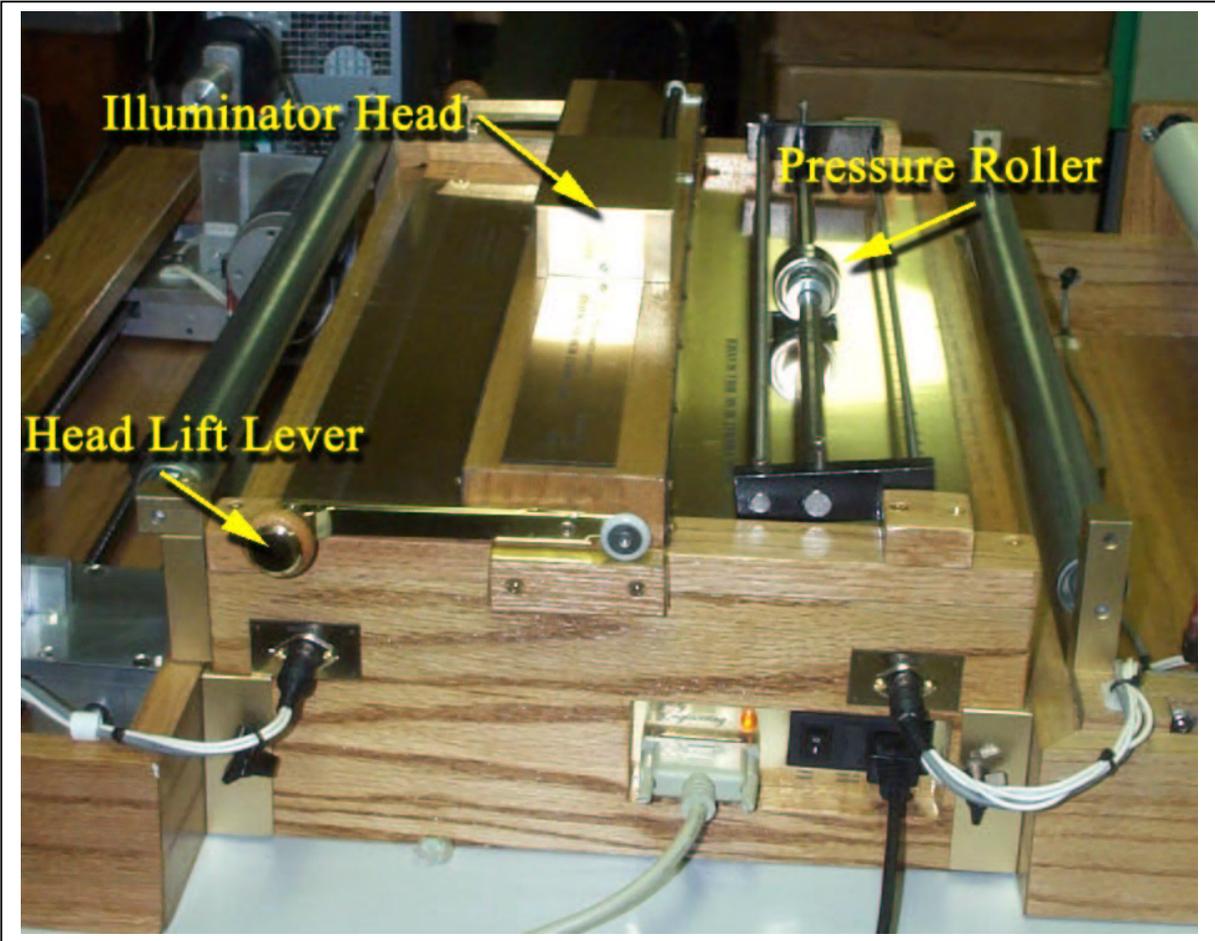
A backlight illuminator head incorporates fluorescent tube illumination, as well as media hold-downs to keep the music media agains the scanning window.

The RollSCAN-1 controller board, a highly integrated, single-board scanner controller, does all of the "heavy lifting" for the scanner. Whereas most scanners are designed primarily for page scanning and most scanner controllers are specifically designed for and built into a particular page scanner, the RollSCAN-1 is designed as a highly flexible, general purpose scanning controller. The RollSCAN-1 permits a continuous "streaming" mode of scanning, necessary for scanning music rolls which can reach hundreds of feet in length. This "streaming" mode is particularly useful for scanning long, rolled or folded documents such as piano rolls, book music, strip charts or pin-fed continuous forms. Based on one of the newest generation of "scanner-on-a chip" IC's, the RollSCAN-1 integrates all of the electronic functions necessary for high performance color or monochrome scanner. These functions include:

- Flexible, programmable CCD/CIS timing and clocking circuitry
- Compatible with a wide range of linear mono and color CCD and CIS devices
- Illumination control, timing and drive circuitry (CCFL requires external inverter)
- Complete 12-bit/36-bit (monochrome/color)analog front-end for CCD/CIS
- Pixel-rate digital signal processor
- 512 Kbyte data buffer
- microstepping motor controller and motor drive circuitry
- PC-compatible EPP parallel port interface
- Can be configured for multiple sensors

In addition to the RollSCAN-1 controller, the scanner body incorporates a specially designed motor controller for driving the motors on the takeup and supply spools.

The scanner body is shown in detail on the following page:

Illuminator Head

Pressure Roller

Head Lift Lever

Stepper Motor

Transmission

Power Supplies

RollSCAN-1

Capstan

CIS module

CIS module

Spool Motor
Controller

Illuminator Power Supply
(inverter)

Illumination System

The scanner's illumination system includes both backlight and frontlight illuminators. Frontlight illumination takes advantage of fluorescent tubes built into the scanner's two contact image sensor modules. Backlight illumination is provided by means of a backlight illuminator head.
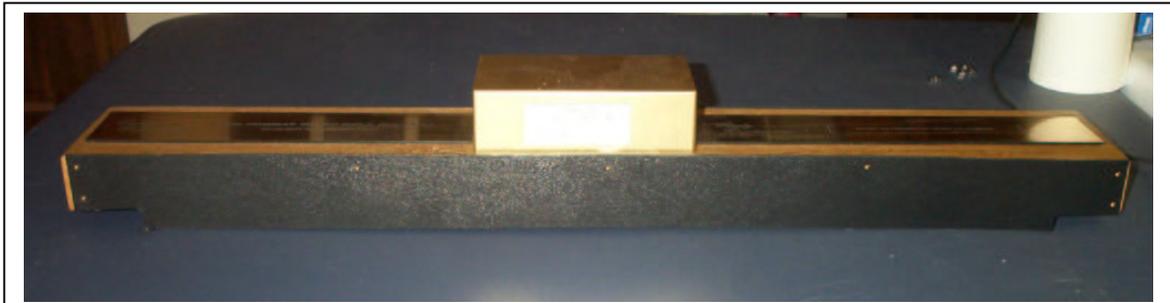

Illuminator Head

How The Scanner "Sees"

As mentioned previously, the scanner employs two, staggered CIS modules. These modules are offset from one another both horizontally and vertically, giving the scanner a somewhat "strange" view of the world. Further, to get the image from both sensors into the RollSCAN-1 board, the signals from the two sensors are assigned to different color channels. Where a "normal" color scanner would have red, green, and blue color components, the roll scanner uses the color channels to receive signals from separate sensors. One sensor is assigned to the "red" channel and the other is assigned to the "green" c hannel. Since only two sensors are used, the "blue" color channel is unused. Complicating matters further, both sensors scan from the outside of the scanning window towards the center.

The scanner software separates the "red" and "green" color channel i mages, compensates for the vertical and horizonatal offsets, and combines the two images into a single, seamless image. "Before" and "After" images are shown below for a scan of a section of a Mills Violano roll.

Typical Frontlit Image : Before Seaming

Same Image After Seaming
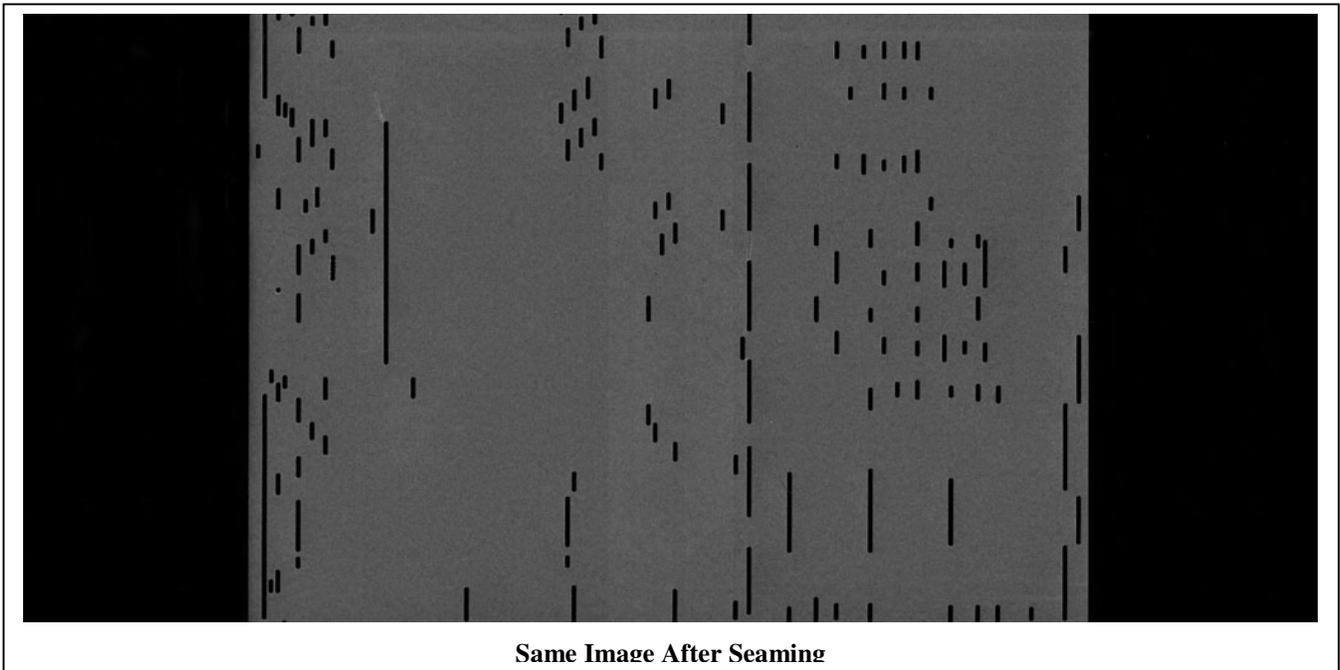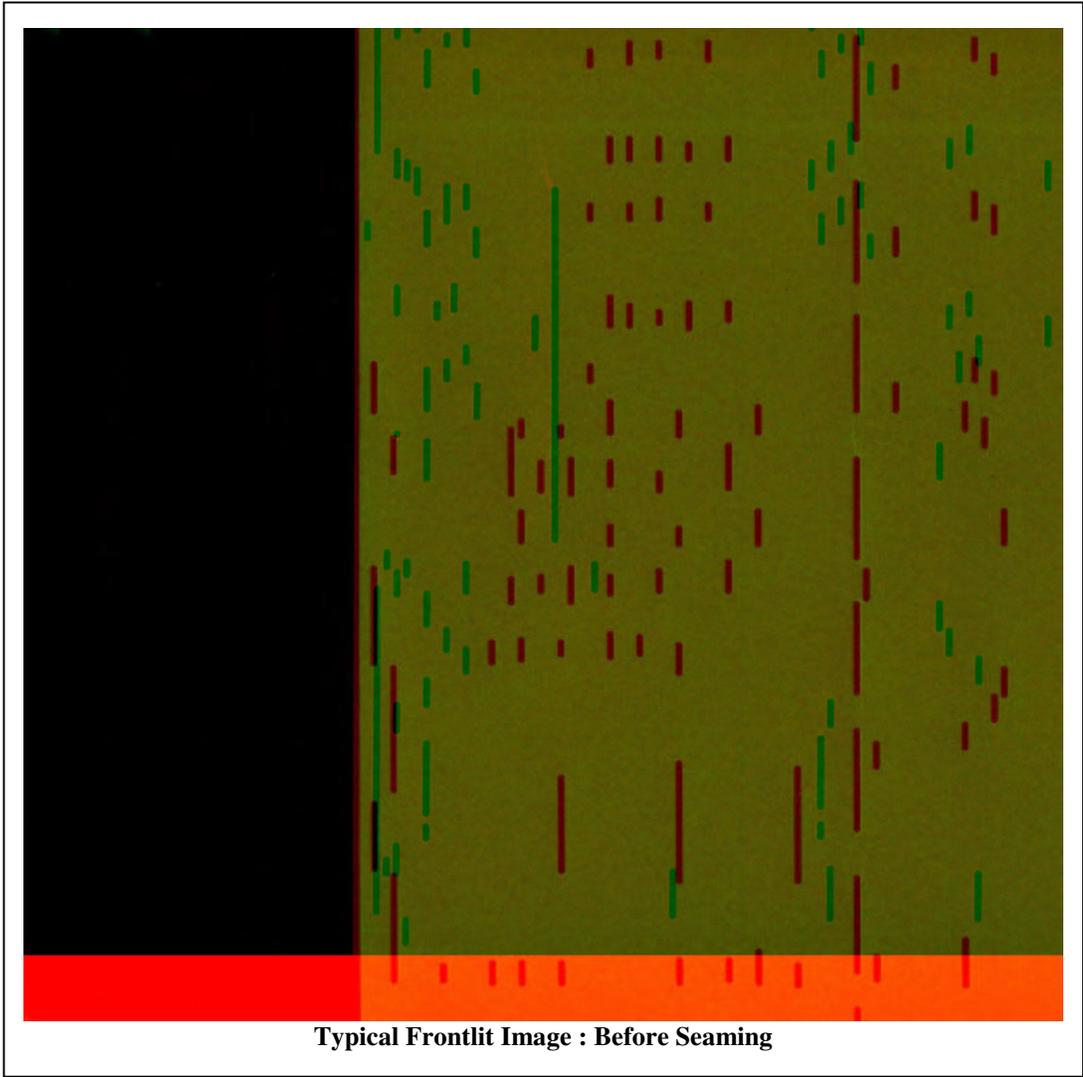
Spool Holder

A unique feature of the scanner is the way it accommodates spools of different types. The supply spoolbox is equipped with a pair of movable spindles mounted on a crank-operated twin-leadscrew mechanism. As the crank is turned one way or the other, the spindles move towards one another or away from one another, always remaining centered on the scanner's centerline.

The spindles are threaded with a 3/8-16 NC thread. Spool chuck adapters for various spool types are simply screwed onto the spindles, and can be quickly and easily changed to accommodate virtually any spool type.

This same twin-leadscrew mechanism is used to load and unload rolls. To unload, the spindles are moved apart and the roll is removed. To load, the roll is seated on one of the spool chucks and the spindles are moved together until the other spool chuck engages the roll.

Photo of supply spoolbox showing crank, leadscrew, and one spindle w/o spool chuck

Performance

The scanner's basic performace parameters are as follows:

Scanning Speed: Approximately 1.6 in/sec for 22" wide swath (~Tempo 80)

Horizontal Resolution: 300 dpi optical. Hardware scanning resolutions of 50, 100, 150 and 200dpi
                                   user selectable.

Vertical Resolution: Adjustable. 300 dpi optical. Nominal step resolution is 209 dpi, but
                                   hardware supports adjustment of scanning resolution in 1 dpi increments
                                   from less than 10 dpi to over 1000 dpi

Maximum Roll Length: Unlimited. Limited only by available disk space.

Typical Roll File Size:
    Raw Data: Approx. 3Mbytes/linear foot in 1-bit mode for a full 22"
                                   wide scan
    Compressed: About 20Kbytes/linear foot typical (data dependent)

Typical FullScan of a Violano Roll: (14.25" wide, 200 feet long)
    Raw Data: Approx. 450Mbytes
    Compressed Data: About 10 Mbytes