

1. DESIGN OF HIERARCHICAL FILE SYSTEM

A hierarchical file system is just a collection of files and directories organized in the structure of an inverted tree. I have implemented this file system using nested dictionaries. In my design, each **file or directory** is called a **NODE** in the file system, which has a dictionary with three keys. The three fields are,

1. **“metadata”**: This key holds a dictionary, which stores the metadata like time of last access, no. of links and permission. and flags to differentiate directory from file. Also size, which is used in case of files.
2. **“childnodes”**: This key holds a dictionary, which contains a dictionary of nodes (*sub_directories*). And each of these nodes have again same fields i.e metadata, contains
3. **“data”**: This is used only in the case of files. This key points to a list, which holds the content of a file in the form of unicode characters.

```
#####  
dict node  
{  
    "metadata": {},  
    "contains": {},  
    "data": []  
}
```

#####

METHODS TO EASE OPERATIONS ON THE FILE SYSTEM DICTIONARY -

My design includes the certain useful method to perform data manipulations on the file system dictionary. The following methods provide functionality to add a new node, get the dictionary of the node, remove a node and so on. The functions are named appropriately based on their functionality.

splitPath(string_variable) :

This method takes in the string **path** and returns a list of individual nodes in the path.

Eg:

```
> print splitPath("/dir1/dir2/file.txt")  
["/", "/dir1", "/dir2", "/file.txt"]
```

setNodeDict(filesys_dictionary, new_path, new_node_dict) :

This method recursively traverse through the dictionary using **new_path** and inserts a new dict at appropriate position in the filesys dictionary.

getCurNode(fileDict, spath) :

This method traverse through the dictionary recursively using the path string and returns the node dictionary.

popFileDict(fileDict,spath):

This method deletes the file or directory provided by the path argument in the fileDict.

getParentDict(fileDict, spath) :

This method returns the parent node of the file or dir at the given path.

checkPath(fileDict,spath) :

Method to check if the given lookup path exists are not.

Using these methods, I have changed all the methods in the class memory appropriately to implement hierarchical file system.

TEST CASES -

My file system worked all complex bash commands I could imagine.

1. Mount the file system .

\$ python memoryHFS.py fusemount

```
rv@rv-ubuntu:~/junk/pocsd/fusepy$  
rv@rv-ubuntu:~/junk/pocsd/fusepy$ df -h  
Filesystem      Size  Used Avail Use% Mounted on  
/dev/sda6       158G  105G   45G  71% /  
none            4.0K    0  4.0K   0% /sys/fs/cgroup  
udev            2.9G  4.0K  2.9G   1% /dev  
tmpfs           589M  1.4M  587M   1% /run  
none            5.0M    0   5.0M   0% /run/lock  
none            2.9G   52M  2.9G   2% /run/shm  
none            100M   56K  100M   1% /run/user  
Memory          2.0M  2.0M  1.0M  67% /home/rv/junk/pocsd/fusepy/fusemount  
rv@rv-ubuntu:~/junk/pocsd/fusepy$
```

2. In the second terminal, created directories using mkdir. The program was also able to create nested directories in a single command using -p option.

```
rv@rv-ubuntu: ~/junk/pocsd/fusepy/fusemount
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt
total 4
drwxr-xr-x 2 root root  0 Sep 28 03:21 .
drwxrwxr-x 7 rv  rv  4096 Sep 28 03:01 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ mkdir dir1 dir2
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt
total 4
drwxrwxr-x 2 root root  0 Sep 28 03:26 dir2
drwxrwxr-x 2 root root  0 Sep 28 03:26 dir1
drwxr-xr-x 4 root root  0 Sep 28 03:21 .
drwxrwxr-x 7 rv  rv  4096 Sep 28 03:01 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ mkdir -p dir2/dir3/dir4
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt
total 4
drwxrwxr-x 3 root root  0 Sep 28 03:26 dir2
drwxrwxr-x 2 root root  0 Sep 28 03:26 dir1
drwxr-xr-x 4 root root  0 Sep 28 03:21 .
drwxrwxr-x 7 rv  rv  4096 Sep 28 03:01 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt dir2/
total 0
drwxrwxr-x 3 root root 0 Sep 28 03:26 dir3
drwxrwxr-x 3 root root 0 Sep 28 03:26 .
drwxr-xr-x 4 root root 0 Sep 28 03:21 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt dir2/dir3/
total 0
drwxrwxr-x 2 root root 0 Sep 28 03:26 dir4
drwxrwxr-x 3 root root 0 Sep 28 03:26 .
drwxrwxr-x 3 root root 0 Sep 28 03:26 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
```

3. FILE creation commands and links to files.

```
rv@rv-ubuntu: ~/junk/pocsd/fusepy/fs
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt
total 4
drwxrwxr-x 3 root root  0 Sep 28 16:11 dir2
drwxrwxr-x 2 root root  0 Sep 28 16:11 dir1
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:10 ..
drwxr-xr-x 4 root root  0 Sep 28 16:04 .
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ echo "this file is under / " > file1
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt
total 4
-rw-rw-r-- 1 root root  22 Sep 28 16:12 file1
drwxrwxr-x 3 root root  0 Sep 28 16:11 dir2
drwxrwxr-x 2 root root  0 Sep 28 16:11 dir1
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:10 ..
drwxr-xr-x 4 root root  0 Sep 28 16:04 .
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ cat file1
this file is under /
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
```


4. Tests for file creation and creating Links.

```
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt  
total 4  
-rw-rw-r-- 1 root root  22 Sep 28 16:12 file1  
drwxrwxr-x 3 root root  20 Sep 28 16:11 dir2  
drwxrwxr-x 2 root root  20 Sep 28 16:11 dir1  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:10 ..  
drwxr-xr-x 4 root root  20 Sep 28 16:04 .  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ln -s ~/junk/pocsd/fusepy/fs/file1 dir2/dir3/file3  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt dir2/dir3/  
total 0  
drwxrwxr-x 2 root root  20 Sep 28 16:11 dir4  
drwxrwxr-x 3 root root  20 Sep 28 16:11 .  
drwxrwxr-x 3 root root  20 Sep 28 16:11 ..  
lrwxrwxrwx 1 root root 35 Dec 31 1969 file3 -> /home/rv/junk/pocsd/fusepy/fs/file1  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ cat dir2/dir3/file3  
this file is under /  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ cd dir2/  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ ln -s /home/rv/junk/pocsd/fusepy/fs/dir2/dir3/file3 file2  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ ls -alt  
total 0  
drwxrwxr-x 3 root root  20 Sep 28 16:11 dir3  
drwxrwxr-x 3 root root  20 Sep 28 16:11 .  
drwxr-xr-x 4 root root  20 Sep 28 16:04 ..  
lrwxrwxrwx 1 root root 45 Dec 31 1969 file2 -> /home/rv/junk/pocsd/fusepy/fs/dir2/dir3/file3  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ cat file2  
this file is under /  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ ln -s /home/rv/junk/pocsd/fusepy/fs/file1 file4  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ ls -alt  
total 0  
drwxrwxr-x 3 root root  20 Sep 28 16:11 dir3  
drwxrwxr-x 3 root root  20 Sep 28 16:11 .  
drwxr-xr-x 4 root root  20 Sep 28 16:04 ..  
lrwxrwxrwx 1 root root 45 Dec 31 1969 file2 -> /home/rv/junk/pocsd/fusepy/fs/dir2/dir3/file3  
lrwxrwxrwx 1 root root 35 Dec 31 1969 file4 -> /home/rv/junk/pocsd/fusepy/fs/file1  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ cat file4  
this file is under /  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ cat file2  
this file is under /  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$
```

5. Moving directories

```
rv@rv-ubuntu: ~/junk/pocsd/fusepy/fs  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt  
total 4  
drwxrwxr-x 2 root root  20 Sep 28 16:24 dir1  
drwxrwxr-x 2 root root  20 Sep 28 16:11 dir2  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:10 ..  
drwxr-xr-x 4 root root  20 Sep 28 16:04 .  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ mv dir2 dir3  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls  
dir1 dir3  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt  
total 4  
drwxrwxr-x 2 root root  20 Sep 28 16:24 dir1  
drwxrwxr-x 2 root root  20 Sep 28 16:11 dir3  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:10 ..  
drwxr-xr-x 4 root root  20 Sep 28 16:04 .  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
```

5. Removing directories with -r option

```
rv@rv-ubuntu: ~/junk/pocsd/fusepy/fs/dir2
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt
total 4
drwxrwxr-x 3 root root  0 Sep 28 16:11 dir2
drwxrwxr-x 2 root root  0 Sep 28 16:11 dir1
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:10 ..
drwxr-xr-x 4 root root  0 Sep 28 16:04 .
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ rm -r dir1
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt
total 4
drwxrwxr-x 3 root root  0 Sep 28 16:11 dir2
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:10 ..
drwxr-xr-x 3 root root  0 Sep 28 16:04 .
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ cd dir2/
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ ls -alt
total 0
drwxrwxr-x 3 root root 0 Sep 28 16:11 dir3
drwxrwxr-x 3 root root 0 Sep 28 16:11 .
drwxr-xr-x 3 root root 0 Sep 28 16:04 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ rm -r dir3
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ ls -alt
total 0
drwxrwxr-x 2 root root 0 Sep 28 16:11 .
drwxr-xr-x 3 root root 0 Sep 28 16:04 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ echo "hello" > file1
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$ ls -alt
total 0
-rw-rw-r-- 1 root root 6 Sep 28 16:20 file1
drwxrwxr-x 2 root root 0 Sep 28 16:11 .
drwxr-xr-x 3 root root 0 Sep 28 16:04 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs/dir2$
```

6. Copying directories

```
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt  
total 4  
drwxrwxr-x 2 root root    0 Sep 28 16:29 dir2  
drwxrwxr-x 2 root root    0 Sep 28 16:29 dir1  
drwxr-xr-x 4 root root    0 Sep 28 16:28 .  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ cp -r dir2 dir3  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$ ls -alt  
total 4  
drwxrwxr-x 2 root root    0 Sep 28 16:30 dir3  
drwxrwxr-x 2 root root    0 Sep 28 16:29 dir2  
drwxrwxr-x 2 root root    0 Sep 28 16:29 dir1  
drwxr-xr-x 5 root root    0 Sep 28 16:28 .  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fs$
```

REMOTE HIERARCHICAL FILE SYSTEM

This design was implemented by improvising the hierarchical file system created in step 1. Designed two functions which would redirect any request for the file system to simpleht.py.

putRpcDict(myserver,fileDict): Put the new dictionary in the server

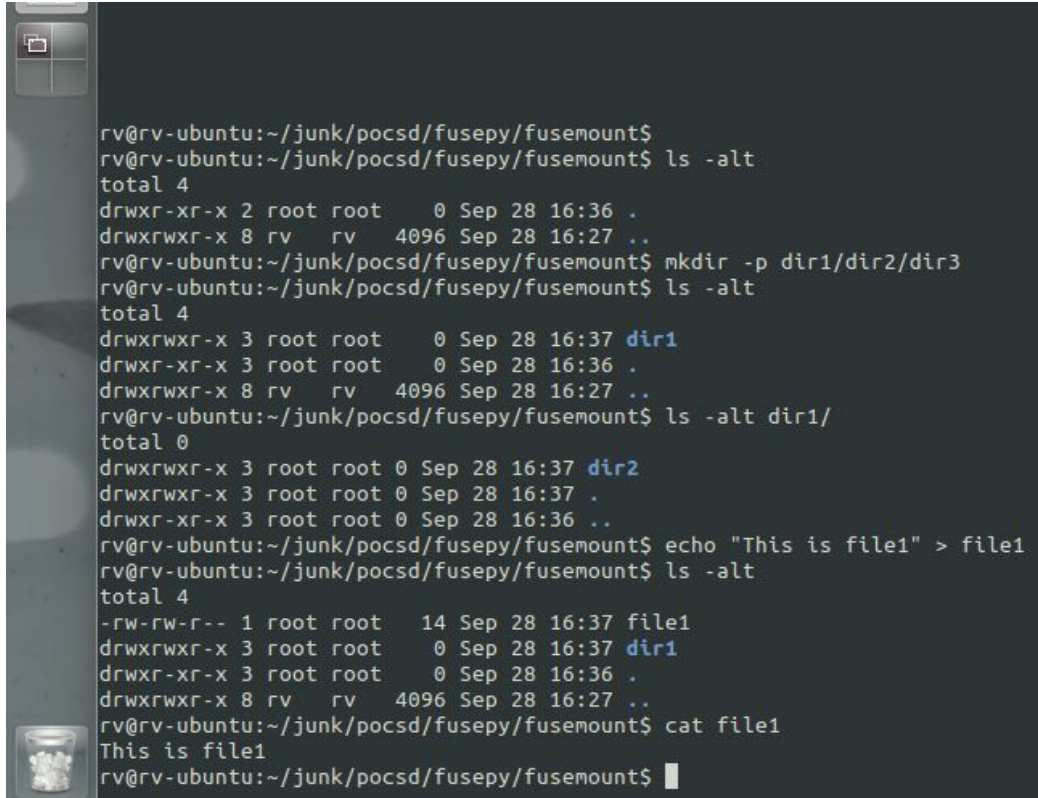
getRpcDict(myserver): Gets the dictionary from the server

Using these function along with dictionary manipulation functions in the first step has given the remote file system functionalities. This design has worked with all the tests same as in the above step.

Tests:

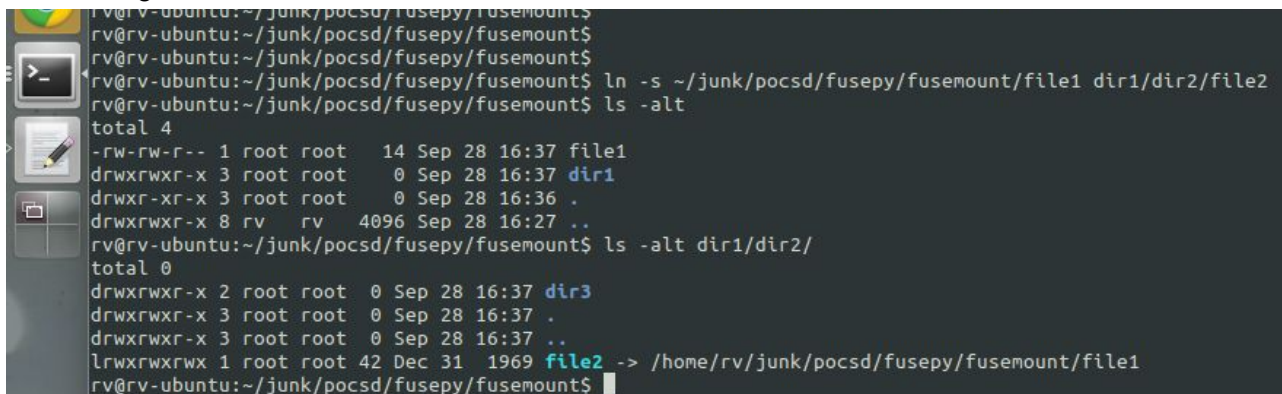
1. Mount the file system on one terminal and run simpleHT.py on other terminal
python remoteHierarchicalFS.py <mount_dir> <url>
Eg: \$ python remoteHierarchicalFS.py fusemount/ <http://127.0.0.1:51234>
2. On the second terminal, run the simpleht.py
term-2 \$ python simpleht.py
3. In the 3rd terminal, cd to the fuse mount and perform file system operations.

2. Creating dirs and files.

A terminal window with a dark background and a light gray sidebar on the left containing icons for a file manager, a terminal, and a trash. The terminal shows a series of commands and their outputs. The user starts in the directory ~/junk/pocsd/fusepy/fusemount. They run 'ls -alt' showing a directory listing with permissions, owner, group, size, and time. Then they run 'mkdir -p dir1/dir2/dir3'. Another 'ls -alt' shows the new directory 'dir1' has been created. Then they run 'ls -alt dir1/' showing an empty directory. Next, they run 'echo "This is file1" > file1'. A third 'ls -alt' shows 'file1' has been created. Finally, they run 'cat file1' which outputs 'This is file1'.

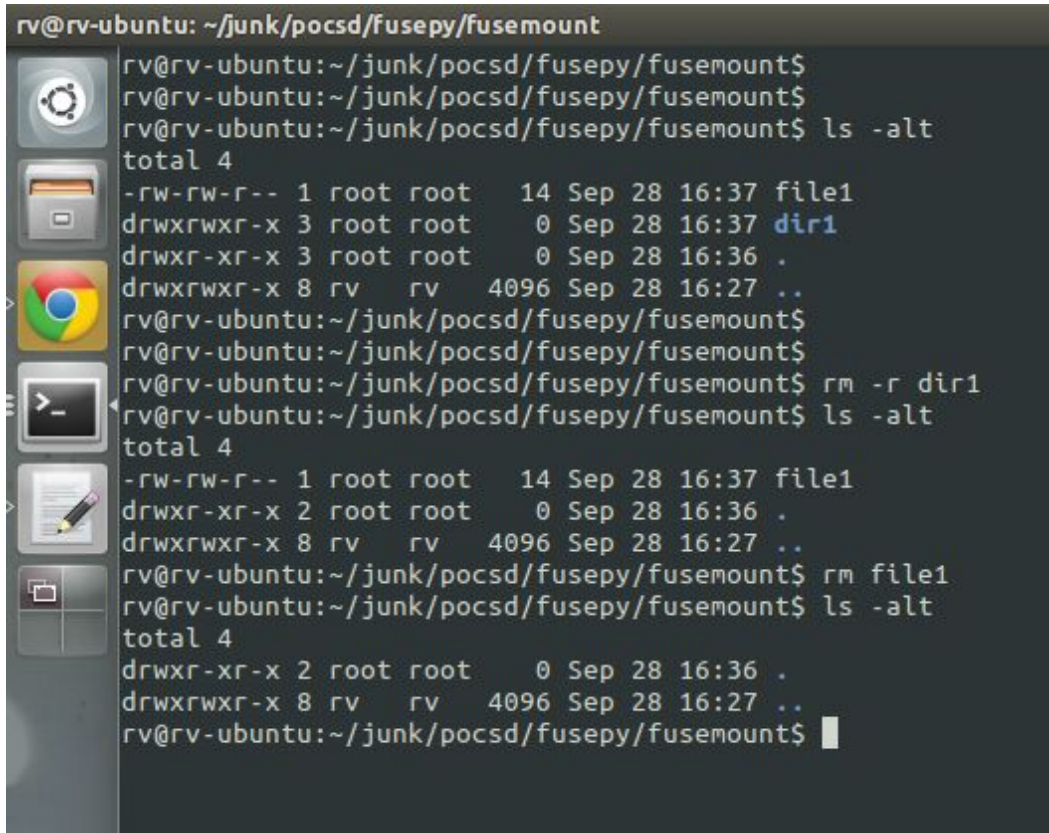
```
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt  
total 4  
drwxr-xr-x 2 root root  0 Sep 28 16:36 .  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ mkdir -p dir1/dir2/dir3  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt  
total 4  
drwxrwxr-x 3 root root  0 Sep 28 16:37 dir1  
drwxr-xr-x 3 root root  0 Sep 28 16:36 .  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt dir1/  
total 0  
drwxrwxr-x 3 root root 0 Sep 28 16:37 dir2  
drwxrwxr-x 3 root root 0 Sep 28 16:37 .  
drwxr-xr-x 3 root root 0 Sep 28 16:36 ..  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ echo "This is file1" > file1  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt  
total 4  
-rw-rw-r-- 1 root root  14 Sep 28 16:37 file1  
drwxrwxr-x 3 root root  0 Sep 28 16:37 dir1  
drwxr-xr-x 3 root root  0 Sep 28 16:36 .  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ cat file1  
This is file1  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
```

3. Creating links

A terminal window similar to the one above, showing the creation of a symbolic link. The user runs 'ln -s ~/junk/pocsd/fusepy/fusemount/file1 dir1/dir2/file2'. Then they run 'ls -alt' showing the updated directory listing with 'file1' and 'dir1'. Next, they run 'ls -alt dir1/dir2/' showing an empty directory. Finally, they run 'ls -la' which shows the symbolic link 'file2' pointing to the full path of 'file1'.

```
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ln -s ~/junk/pocsd/fusepy/fusemount/file1 dir1/dir2/file2  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt  
total 4  
-rw-rw-r-- 1 root root  14 Sep 28 16:37 file1  
drwxrwxr-x 3 root root  0 Sep 28 16:37 dir1  
drwxr-xr-x 3 root root  0 Sep 28 16:36 .  
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt dir1/dir2/  
total 0  
drwxrwxr-x 2 root root  0 Sep 28 16:37 dir3  
drwxrwxr-x 3 root root  0 Sep 28 16:37 .  
drwxrwxr-x 3 root root  0 Sep 28 16:37 ..  
lrwxrwxrwx 1 root root 42 Dec 31 1969 file2 -> /home/rv/junk/pocsd/fusepy/fusemount/file1  
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
```

4. Removing directories and files

A terminal window titled 'rv@rv-ubuntu: ~/junk/pocsd/fusepy/fusemount' with a sidebar containing icons for system settings, file manager, web browser, terminal, text editor, and application launcher. The terminal shows a series of commands and their outputs. First, the user runs 'ls -alt', showing a directory listing with 'file1', 'dir1', '.', and '..'. Then, the user runs 'rm -r dir1', and the next 'ls -alt' shows 'dir1' has been removed. Finally, the user runs 'rm file1', and the last 'ls -alt' shows 'file1' has been removed, leaving only '.' and '..' in the directory listing.

```
rv@rv-ubuntu: ~/junk/pocsd/fusepy/fusemount
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt
total 4
-rw-rw-r-- 1 root root  14 Sep 28 16:37 file1
drwxrwxr-x 3 root root   0 Sep 28 16:37 dir1
drwxr-xr-x 3 root root   0 Sep 28 16:36 .
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ rm -r dir1
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt
total 4
-rw-rw-r-- 1 root root  14 Sep 28 16:37 file1
drwxr-xr-x 2 root root   0 Sep 28 16:36 .
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ rm file1
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$ ls -alt
total 4
drwxr-xr-x 2 root root   0 Sep 28 16:36 .
drwxrwxr-x 8 rv  rv  4096 Sep 28 16:27 ..
rv@rv-ubuntu:~/junk/pocsd/fusepy/fusemount$
```