Implementing a floppy image "jukebox" on the H67 IDE+

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Overview

With the advent of the H67 IDE+ (http://koyado.com/Heathkit/Z67-IDE-plus.html) there is now a relatively massive amount of storage (one or more gigabytes) available via the H67 software interface on the Heathkit H8/H89 computers. The Heath Disk Operating System (HDOS) is capable of directly accessing only a relatively small portion (15 megabytes) of this storage; the remainder is otherwise essentially wasted space in a standard HDOS environment.

This write-up describes a method for storing sector-by-sector images of floppy disks in this otherwise unused storage space, and then accessing these images via a specially-designed HDOS device driver. To the user these appear simply a floppy disk drive.

This idea offers several advantages over relying on older floppy drives:

- Most 5¼" floppy drive units are 30 or more years old and can be unreliable and hard to maintain and repair.
- The hard-sectored media used on the Heathkit H17 drives are no longer in production and new old-stock media is expensive. Recycled (used) media is often unreliable.
- The original drives are very slow in comparison to the H67/IDE+.
- Storing physical media takes up space. Finding the disk you want and manually mounting/unmounting each time is tedious.
- Since floppy drives and media are unreliable users must maintain duplicate copies of critical files and disks, further compounding the problem.

Analysis

The original Heath software allowed HDOS to access up to 10 megabytes of storage. This software has since been modified to allow HDOS to access up to 15 megabytes of storage via the H67 device driver:

Parameter	***Value***
Sector Size	256 bytes
Sectors per track	40
Tracks per cylinder	6
Sectors per cylinder	240
Cylinders per volume	244
Total addressable sectors	58,560
Total addressable storage	14,991,360 bytes

The disk controller itself is capable of addressing *more* space than this however. It has a 21 bit address space, hence the number of addressable sectors is: $2^{21} = 2{,}097{,}152$ or 538,870,912 bytes (half a gigabyte). The HDOS driver is restricted to 15 megabytes because it uses only 2-byte addressing for the sectors. Presumably the original designers chose this approach since it is more efficient to implement in assembly language. In addition, thirty years ago 15 megabytes was considered a very large number – more than adequate for any conceived use of the day.

The Z67-IDE+ is a modern design which uses compact flash (CF) memory cards for storage and is electrically compatible with the original Z67 disk drive unit. It is typically used with CF cards with a capacity of 1 or more gigabytes of storage. Since that is more than the ½ gig of addressable space much of this space would be non-addressable and essentially wasted.

There are two ways to tap into this additional space. One is through the use of switch-selectable subsets. Through the use of thumb-wheel selector switches attached to the Z67-IDE+ you can map the I/O requests into different addressable subsets. Each addressable unit is $2^{27} = 134{,}217{,}728$ bytes (128 megabytes) in size. Using this feature you can divide the CF space into many different system configurations.

Another way to tap into extra space is a special access mode designed specifically to support the jukebox functionality. Each I/O operation to the IDE+ is initiated through a six-byte long command block, which includes a Control byte that can be used to issue special requests. Beginning with release 1.4N of the Z67-IDE+ firmware there is an ability to reserve ½ gig of space exclusive of the normal I/O functions of the device. This reserved area is accessed by specifying 0x18 (decimal 24) as the value of the Control byte in an I/O operation (standard I/O requests used by the Z67 device driver use a Control byte of 0x00).

Design

There are two elements to the design of the jukebox: a device driver to perform the I/O function and a librarian program to maintain a library of disks and easily find and mount desired media images. The images are sector-for-sector copies of the originals stored in H8D format.

Device Driver

The device driver can be configured to mount from 1 to 8 disk volumes at a time. The driver file is VD.DVD, hence it appears as the device VD: (for "virtual diskette"), addressable as units VD0: through VD7:.

All of the I/O to the Z67-IDE+ is done using a Control byte value of 0x18. *This means the device driver effectively has dedicated access to its own reserved ½ gigabyte space!* The device driver divides this space up into "slots." Each "slot" consists of a contiguous 512 sectors (where each sector is equal to 256 bytes). There are 4,096 "slots", numbered from 0 to 4,095. One or more "slots" are used to hold exact sector-by-sector floppy disk images. The simplest case, an H-17 H8D image, consists of 400 sectors and fits in a single "slot". Larger images (e.g. images taken from H-37 soft sectored disks) may require multiple "slots."

The starting sector number for each "slot" is easily computed (slot number * 512, which can be done as a simple 9-bit shift operation). The device driver maintains a table with the starting sector for each "slot." I/O requests are trivial to handle – the requested sector number is simply added to the starting sector for the associated "slot" and the read or write operation proceeds accordingly.

The driver maps each device to a "slot." There is a SET option to change the mapping, e.g.

```
SET VD1: SLOT 100
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Would map unit 1 to slot number 100. The slot number must be assigned *before* the unit is mounted. Slot assignments are stored within the device driver and are persistent (i.e. they will retain their settings even if the system is rebooted or powered down and restarted).

Librarian

Since the jukebox can access such a large number of stored images it is useful to have a utility to manage access.

The librarian can manage a library of up to 4,096 images.