Team EHNA

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Description of our file system

VCB Structure

```
struct VCB {
        int numBlocks;        // number of blocks in our volume
        int sizeBlocks;        // size of each block
        int bitmapLocation;  // block index location of our bitmap
        int rootLocation;      // block index location of our root directory
        long magicNumber;  // unique signature of our filesystem
};
```

Our Volume Control Block Structure is located at block 0 of our LBA. It contains all of the necessary information about our volume. This includes the number of blocks in our volume, the size of each block, the location of our free space map in the LBA, the location of our Root Directory in the LBA and the magic number for our file system.

For our volume size, we use the limit of 10MB. It contains 19531 blocks with each block being 512 bytes. Our file system's unique magic number is 0x45484E41, which is the hexadecimal representation of our team name. The location of our free space map starts at block index 1 while our root directory starts at block index 6. Therefore,

numBlocks = 19531

sizeBlocks = 512

bitmapLocation = 1

rootLocation = 6

magicNumber = 0x45484E41

Free Space Structure

We decided on a bitmap for overseeing and controlling our available free space. This map is sized according to the maximum block size for the project which is 19,531 blocks, which corresponds to 19,531 bits or 2,442 (2,441.375) bytes. We decided to use an unsigned integer array for mapping. Each unsigned integer is 4 bytes so that means we need a total array of size of 611 to map each of the bits.

Total Size Needed	19,531 blocks	19,531 bits
Size in Bytes	2,442 bytes	
Unsigned Integer Size	4 bytes	32 bits
Array Size	611 Integers	19,552 bits

Notice that there are some extra bits that aren't being used which could be problematic if those were accessible. To fix this, a maximum block count of 19,531 was added in bitmap.c that ensures that the total block count isn't being exceeded–and we aren't trying to write to space that doesn't exist.

For finding free space a combination of an iterative and recursive solution were used. First the bitMap is iterated through until a free space is found, then a recursive function is called to check if that free space is of the required length. If it is, the bit position is returned, otherwise the next free space is iterated to. (There are a multitude of ways to make finding free space more efficient, and that is something we will probably revisit later)

Directory System

```
typedef struct directoryEntry {
        char name [256];          // file name
        Extent ext[3];            // Extent table
        Int fileSize;             // file size in byte
        Int isDirectory;          // directory flag if directory = 1 file = 0
        time_t creationDate;      // meta data for date creation date tracking
        time_t modificationDate;  //modification date tracking
        time_t accessDate;        //access date tracking
}
```

Our root directory starting block is at block 6. And each directory will have a total of 8 entries. Currently the root directory contains the root directory Entry and 6 initiated empty directory entry.Those empty directory contain ext[0].blockNumber = -1 and fileSize = -1 to indicate that it is an empty directory entry. The whole root directory will take up 2432 bytes, which is about 5 blocks. Total wasted byte is 128.

Extents System

```
typedef struct Extent {
        int blockNumber;
        int count;
} Extent;
```

In order to dynamically expand the size of our files easily, we needed to implement a method to non contiguously allocate free space. To accomplish this we decided to create an extents system. Our extents system works by using an extents table in our DE struct that holds 3 entries. Each one of these entries is an extent struct seen above, containing a starting block number for a chunk of data and how many blocks that data occupies. Once these 3 entries are filled, an indirect extents table is created which holds 64 additional entries. A reference to this indirect extents table's location is then placed at Ext[2].blockNumber, and the count is set to -1 to indicate that there is only one indirect table. If this table is filled, a second table is created and its location is referenced in Ext[2].blockNumber and the count is set to -2. This second table holds a list of integers that reference the location of an extent table. If a file is very large and uses over 8,192 separate extents, then a third table is created, following the same pattern. This allows us to create files with over 1 million separate extents/block allocations, with files having a max size of 500 mb in the worst case.

Problems and Solutions

Problem #1

One of our group members, Nathan, had to drop the class last minute unexpectedly.

Solution

We immediately held a team meeting immediately after he informed us that he had to drop the course in order to plan how we would get the work done without him. With the extension and the meeting, we think the group responded well with losing a team member. We were able to allocate the work amongst the three of us in a way that we were able to get work done effectively.

Problem #2

Switching from contiguous allocation to non contiguous allocation cause lot of bugs in our program.

Solution

After having a few meetings, we decided to add an extents system to work with our bitmap to allow functions to allocate memory non-contiguously. While working on updating our pre-existing functions to work with extents, I found many bugs in our functions. We ended up spending a lot of time debugging and updating the functions.

Problem #3

Parsepath was an integral part of our file system. Most commands used it since a path was usually used in order to execute a command. This meant that any bugs in parsepath caused everything to fail, and we couldn't properly test functions without parsepath working.

Solution

We had to prioritize getting the parsepath function done and working flawlessly. Since parsepath was one of the first things called at the beginning of a function, if we were experiencing problems the first thing to check was to see if parsepath was returning the correct values. Doing this allowed us to avoid spending time looking for bugs in the wrong places.

How our driver program works

Our file system relies on the shell provided by the professor. This C - program then calls our initFileSystem() function which initializes the filesystem with the given block size and number of blocks provided inside the Makefile. First thing it does is allocate space for the volume control block, then read block 0 from our disk to get the volume control block data. It then checks if the magic number read from disk matches our filesystems magic number to determine if our volume needs to be formatted. If it does, then our volume is formatted with the help of the formatVolume() function. This function sets the number of blocks for the filesystem provided by the makefile into our volume control block as well as the size of the blocks, bitmap location, root location and our magic number. It also calls two helper functions which initialize our freespace bitmap and initialize our root directory. Once done, our changes to our VCB and newly formatted volume are written to disk. The driver then returns to the init function and reads from disk our freespace map and current working directory (root directory on initialization).

Now that our filesystem is initialized and formatted, the program returns back to the main shell, fsshell.c. This shell imitates the linux shell and can perform commands such as :

ls - Lists the file in a directory
cp - Copies a file - source [dest]
mv - Moves a file - source dest
md - Make a new directory
rm - Removes a file or directory
touch - creates a file
cat - (limited functionality) displays the contents of a file
cp2l - Copies a file from the test file system to the linux file system
cp2fs - Copies a file from the Linux file system to the test file system
cd - Changes directory
pwd - Prints the working directory
history - Prints out the history
help - Prints out help
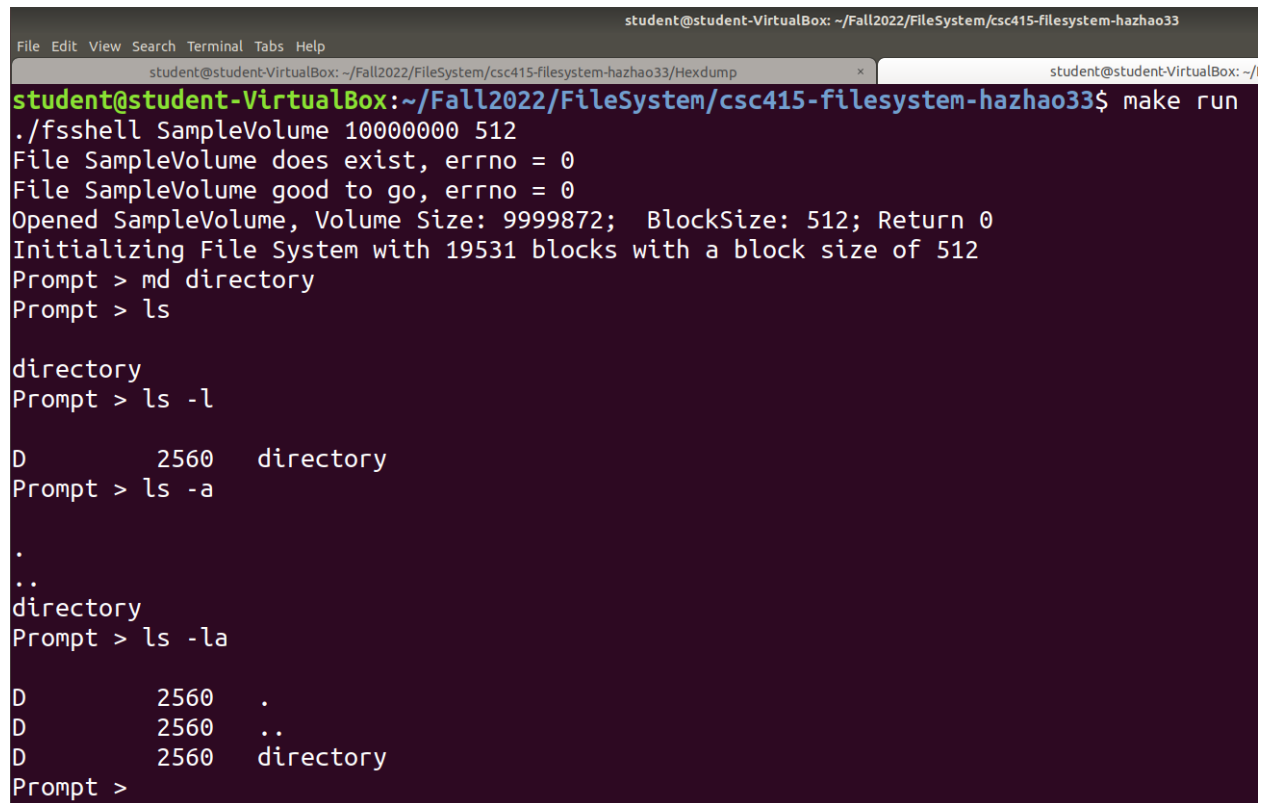
These commands are carried out with the help of directory functions that are very similar to actual Linux functions. Since this file system utilizes writing to disk, all changes will be saved for the user. For example, if the user makes a new directory called "newdir", this directory will remain when they close the file system and re-initialize it at a later date.

ExitFileSystem() is then called when the user decides to exit the filesystem. This function deallocates space for our global volume control block struct, global bitmap and

our global current working directory pointer. However, it does make sure to write the bitmap to disk in order to save all changes made to our freespace map.

Commands Screenshots

ls - Lists the file in a directory

```
000E00: 2E 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E10: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E20: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E30: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E40: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E50: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E60: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E70: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E80: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E90: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EA0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EB0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EC0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000ED0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EE0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EF0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................

000F00: 06 00 00 00 05 00 00 00   00 00 00 00 00 00 00 00 | ................
000F10: 00 00 00 00 00 00 00 00   C0 09 00 00 01 00 00 00 | ........�......
000F20: CA F7 88 63 00 00 00 00   CA F7 88 63 00 00 00 00 | ���C....���C....
000F30: CA F7 88 63 00 00 00 00   2E 2E 00 00 00 00 00 00 | ���C............
000F40: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F50: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F60: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F70: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F80: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F90: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FA0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FB0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FC0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FD0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FE0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FF0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
```

```
001000: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001010: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001020: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001030: 00 00 00 00 00 00 00 00  06 00 00 00 01 00 00 00 | ................
001040: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001050: C0 09 00 00 01 00 00 00  CA F7 88 63 00 00 00 00 | �.......���C....
001060: CA F7 88 63 00 00 00 00  CA F7 88 63 00 00 00 00 | ���C....���C....
001070: 64 69 72 65 63 74 6F 72  79 00 00 00 00 00 00 00 | directory.......
001080: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001090: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0010A0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0010B0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0010C0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0010D0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0010E0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0010F0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................

001100: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001110: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001120: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001130: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001140: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001150: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001160: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001170: 0B 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
001180: 00 00 00 00 00 00 00 00  C0 09 00 00 01 00 00 00 | ........�.......
001190: CE F7 88 63 00 00 00 00  CE F7 88 63 00 00 00 00 | ���C....���C....
0011A0: CE F7 88 63 00 00 00 00  00 00 00 00 00 00 00 00 | ���C...........
0011B0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0011C0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0011D0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0011E0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
0011F0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00 | ................
```

cp - Copies a file - source [dest]

```
File  Edit  View  Search  Terminal  Tabs  Help
        student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-hazhao33/Hexdump          ×              student@student-VirtualB
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make ru
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > cp2fs text
Prompt > cp text text2
Prompt > cat text
World Hello
Test this

Testing again
World Hello
Test this

Prompt > cat text2
World Hello
Test this

Testing again
World Hello
Test this

aPrompt > █
```

```
001000: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001010: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001020: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001030: 00 00 00 00 00 00 00 00   06 00 00 00 01 00 00 00 | ................
001040: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001050: C0 09 00 00 01 00 00 00   3D 4D 89 63 00 00 00 00 | �.......=M�c....
001060: 3D 4D 89 63 00 00 00 00   3D 4D 89 63 00 00 00 00 | =M�c....=M�c....
001070: 74 65 78 74 00 00 00 00   00 00 00 00 00 00 00 00 | text............
001080: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001090: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010A0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010B0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010C0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010D0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010E0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010F0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................

001100: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001110: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001120: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001130: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001140: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001150: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001160: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001170: 0B 00 00 00 01 00 00 00   00 00 00 00 00 00 00 00 | ................
001180: 00 00 00 00 00 00 00 00   3C 00 00 00 00 00 00 00 | ........<.......
001190: 42 4D 89 63 00 00 00 00   42 4D 89 63 00 00 00 00 | BM�c....BM�c....
0011A0: 42 4D 89 63 00 00 00 00   74 65 78 74 32 00 00 00 | BM�c....text2...
0011B0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011C0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011D0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011E0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011F0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
```

mv - Moves a file - source dest

```
001000:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001010:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001020:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001030:  00 00 00 00 00 00 00 00   06 00 00 00 01 00 00 00  |  ................
001040:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001050:  C0 09 00 00 01 00 00 00   94 FB 88 63 00 00 00 00  |  �.......���C....
001060:  94 FB 88 63 00 00 00 00   94 FB 88 63 00 00 00 00  |  ���C....���C....
001070:  6F 6E 65 00 00 00 00 00   00 00 00 00 00 00 00 00  |  one.............
001080:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001090:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0010A0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0010B0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0010C0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0010D0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0010E0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0010F0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................

001100:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001110:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001120:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001130:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001140:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001150:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001160:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001170:  0B 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
001180:  00 00 00 00 00 00 00 00   C0 09 00 00 01 00 00 00  |  ........�.......
001190:  96 FB 88 63 00 00 00 00   96 FB 88 63 00 00 00 00  |  ���C....���C....
0011A0:  96 FB 88 63 00 00 00 00   00 69 6C 65 00 00 00 00  |  ���C.....ile....
0011B0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0011C0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0011D0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0011E0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
0011F0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |  ................
```

```
001800: 2E 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001810: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001820: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001830: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001840: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001850: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001860: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001870: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001880: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001890: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0018A0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0018B0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0018C0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0018D0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0018E0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0018F0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................

001900: 0B 00 00 00 05 00 00 00   00 00 00 00 00 00 00 00 | ................
001910: 00 00 00 00 00 00 00 00   C0 09 00 00 01 00 00 00 | ........�.......
001920: 96 FB 88 63 00 00 00 00   96 FB 88 63 00 00 00 00 | ���c....���c....
001930: 96 FB 88 63 00 00 00 00   2E 2E 00 00 00 00 00 00 | ���c............
001940: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001950: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001960: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001970: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001980: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001990: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0019A0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0019B0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0019C0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0019D0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0019E0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0019F0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
```

```
001A00: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001A10: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001A20: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001A30: 00 00 00 00 00 00 00 00   06 00 00 00 05 00 00 00 |  ................
001A40: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001A50: C0 09 00 00 01 00 00 00   94 FB 88 63 00 00 00 00 |  �.......���c....
001A60: 94 FB 88 63 00 00 00 00   94 FB 88 63 00 00 00 00 |  ���c....���c....
001A70: 6E 65 77 6E 61 6D 65 00   00 00 00 00 00 00 00 00 |  newname.........
001A80: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001A90: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001AA0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001AB0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001AC0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001AD0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001AE0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001AF0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................

001B00: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B10: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B20: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B30: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B40: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B50: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B60: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B70: 10 00 00 00 01 00 00 00   00 00 00 00 00 00 00 00 |  ................
001B80: 00 00 00 00 00 00 00 00   01 00 00 00 00 00 00 00 |  ................
001B90: 99 FB 88 63 00 00 00 00   99 FB 88 63 00 00 00 00 |  ���c....���c....
001BA0: 99 FB 88 63 00 00 00 00   00 00 00 00 00 00 00 00 |  ���c...........
001BB0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001BC0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001BD0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001BE0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
001BF0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 |  ................
```

md - Make a new directory


```
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > md directory
Prompt > ls -la

D        2496    .
D        2496    ..
D        2496    directory
Prompt >
```

```
000E00: 2E 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E10: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E20: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E30: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E40: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E50: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E60: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E70: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E80: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000E90: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EA0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EB0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EC0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000ED0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EE0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000EF0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................

000F00: 06 00 00 00 05 00 00 00   00 00 00 00 00 00 00 00 | ................
000F10: 00 00 00 00 00 00 00 00   C0 09 00 00 01 00 00 00 | ........◆...
000F20: C3 FC 88 63 00 00 00 00   C3 FC 88 63 00 00 00 00 | ◆◆◆C....◆◆◆C....
000F30: C3 FC 88 63 00 00 00 00   2E 2E 00 00 00 00 00 00 | ◆◆◆C............
000F40: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F50: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F60: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F70: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F80: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000F90: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FA0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FB0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FC0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FD0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FE0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
000FF0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
```

```
001000:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001010:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001020:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001030:  00 00 00 00 00 00 00 00   06 00 00 00 01 00 00 00  | ................
001040:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001050:  C0 09 00 00 01 00 00 00   C3 FC 88 63 00 00 00 00  | �.......���c....
001060:  C3 FC 88 63 00 00 00 00   C3 FC 88 63 00 00 00 00  | ���c....���c....
001070:  64 69 72 65 63 74 6F 72   79 00 00 00 00 00 00 00  | directory.......
001080:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001090:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010A0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010B0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010C0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010D0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010E0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010F0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................

001100:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001110:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001120:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001130:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001140:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001150:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001160:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001170:  0B 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001180:  00 00 00 00 00 00 00 00   C0 09 00 00 01 00 00 00  | ........�.......
001190:  CE FC 88 63 00 00 00 00   CE FC 88 63 00 00 00 00  | ���c....���c....
0011A0:  CE FC 88 63 00 00 00 00   00 00 00 00 00 00 00 00  | ���c...........
0011B0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011C0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011D0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011E0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011F0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
```

rm - Removes a file or directory

```
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > md directory
Prompt > ls -la

D       2496   .
D       2496   ..
D       2496   directory
Prompt > ls

directory
Prompt > rm directory
Prompt > ls

Prompt >
```

```
001000: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001010: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001020: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001030: 00 00 00 00 00 00 00 00  06 00 00 00 01 00 00 00  | ................
001040: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001050: C0 09 00 00 01 00 00 00  C3 FC 88 63 00 00 00 00  | ◆.......◆◆◆C....
001060: C3 FC 88 63 00 00 00 00  C3 FC 88 63 00 00 00 00  | ◆◆◆C....◆◆◆C....
001070: 00 69 72 65 63 74 6F 72  79 00 00 00 00 00 00 00  | .irectory.......
001080: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001090: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0010A0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0010B0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0010C0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0010D0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0010E0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0010F0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................

001100: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001110: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001120: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001130: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001140: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001150: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001160: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
001170: FF FF FF FF 00 00 00 00  00 00 00 00 00 00 00 00  | ◆◆◆◆............
001180: 00 00 00 00 00 00 00 00  FF FF FF FF 01 00 00 00  | ........◆◆◆◆....
001190: CE FC 88 63 00 00 00 00  CE FC 88 63 00 00 00 00  | ◆◆◆C....◆◆◆C....
0011A0: CE FC 88 63 00 00 00 00  00 00 00 00 00 00 00 00  | ◆◆◆C............
0011B0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0011C0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0011D0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0011E0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
0011F0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  | ................
```

001070 : is the start of the directory. The data for the directory was not literally removed. Instead, the directory was changed to an empty state, meaning :

First character in its name was changed to '\0' which you can see at – 001070

Directory's starting lba location was changed -1 as seen at – 001170 to 001173

Directory's file size was changed to -1 as seen at – 001188 to 00118b

touch - creates a file

```
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > touch file
Prompt > ls

file
Prompt > █
```

```
001000: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001010: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001020: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001030: 00 00 00 00 00 00 00 00   06 00 00 00 01 00 00 00 | ................
001040: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001050: C0 09 00 00 01 00 00 00   4E 07 89 63 00 00 00 00 | �.......N.�C....
001060: 4E 07 89 63 00 00 00 00   4E 07 89 63 00 00 00 00 | N.�C....N.�C....
001070: 66 69 6C 65 00 00 00 00   00 00 00 00 00 00 00 00 | file............
001080: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001090: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010A0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010B0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010C0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010D0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010E0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0010F0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................

001100: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001110: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001120: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001130: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001140: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001150: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001160: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
001170: 0B 00 00 00 01 00 00 00   00 00 00 00 00 00 00 00 | ................
001180: 00 00 00 00 00 00 00 00   01 00 00 00 00 00 00 00 | ................
001190: 51 07 89 63 00 00 00 00   51 07 89 63 00 00 00 00 | Q.�C....Q.�C....
0011A0: 51 07 89 63 00 00 00 00   00 00 00 00 00 00 00 00 | Q.�C............
0011B0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011C0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011D0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011E0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
0011F0: 00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00 | ................
```

cat - (limited functionality) displays the contents of a file


```
                              student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-hazhao33
File  Edit  View  Search  Terminal  Tabs  Help
        student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-hazhao33/Hexdump          ×          student@student-VirtualBox: ~/Fa
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > cp2fs text
Prompt > cat text
Testing Cat
Prompt >
```

cp2l - Copies a file from the test file system to the linux file system


```
                              student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-hazhao33
File  Edit  View  Search  Terminal  Tabs  Help
        student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-hazhao33/Hexdump          ×          student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-haz
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > cp2fs text
Prompt > cat text
Testing Cat
Prompt > cp text text2
Prompt > ls

text
text2
Prompt > cat text2
Testing Cat
Prompt > cp2l text2
Prompt > exit
System exiting
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ ls
b_io.c     bitMap.o     extents.h    fsInit.c    fsshell    mfs.c                           SampleVolume
b_io.h     directory.c  extents.o    fsInit.o    fsshell.c  mfs.h                           text
b_io.o     directory.h  fileInfo.c   fsLow.h     fsshell.o  mfs.o                           text2
bitMap.c   directory.o  fileInfo.h   fsLowM1.o   Hexdump    MilestoneOne_writeup.pdf        volumeControlBlock.h
bitMap.h   extents.c    fileInfo.o   fsLow.o     Makefile   README.md
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$
```

```
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > cp2fs text
Prompt > cat text
Testing Cat
Prompt > cp text text2
Prompt > ls

text
text2
Prompt > cat text2
Testing Cat
Prompt > cp2l text2
Prompt > exit
System exiting
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ ls
b_io.c     bitMap.o     extents.h    fsInit.c    fsshell    mfs.c                SampleVolume
b_io.h     directory.c  extents.o    fsInit.o    fsshell.c  mfs.h                text
b_io.o     directory.h  fileInfo.c   fsLow.h     fsshell.o  mfs.o                text2
bitMap.c   directory.o  fileInfo.h   fsLowM1.o   Hexdump    MilestoneOne_writeup.pdf  volumeControlBlock.h
bitMap.h   extents.c    fileInfo.o   fsLow.o     Makefile   README.md
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ cat text2
Testing Cat
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ ▮
```

cp2fs - Copies a file from the Linux FS to the test FS


```
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ ls
b_io.c     bitMap.o     extents.h    fsInit.c    fsshell    mfs.c                SampleVolume
b_io.h     directory.c  extents.o    fsInit.o    fsshell.c  mfs.h                text
b_io.o     directory.h  fileInfo.c   fsLow.h     fsshell.o  mfs.o                volumeControlBlock.h
bitMap.c   directory.o  fileInfo.h   fsLowM1.o   Hexdump    MilestoneOne_writeup.pdf
bitMap.h   extents.c    fileInfo.o   fsLow.o     Makefile   README.md
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > cp2fs text
b-write called
 index = 1
 location of parent = 6
Prompt > ls

text
Prompt > ▮
```

```
001000:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001010:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001020:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001030:  00 00 00 00 00 00 00 00   06 00 00 00 01 00 00 00  | ................
001040:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001050:  0D 00 00 00 01 00 00 00   6F 09 89 63 00 00 00 00  | ........o.�c....
001060:  6F 09 89 63 00 00 00 00   6F 09 89 63 00 00 00 00  | o.�c....o.�c....
001070:  74 65 78 74 00 00 00 00   00 00 00 00 00 00 00 00  | text............
001080:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001090:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010A0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010B0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010C0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010D0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010E0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0010F0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................

001100:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001110:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001120:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001130:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001140:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001150:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001160:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
001170:  0B 00 00 00 01 00 00 00   00 00 00 00 00 00 00 00  | ................
001180:  00 00 00 00 00 00 00 00   0D 00 00 00 00 00 00 00  | ................
001190:  72 09 89 63 00 00 00 00   72 09 89 63 00 00 00 00  | г.�c....г.�c....
0011A0:  72 09 89 63 00 00 00 00   00 00 00 00 00 00 00 00  | г.�c............
0011B0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011C0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011D0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011E0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
0011F0:  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  | ................
```

cd - Changes directory

```
File Edit View Search Terminal Help
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > pwd
/
Prompt > md one
Prompt > cd one
Prompt > ls

Prompt > pwd
/one/
Prompt > cd ..
Prompt > pwd
/
Prompt > ls

one
Prompt >
```

pwd - Prints the working directory

```
File Edit View Search Terminal Help
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > pwd
/
Prompt > md one
Prompt > cd one
Prompt > ls

Prompt > pwd
/one/
Prompt > cd ..
Prompt > pwd
/
Prompt > ls

one
Prompt >
```

history - Prints out the history


```
student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-hazhao33
File  Edit  View  Search  Terminal  Help
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > history
history
Prompt >
```

help - Prints out help


```
es    Terminal ▾                                    Mon 17:34 ●
                        student@student-VirtualBox: ~/Fall2022/FileSystem/csc415-filesystem-hazhao33
File  Edit  View  Search  Terminal  Help
student@student-VirtualBox:~/Fall2022/FileSystem/csc415-filesystem-hazhao33$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872;  BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > help
ls      Lists the file in a directory
cp      Copies a file - source [dest]
mv      Moves a file - source dest
md      Make a new directory
rm      Removes a file or directory
touch   Touches/Creates a file
cat     Limited version of cat that displace the file to the console
cp2l    Copies a file from the test file system to the linux file system
cp2fs   Copies a file from the Linux file system to the test file system
cd      Changes directory
pwd     Prints the working directory
history Prints out the history
help    Prints out help
Prompt >
```