CHAPTER 24

Video Music/Music Video: Translating Video Signals into Sound, Hacking Cheap Camera Circuits, and Extracting Sounds From Remote Controls

You will need:

- A video camera or camcorder (it will not be destroyed).
- A video monitor.
- A cheap, hackable CCD video camera circuit board.
- Some phototransistors.
- Some photoresistors.
- A 74C14 Hex Schmitt Trigger.
- A CD3093 Quad NAND Gate.
- An infrared remote control from a TV or other appliance.
- An audio amplifier.
- Some raw speakers of various sizes.
- Some small mirrors, a laser pointer or flashlight.
- A piezo disk.

Various ingenious software tools exist for translating pictorial data into sound and vice versa: Soundhack's "Open Any . . ." turns any computer file into a sound file (i.e. a Photoshop-to-hit-record converter), STEIM's "Big Eye," and Max's "Jitter" track moving objects in a video image and extract MIDI or audio information. But here are a few simple hardware approaches to the same task that bypass the computer.

LIGHT AND SHADOW

Several artists have translated images directly to sound by placing photoresistors on video monitors or projection screens (see Art & Music 10 "Visual Music"). Wire up a few photoresistor-controlled oscillators (see Chapter 18), using long sections of stranded wire to connect the photoresistors to the circuit board. Place the sensitive side of a photoresistor

ART & MUSIC 10

VISUAL MUSIC

Electronics have pervaded and altered our visual world as profoundly as our sonic one and, furthermore, allowed us to link the two in peculiar, causal ways. In his 1965 work “Magnet TV,” Nam June Paik sat a large magnet on top of a television set to distort its image; although technically rather crude, this piece presaged the considerably more “sophisticated” electronic image processing that would come to typify much subsequent video art. “Magnet TV” established a hacker precedent that would remain a consistent presence in Paik’s work, as well as in that of many multimedia artists who followed him.

Before lightning-fast personal computers with massive amounts of memory made digital video processing as commonplace as word processing, Paik-like hacks were the only affordable way to manipulate visual images in real time, or to create linkages between video and audio. Video feedback was as popular a tool for early video artists as audio feedback was for electronic music composers: Bill Viola (USA) made extensive use of it in the 1970s; more recently Billy Roisz (Austria) has VJ-ed with video feedback, modifying it through video mixers and keyers, and splitting the video signal to feed the PA as well, so that the bursts and jitter of the images are heard in parallel as glitches and hums (see Figure 24.1).

“Cloud Music” was a video/music installation developed by David Behrman, Bob Diamond, and Robert Watts between 1974 and 1979. In the earliest version, a camera

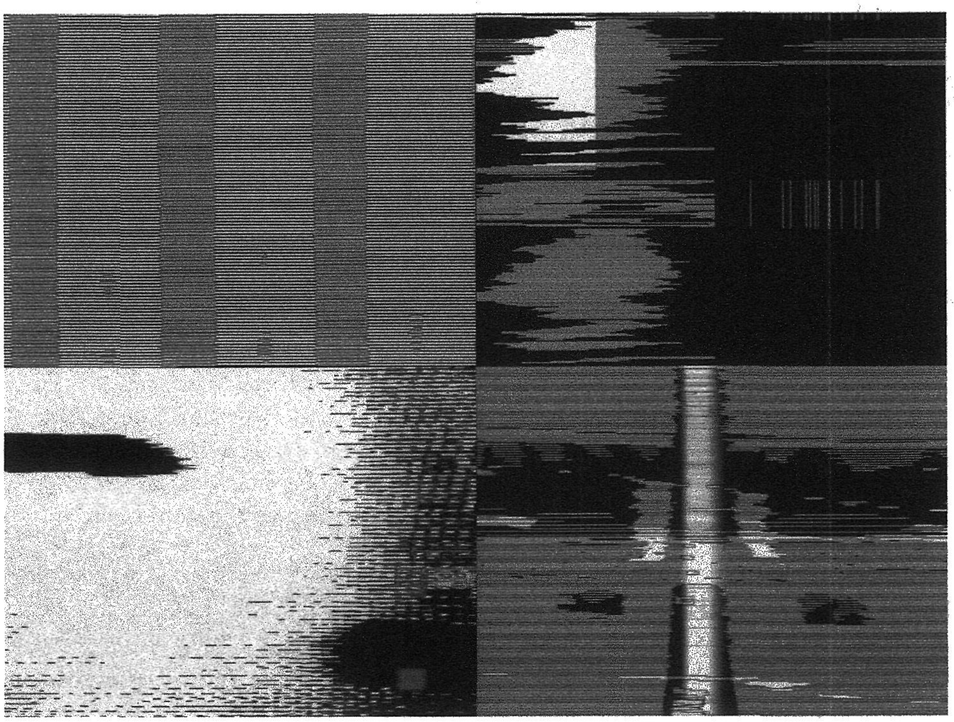
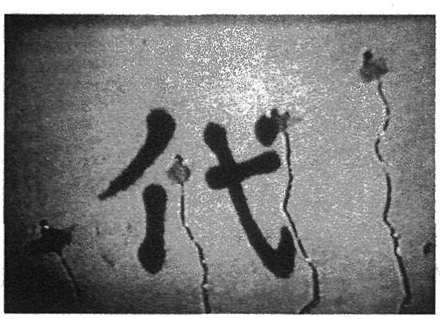


Figure 24.1 Four stills from video feedback performance by Billy Roisz.

was pointed at the sky and connected to a video monitor. A number of photoresistors were affixed to the screen and connected to circuits. The light values of the passing clouds changed the resistance of the photoresistors, and, in turn, affected the sound score. Yasunao Tone (JP/USA) used a similar approach in his "Molecular Music" (1982–85): photoresistors were taped to the surface of a screen onto which a film was projected; each photoresistor controlled the pitch of an oscillator (similar to those described in Chapter 18), and the resulting sound mass responded directly to changes in the projected images (see Figure 24.2). Today Tone is best known as the "grandfather of glitch": he began "wounding CDs" in 1985 by applying Scotch Tape, punctured by pinholes, to the underside of the disks; the resulting frenetic digital error-fest was the first documented music made with intentionally damaged CDs (see audio track 20). The intertwining of light and sound are central to Tone's work: the deflection of lasers through pinholes is a miniaturized, but nonetheless logical, extension of film interrupting the projector's light before it strikes the photoresistors. Similar experiments in controlling circuits through photoresistors reacting to projected light have been done more recently by Jeffrey Byron and Jay Trautman, Joe Grimm, and Kyle Evans (see their videos on the DVD).

In 1969, long before planetarium laser shows, Lowell Cross (USA), a frequent collaborator of John Cage and David Tudor, created the first sound-modulated laser projections for his work "VIDEO/ LASER II": the laser (enormous at the time—see Figure 24.3) was reflected off mirrors mounted on transducers called galvanometers, which vibrated in response to sound input to create curving Lissajous patterns on the wall. (Lowell Cross also built a photoresistor-based matrix mixer embedded in a chessboard for the famous 1968 John Cage/Marcel Duchamp chess-playing performance, "Reunion".)

In 1999, when Stephen Vitiello had an artist's studio on the ninety-first floor of the World Trade Center in New York City, he and Bob Bielecki (see Art & Music 11 "The Luthiers," Chapter 28) hooked up a photoresistor to a battery (as shown in Figure 24.12), placed it on the eyepiece of a telescope, aimed it down at New Jersey, and sat together listening to the flashing lights on a police car across the Hudson. Vitiello has made a series of recordings using this "audio-telescope" (see audio track 18). Norbert Möslang and Andy Guhl of Voice Crack (see Art & Music 8 "Composing Inside Electronics," Chapter 14), have used similar circuits to extract surprisingly rich rhythmic



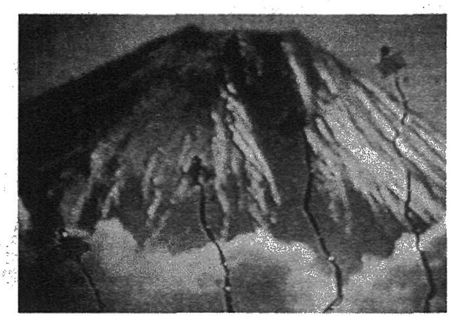


Figure 24.2 Two stills from "Molecular Music," Yasunao Tone.

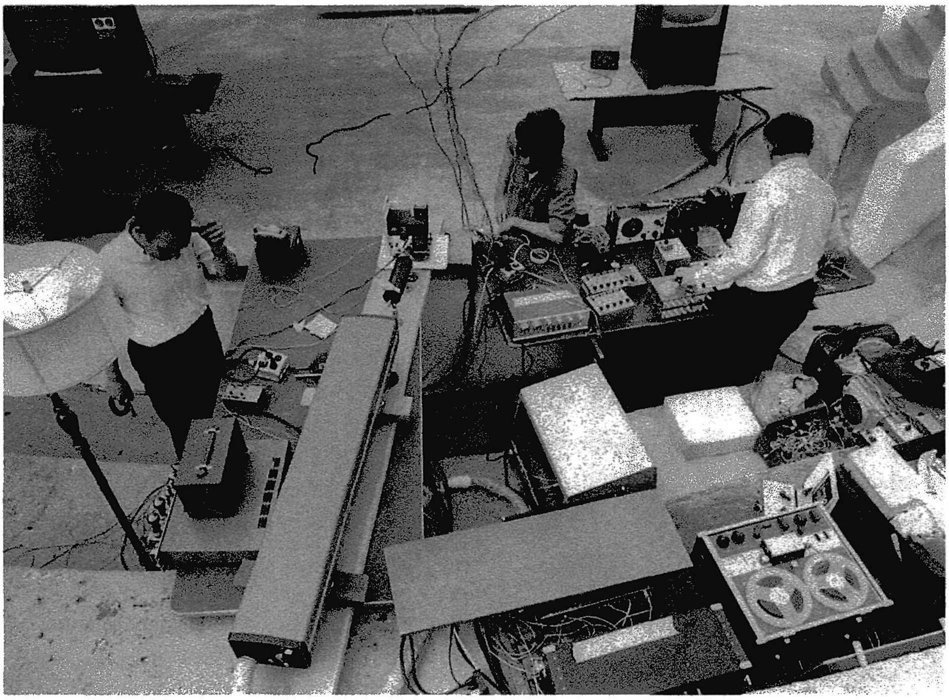


Figure 24.3a Lowell Cross (left), Eugene Turitz (center), and David Tudor (right) setting up for the first laser light show to use *x-y* scanning, Mills College, Oakland, California, May 9, 1969.

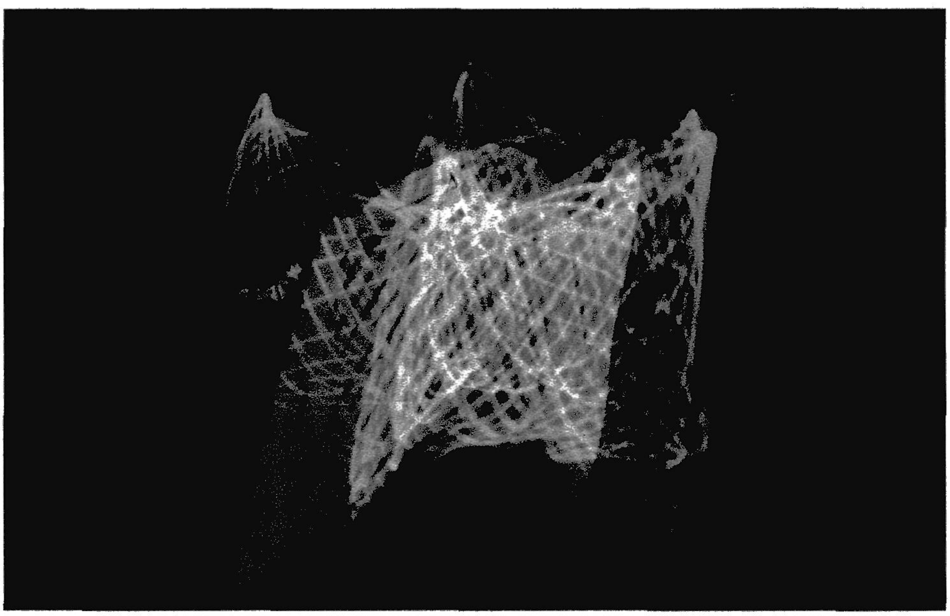


Figure 24.3b Laser projected image from "VIDEO/LASER II" (December 1969), Lowell Cross.

and harmonic textures from the light patterns of bicycle flashers and LEDs on toys (see audio track 19 and Andy Guhl's video on the DVD).

Computers finally caught up with video, but visual hacking hasn't stopped. The disparity between the $100 portable LCD TV and the $5,000 video projector offended the sensibility of the Dutch electronic performance trio BMBCon (Justin Bennett, Wikke't Hooft, and Roelf Toxopeus), so in the mid-1990s they took the screens from damaged stadium TVs (which have the same dimensions as 35 mm slides) and dropped them into old slide projectors from the flea market—voilá: the home-made, low-budget video projector (see Figure 24.4 and their video on the DVD). In my installation "Daguerreotypes" (2006) high intensity LEDs shine through LCDs from toys and games, projecting a sort of miniature *wayang* shadow play onto the walls of a gallery (Figure 24.5).

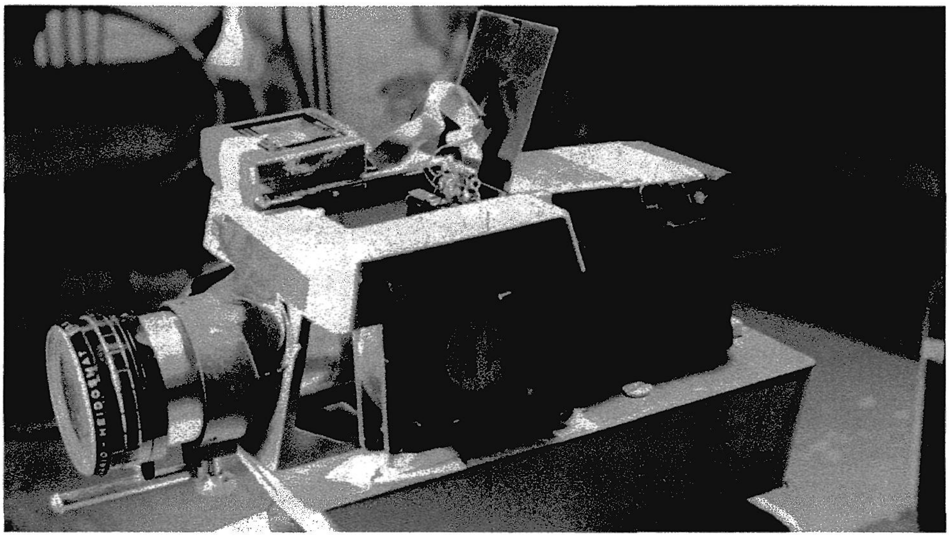


Figure 24.4 Homemade LCD projector, BMBCon.

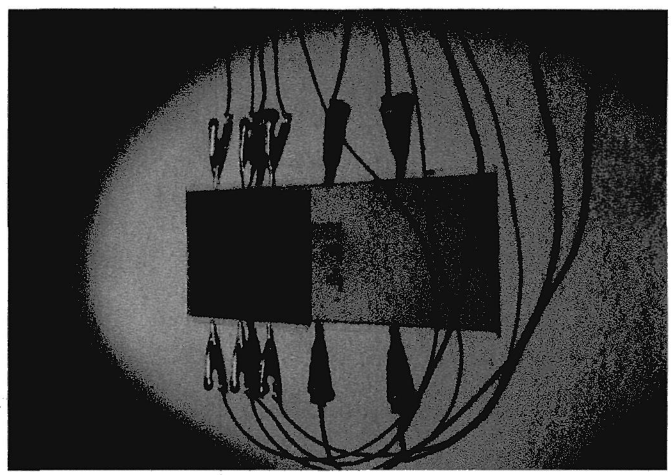


Figure 24.5 Detail from "Daguerreotypes" installation with LCD screens and LEDs, Nicolas Collins.

Jon Satrom (USA) has built his VJ career on transforming a child's "video paint box" into an instrument he calls the "Vitch" (see Figure 24.6 and his video on the DVD). By inserting circuit bending-style jumpers between various points on the circuit board, Satrom is able to disrupt the toy's functions to produce a remarkable range of fragmented, frozen, superimposed, and digitally warped images (essentially a video equivalent of the keyboard malfunctions described by Phil Archer in Art & Music 9, "Circuit Bending," Chapter 15). Similar video circuits have been bent by Jordan Bartee (USA), J. D. Kramer (USA), Phil Stearns (USA), and the trio of Abbot, Archer, and Tombs (UK)—see their videos on the DVD. Tali Hinkis and Kyle Lapidus of the video hacking duo LoVid (USA) have created wonderful homemade video synthesizers, occasionally built into soft sculpture and wearables. Their "Kiss Blink Sync Vessel" is a collection of modules, embedded in tabletops, that can be patched together to synthesize both video and sound (see Figure 24.7 and their video on the DVD).

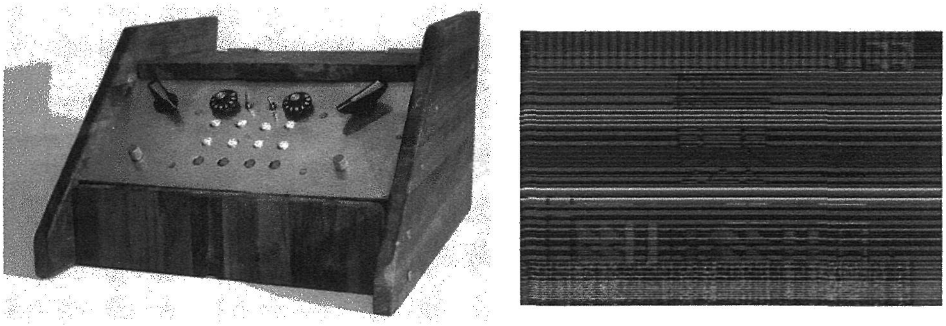


Figure 24.6 The "Vitch," Jon Satrom (left). Video image from performance with the "Vitch," Jon Satrom (right).

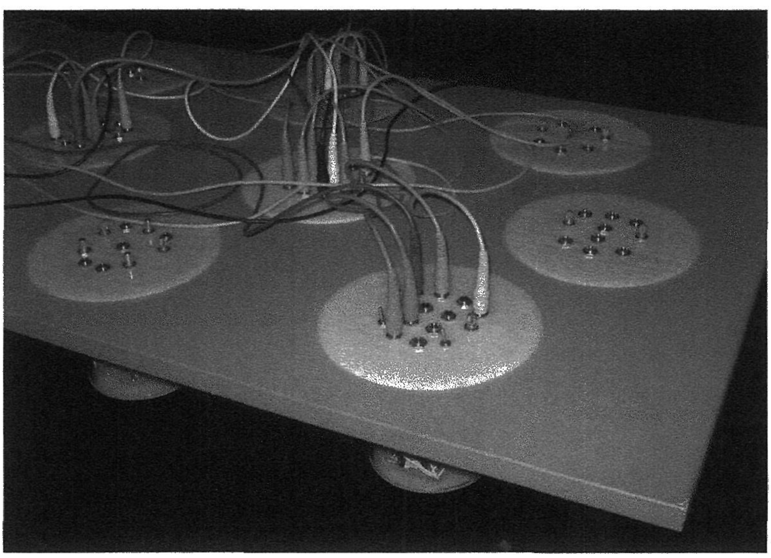


Figure 24.7 "Kiss Blink Sync Vessel" by LoVid.

And in a pseudo-Victorian twist that would make John Bowers proud, Dutch artists Arthur Elsenaar and Remko Scha attach electrodes to Elsenaar's face and electrically stimulate the muscles of expression to provide an "emotional display" for their computer (see Figure 24.8 and their video on the DVD).

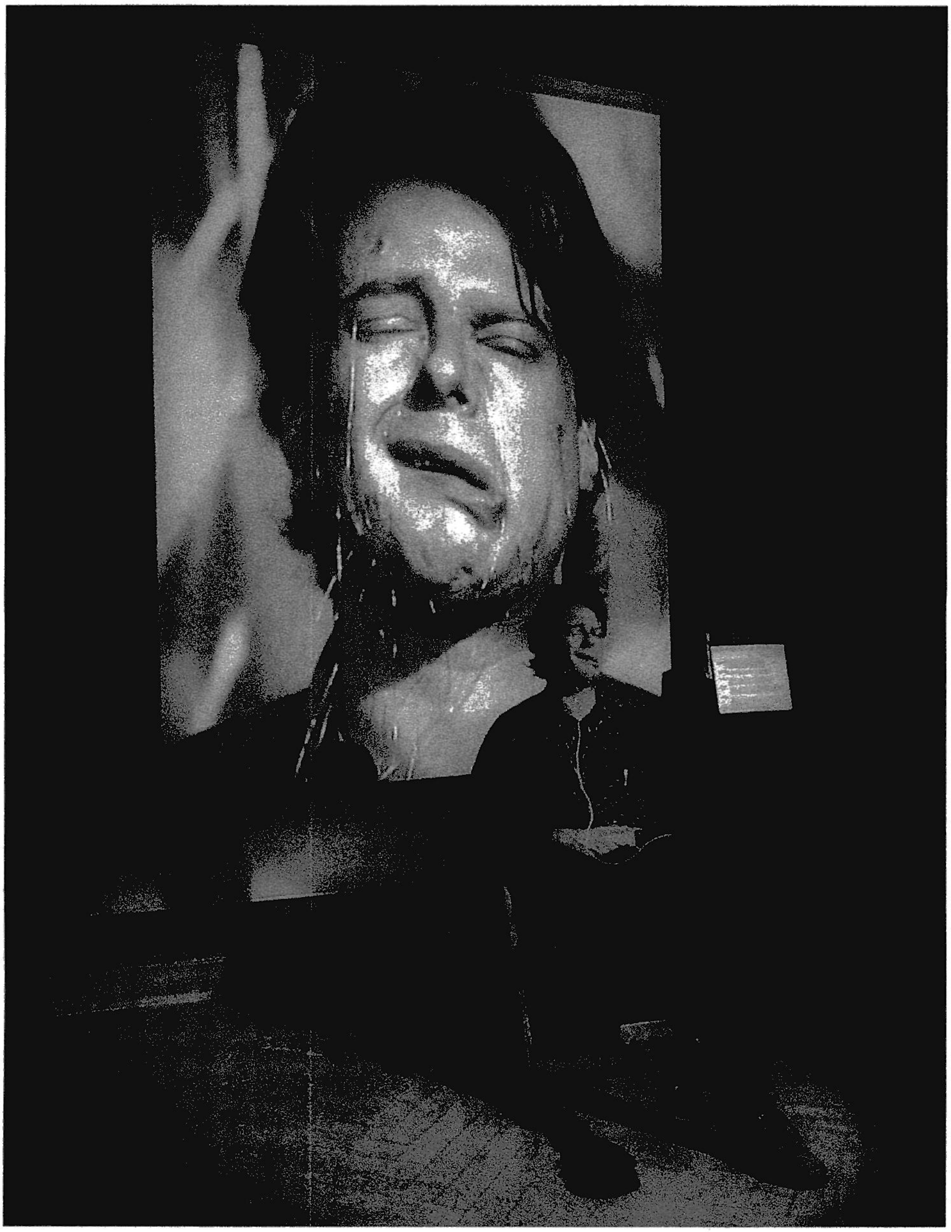


Figure 24.8 Portrait of Arthur Elsenaar's face displaying an artificial facial expression.

against the screen of a video monitor and use a thin strip of opaque electrical tape across the back to hold it in place; repeat for each photoresistor, distributing them across the screen. Connect a camera or other video source to the monitor and listen as you sweep the camera across the room or play back a tape. Action! Instant soundtrack! You can do this on a projection screen as well—the effect is stronger with film projection than video because of the increased contrast between light and dark. LCD screens on laptops work but similarly have less contrast than ordinary TVs.

You can also use the photoresistors to adjust the *loudness* of any audio signal (CD, computer, microphone, etc.) in response to fluctuations in the image, by adapting the gating and panning circuits from Chapter 21 to work with photoresistors affixed to a monitor or projection screen. You can adapt the Theremin circuit in Chapter 20 (Figure 20.9) for video response as well—using the image to control both pitch and volume of multiple oscillators gives the resultant texture considerably more variety.

FRAME RATE MUSIC

We can also listen directly to a video signal itself. Use a Y-cord to split the analog video output of a camera. Connect one leg of the Y to a video monitor and the other to an amplifier and speaker—that's right: the *video* output to the *audio* input. As luck would have it, a camera puts out a video signal that is approximately the same amplitude as a line-level signal from a CD, etc. Pan the camera around the room as you listen. You should hear a steady drone whose overtones fluctuate in response to the image content and brightness. The fundamental pitch is a function of the video frame rate (between B♭ and B♮ with NTSC video, between G and G♯ with PAL), and therefore unwavering if the camera is functioning normally, while the overtone balance directly represents the image data, line by line. Very nice, if you like drones.

Aim the camera through a rotating fan; vary the fan speed and you should hear interference patterns between the frame rate and the fan speed. Focus on a white card off-center on a black turntable mat, and switch between 33 and 45rpm. Aim the camera at the monitor and look and listen as you experiment with video feedback. A video mixer, keyer, or special effects box introduces audible artifacts as well as visible ones. With a Y-chord splitter you can see and hear the effects—this is a technique used by several experimental VJs and video artists, including Jon Satrom, Billy Roisz, and LoVid (see Art & Music 10 "Visual Music"). Aim an infrared remote at the camera (most video cameras detect infrared light and display it as hot white) and listen to the burst pattern of the encoded data (see Channel Surfing Music below).

You can similarly listen to the video output of your DVD player—fanning it will have no effect, but it's an easy way to generate an automatic soundtrack.

The frame rate is fixed, and normally doesn't budge unless you move between NTSC and PAL. But if you invest in a cheap black and white CCD camera circuit board (scrounged from a surveillance camera, or available from most electronic surplus outlets for a modest price), you can experiment with tickling the clock frequency by a laying of hands (as we did in Chapters 11 and 12) or replace the clock crystal with a variable oscillator (as discussed in Chapter 20). The crystal is usually pretty conspicuous on the circuit board—often a metallic-silver small cylinder or block (see Figure 24.9).

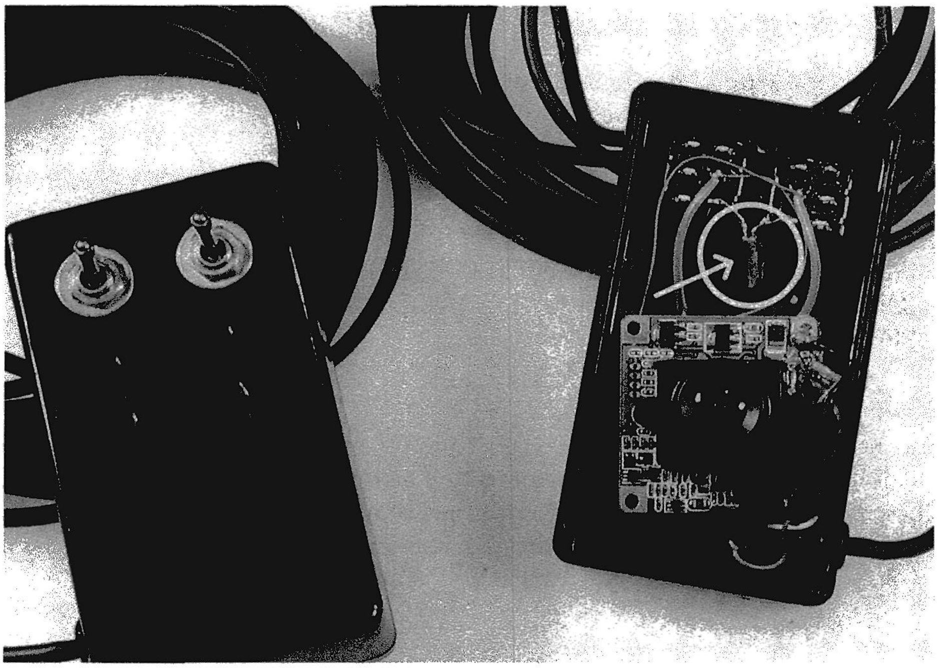


Figure 24.9 Camera board with switch for disconnecting crystal (circled, right) and electrodes for tickling clock frequency (left, visible below switches).

Split the camera output between a video monitor and amplifier using a Y-cord as before, so you can see as well as hear the effect of your hack. The video image produced by a tickled camera is reminiscent of 1960s "scratch animation" films, and the sound is somewhat meatier than the typical hands-upon-radio swoops. Sometimes lifting one leg of the camera's crystal time base makes it just unstable enough to produce a coherent image when left alone, but jitter like crazy when touched (I have no idea how this can possibly work, but it does). If you replace the crystal with your own adjustable clock circuit you can transform the video camera into an oscillator whose pitch is controlled by a pot, photoresistor, sequencer-driven 4046 VCO, etc., but whose timbre is a function of what it sees. To the best of my knowledge no one has built a synthesizer with such a hacked camera as its basic oscillator module, so jump on this one.

The hacked camera will not generate a stable sync signal when tickled. Most video monitors will continue to display scratchy video in the absence of a stable sync, but most video projectors are too "smart": they will interpret intermittent or erratic sync as an indication that there is no video signal at all, and will display that irritating blue screen with the legend "no video input." A circuit that provides a proper sync under scratch video is beyond the scope of this book, sorry. Use an old TV instead: focus a video camera at the screen and send *that* signal to the projector. Or invest in a cheap video mixer, keyer, or other device that generates its own sync or lets you patch in a second, "normal" camera for a sync signal.

As long as we are on the subject of old TVs, I would be remiss if I did not remind you, the reader, of the beautifully liquid image distortion that results from putting a hefty magnet in close proximity to a television picture tube (ineffective on modern LCD screens). Take an old TV. Tune it to any station or even inter-station static. Move a big magnet over the top and sides, and watch the image wiggle—a gift from Nam June Paik (see Art & Music 10 "Visual Music").

I must warn you once again of the electrocution hazards posed by all of the above projects. The fingers-on-circuit activities have the usual risk:

> **EXERCISE EXTREME CAUTION WHEN CONNECTING THE CARESSED CAMERA BOARD TO ANY AC-POWERED VIDEO MONITORS OR PROJECTORS!**

But the greatest danger with the magnet-on-TV experiment is that the circuitry inside old-fashioned TVs and video monitors (the kind that use "picture tubes" instead of LCD screens) actually steps *up* the wall voltage from a deadly-enough 120/240 volts to several thousand volts (kilovolts, as they are known—although we might dub them "killervolts"). Please, no matter how much you want to get the magnet closer to the tube:

> **DO NOT OPEN UP THE TV!**

(Or you're in for a nasty shock.)

VIDEO-FREE VIDEO

Visual display of sound patterns can be accomplished without video cameras and monitors, of course. As we mentioned at the end of Chapter 5, you can take a large raw loudspeaker, fill it with sand or talcum powder, connect to an amplifier, play some sound, and watch the dancing dust. Coat the inside of the cone with paint or rubber cement, fill it with water or oil, and repeat the experiment; you can reflect a focused light or laser pointer off the water's surface onto the wall or ceiling (see Figure 24.10). This works best with low frequency sound. A mirror glued to the center of the cone also reflects a laser nicely. Planetarium laser-shows use electromagnetic transducers called "galvanometers" to deflect mirrors on several axes—sometimes these gizmos turn up on surplus sites, but the old speaker-and-mirror technique works pretty well.

CHANNEL SURFING MUSIC

In Chapter 3 we used coils to pick up the electromagnetic signals given off by various appliances and electronic devices. We can also eavesdrop on light signals of various kinds by using a specialized type of light sensor: the *phototransistor.* A phototransistor is the heart of any infrared remote control receiver circuit, such as that in your TV. It looks

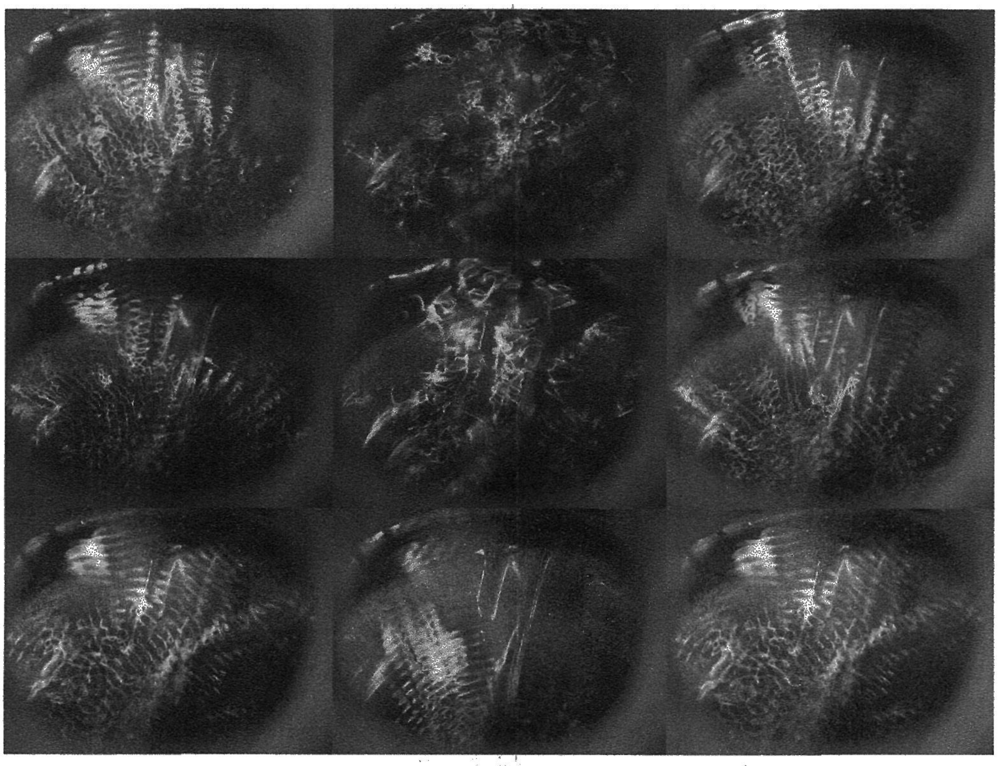
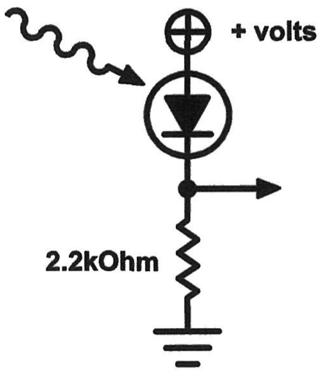


Figure 24.10 Water-filled speaker, showing ripples produced by low-frequency sound.

just like an LED, so make sure you keep them clearly separated in your parts collection. You can find them quite easily, even at Radio Shack. Phototransistors detect the pulses of infrared light sent by your remote control and convert them into a stream of binary pulse waves that are, in turn, translated back into digital data by the microprocessor in the TV. Earlier in this chapter we detected these data burst using a video camera, but phototransistors are cheaper (and smaller).

Aim a remote control at the simple circuit in Figure 24.11. Keep it close, and you should hear pulse trains as you press the buttons. If not, reverse which leg of the phototransistor connects to +9 volts and which connects to the load resistor. Normally the phototransistor is "off" and the 2.2 kOhm resistor holds the output to ground (0 volts). When infrared light strikes the phototransistor it turns on and effectively connects the output to +9 volts. So bursts of light from the remote cause the output to switch between 0 and 9 volts, just like our old friend the CMOS oscillator, only here the waveform is not a simple square but instead a cycling sequence of pulse waves of various duty cycles, which has rather a different timbre.

The variation between one button and another may sound pretty subtle: although the encoded numbers are different, the base frequency remains the same—the effect is similar to listening to video, where the constancy of the fundamental sometimes overpowers the variations in image-dependent overtone content. Try several different remotes. You'll notice that the loudness of the signal falls off pretty sharply as you pull



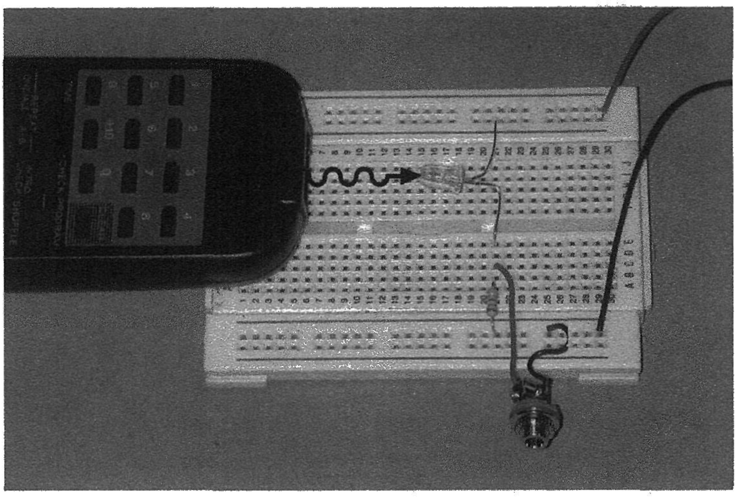
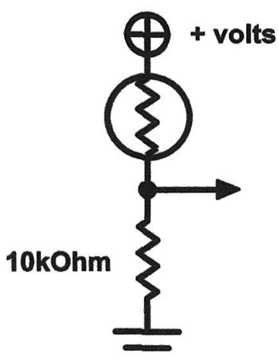


Figure 24.11
Simple infrared detector circuit.

the remote farther from the circuit, so you do have some dynamic control over this instrument.

You can substitute an ordinary photoresistor for the phototransistor. You may need to increase the size of the load resistor from 2.2 kOhm to 10 kOhm or larger, as shown in Figure 24.12. Because photoresistors are sensitive to light across the spectrum (not just infrared), you will get much more interference from the power grid's AC frequency present in incandescent and fluorescent lighting (60 hz in the United States, 50 hz in Europe), resulting in an underlying drone. But you may find this interesting rather than irritating, so try it.

Although the indicator lights on many electronic devices look steady, most are in fact "scanned" by the central processor unit. You can use our light-detector circuits to extract unexpected sound patterns from almost any gizmo with LEDs. Try it on bicycle flashers (see audio track 19), toys with blinking lights, the front panels of studio gear, TV screens, computer monitors. Certain bicycle lights and blinking toys sound astonishingly much like heavy metal chord progressions.



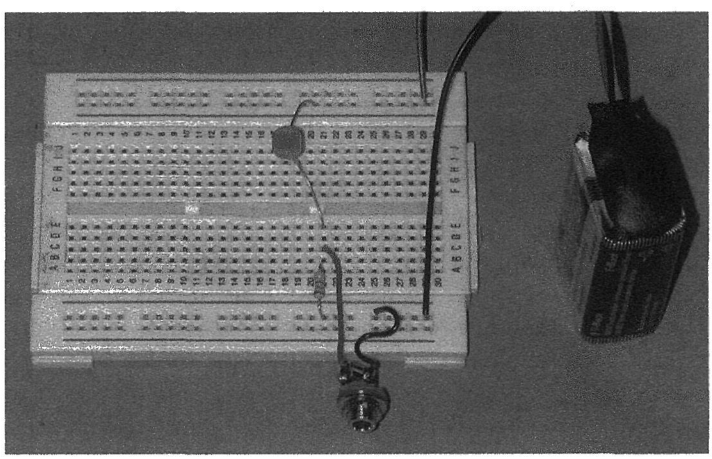


Figure 24.12
Simple photoresistor light-to-sound converter.

For greater variation try using the phototransistor or photoresistor circuit above as the control input to the basic 4093 gateable oscillator circuit from Chapter 20. If you also use a photoresistor for the oscillator's frequency control, you get a pretty expressive "multi-phase" light-to-sound converter that responds to both ambient and modulated light sources (such as remote controls) (see Figures 24.13 and 24.14). Add a Theremin-style control of output volume (see Figure 20.9 in Chapter 20) for additional expression.

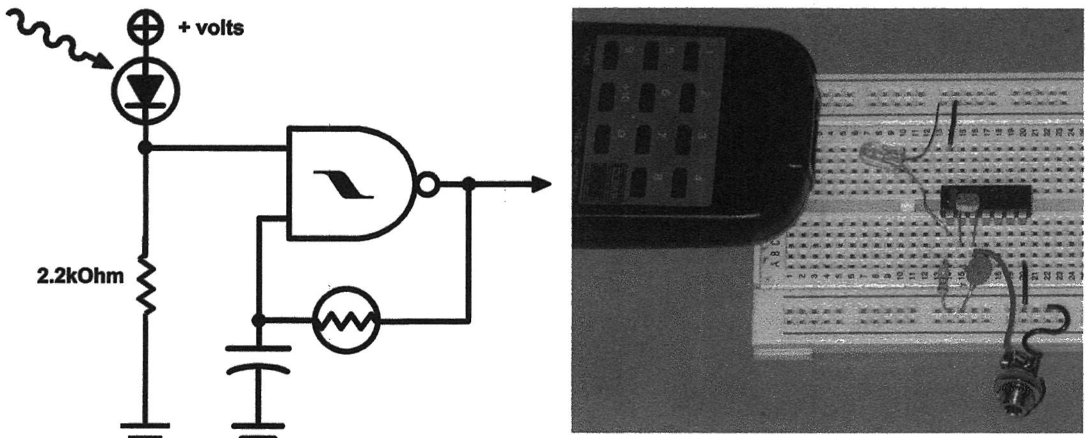


Figure 24.13 Infrared-gated oscillator with photoresistor-controlled frequency.

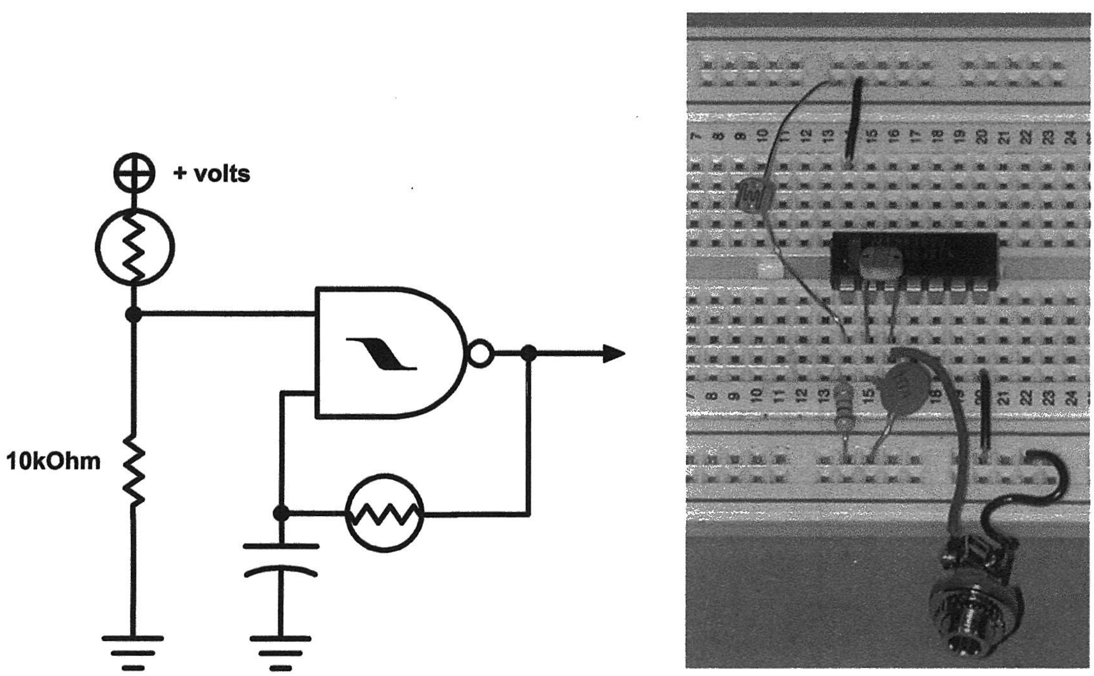


Figure 24.14 Photoresistor-gated oscillator with photoresistor-controlled frequency.

For a battery-free alternative you can connect a dozen or so phototransistor in series and hook either end of the chain up to the leads on a piezo disk (see Figure 24.15). Aim an infrared remote at your circuit and you should hear a quiet, tinny refrain of the familiar pulse train. As we suggested at the end of Chapter 20, clamping the disk to a resonator of some sort (matchbox, pie tin, etc.) will increase its loudness. Engineers at the Information Technology Research Institute at the National Institute of Advanced Industrial Science and Technology (Japan) used a similar passive design for an installation by Laurie Anderson in a Japanese Garden at Expo 2005 in Aichi, Japan. Visitors participating in "Walk" could listen to poems in four languages, transmitted with infrared light, and picked up by handheld "Aimulets" (see Figure 24.16).

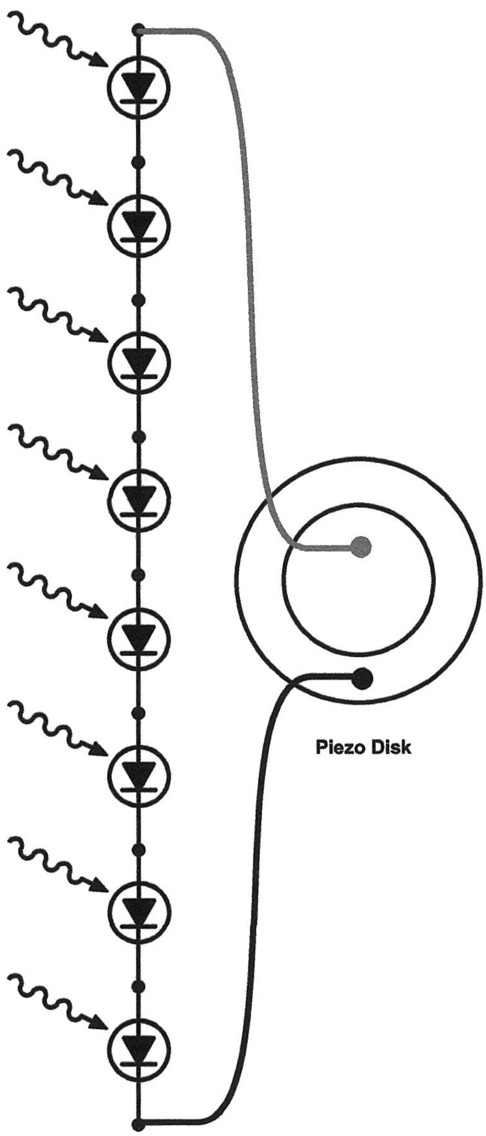


Figure 24.15
Phototransistor ladder driving a piezo disk directly.

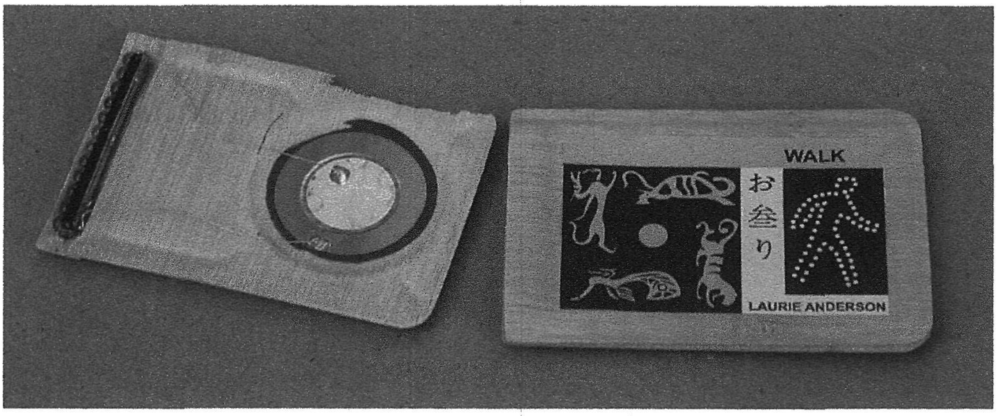


Figure 24.16 "Walk" by Laurie Anderson: photodiodes driving piezo directly, with molded bamboo resonator; designed by the Information Technology Research Institute at the National Institute of Advanced Industrial Science and Technology, Japan.

BAR CODE

Infrared transmitters and detectors are combined in the bar code readers used in our UPC dominated world—from handheld wands to the deliriously diffracted laser beams at supermarket checkout, all work by bouncing light off packaging and detecting the difference between the light and dark stripes. Handheld "wands", and their core elements, can be found quite easily and cheaply from electronic surplus sites online.

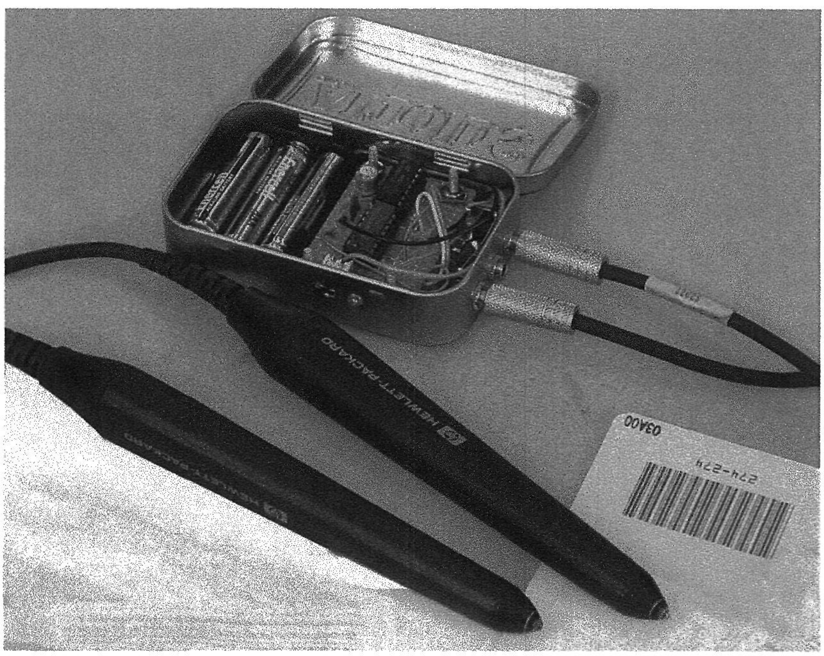


Figure 24.17 Bar code readers with power supply and planning circuit (Nicolas Collins).

Most require a 5-volt power supply (try 3 AA batteries in series). Sometime they come with wiring data, otherwise you'll have to decode it (buy a few, in case of a real flameout). Hook up power, connect the data output to an amp, pass the wand across some bar code, and you'll be rewarded with a noisy waveform similar to the tape head scratching transit cards (no surprise here, since both the magnetic tape and the UPC are encoding binary data).

Since the bar code reading mechanism detects any light/dark difference, they can be used as generic image-to-sound translators: pass them over newsprint, photographs, TV screens, Dalmations, facial stubble .... Figure 24.17 shows two wands with a homemade power supply. The batteries are all that's really needed, the extra circuitry in the box makes each wand's data stream to alternate between the left and right output channels with every pulse (for a little more variety).