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December 6th, 1998

Digital Audio Processing
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Chapter 12 "Art of Digital Audio" Abstract

The twelfth chapter in Watkinson's text is a rather lengthy look at the optical disk audio medium. The subject of the optical disk indeed warrants such a exhaustive analysis since it is the format through which most people encounter digital audio. Optical disks, such as the Compact Disc or the MiniDisc, are quite common in today's society and are probably most people's first (and often only) introduction to digital audio. The technology that goes into optical disks is quite complicated and thus contributes to the length of this chapter.

Optical disk formats can be divided into three major categories: 1) mass replication moulded disks (such as regular CDs, CDROM, or prerecorded MiniDisc); 2) write once read mostly (WORM) disks (such as the recordable CDs [CDR]); and 3) erasable optical disks on which an infinite amount of new and different recordings can be made over the same track. The first category of disks are made at a factory from a metal stamper which imprints a pattern of bumps into the aluminum disk as encoding for the binary data. These disks are then covered with a plastic substrate and information on them can not be changed. In this manner, moulded disks are similar to vinyl records.

WORM disks, on the other hand, are recorded not at a manufacturing house but by the consumer himself. These disks are sold blank to the public who in turn use specifically designed recorders to "burn" (or record) onto these disks. Once a program is recorded, however, it cannot be changed. CDRs are actually made differently than regular CDs in order to facilitate this recording capability. CDRs usually contain a thin layer of metal underneath which is a special compound material (this material gives CDRs their blue-green color). When recording, the laser heats to ten times its reading output and thus causes the compound to heat to the point of decomposition. Gassing then occurs that raises a blister in the thin metal layer above it. These blisters become the bumps similar to those normally embossed at a factory.

The third catgeory of disks, rerecordable optical disks, rely on magneto-optic principles. These disks use a special compound which becomes magnetically very coercive when heated past a specific temperature (the Curie temperature). Upon cooling, the material reverts back to its state of high coercivity and thus retains any magnetic charge which it received while heated. Digital audio uses this process to its advantage by placing a magnetic field (flowing through a coil) below the disk itself. This field contains a polarity that is opposite to the blank state of the disk. Since the disk is below its Curie tempature, though, none of its particles are affected by this applied field. As a laser passes over the disk, however, and heats up parts of the disk, these areas come under the influence of the coil beneath them and switch magnetic direction. To erase, the laser needs only to continuously pass along the medium while the direction of the coil's field is reversed. A corollary to this type of recording always uses a continuously operating laser but constantly changes the field of the coil to encode the digital information. Obviously for reading such disks, the power of the laser is reduced so that the medium does not lose its charge. The method of readout is based on the rotation of a light beam's plane of polarization when it passes through a magnetic field (the Kerr effect). A suitable pickup can detect the change of rotation of polarized light through the disk and thus retrieve the recorded digital audio data.

One of the main benefits of compact discs (both prerecorded and recordable) is its low susceptibility to environmental hazards such as dirt, hair, grease, dust, or scratches. The relatively thick plastic coating over the metal information layer keeps these dangers out of contact with the data. The plastic layer also serves to refract the reading laser beam and increase its incident angle on the disc. This process is necessary since the size of each bump on the discs is much smaller than a speck of dust. Without this refraction, a small dust particle would obscure a large amount of data and procedure a probably uncorrectable burst error. Since the incoming laser beam, though, is basically focused by the refractive qualities of the plastic, the laser can be transmitted with a relatively large wavelength that allows it to be unaffected by most common surface contaniments.