I have used Ubuntu22.04 Platform to execute this

g++ (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0

Copyright (C) 2021 Free Software Foundation, Inc.

pre-requisite

check and handle the permission issues and use sudo or execute as root user wherever required.

check whether g++ is available to compile the code otherwise install it.

Assumptions srcPath and dstPath are mounted on two different MountPaths.

g++ syncPathsThreads.cpp -o sync

**Used thread by adding into vector thread.emplace\_back**

Compile the Program :

g++ syncPathsThreads.cpp -o syncpath

**usage:**

This Program Sync Files, Folders, Subfolders, Links from One Mount path to Another Mount Path

Usage: ./syncpath SourcePath DestinationPath NumThreads

Assumptions: Both srcPath and DestPath are mounted on two different mountpaths.

Program Output: Expect a message like Path Sync Completed Successfully!!

At the end of the output message.

Run by passing two paths:

**Use Case 1 ) Sync files and dirs of /a/ to /n/**

Content of /a/

ls -ltri /a/

total 148

258470 -rw-rw-r-- 6 ubuntu ubuntu 0 Sep 30 19:58 test.txt

258470 -rw-rw-r-- 6 ubuntu ubuntu 0 Sep 30 19:58 hlink

347100 -rw-rw-r-- 3 ubuntu ubuntu 0 Oct 1 18:12 d.txt

347103 lrwxrwxrwx 1 root root 5 Oct 1 18:12 **linkd** -> d.txt

355497 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 04:57 **testd**

347150 -rwxrwxr-x 3 ubuntu ubuntu 47424 Oct 2 14:03 **rec**

347147 -rwxrwxr-x 3 ubuntu ubuntu 16272 Oct 2 14:03 **listDirC**

347148 -rwxrwxr-x 3 ubuntu ubuntu 16696 Oct 2 14:03 **copydir**

347149 -rwxrwxr-x 3 ubuntu ubuntu 47256 Oct 2 14:03 **copyRec**

355514 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 14:38 **gh.txt**

355518 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 17:05 **new**

347194 -rw-rw-r-- 6 ubuntu ubuntu 0 Oct 2 17:05 blink

347194 -rw-rw-r-- 6 ubuntu ubuntu 0 Oct 2 17:05 b.txt

355520 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 17:07 **newone**

347196 -rw-rw-r-- 3 ubuntu ubuntu 0 Oct 2 17:07 b1.txt

./syncpath /a /n 3

Where /a and /n is mounted on the same filesystem.

After Execution Content of /n/

ls -ltri /n/

total 148

258470 -rw-rw-r-- 10 ubuntu ubuntu 0 Sep 30 19:58 test.txt

258470 -rw-rw-r-- 10 ubuntu ubuntu 0 Sep 30 19:58 hlink

347100 -rw-rw-r-- 5 ubuntu ubuntu 0 Oct 1 18:12 d.txt

347150 -rwxrwxr-x 5 ubuntu ubuntu 47424 Oct 2 14:03 **rec**

347147 -rwxrwxr-x 5 ubuntu ubuntu 16272 Oct 2 14:03 **listDirC**

347148 -rwxrwxr-x 5 ubuntu ubuntu 16696 Oct 2 14:03 **copydir**

347149 -rwxrwxr-x 5 ubuntu ubuntu 47256 Oct 2 14:03 **copyRec**

347194 -rw-rw-r-- 10 ubuntu ubuntu 0 Oct 2 17:05 blink

347194 -rw-rw-r-- 10 ubuntu ubuntu 0 Oct 2 17:05 b.txt

347196 -rw-rw-r-- 5 ubuntu ubuntu 0 Oct 2 17:07 b1.txt

355528 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **newone**

355530 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **new**

260186 lrwxrwxrwx 1 ubuntu ubuntu 5 Oct 8 13:20 **linkd** -> d.txt

355529 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **gh.txt**

355527 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **testd**

**Use Case 2) Create new directory inside directory and observed whether it is copied after running the program.**

mkdir -p /a/octd

/n/ is existing directory

ls -ltri /a/

total 152

258470 -rw-rw-r-- 10 ubuntu ubuntu 0 Sep 30 19:58 test.txt

258470 -rw-rw-r-- 10 ubuntu ubuntu 0 Sep 30 19:58 hlink

347100 -rw-rw-r-- 5 ubuntu ubuntu 0 Oct 1 18:12 d.txt

347103 lrwxrwxrwx 1 root root 5 Oct 1 18:12 **linkd** -> d.txt

355497 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 04:57 **testd**

347150 -rwxrwxr-x 5 ubuntu ubuntu 47424 Oct 2 14:03 **rec**

347147 -rwxrwxr-x 5 ubuntu ubuntu 16272 Oct 2 14:03 **listDirC**

347148 -rwxrwxr-x 5 ubuntu ubuntu 16696 Oct 2 14:03 **copydir**

347149 -rwxrwxr-x 5 ubuntu ubuntu 47256 Oct 2 14:03 **copyRec**

355514 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 14:38 **gh.txt**

355518 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 17:05 **new**

347194 -rw-rw-r-- 10 ubuntu ubuntu 0 Oct 2 17:05 blink

347194 -rw-rw-r-- 10 ubuntu ubuntu 0 Oct 2 17:05 b.txt

355520 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 17:07 **newone**

347196 -rw-rw-r-- 5 ubuntu ubuntu 0 Oct 2 17:07 b1.txt

355531 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:23 **octd**

./synct /a/ /n/ 3

ls -ltr /n/

total 152

-rw-rw-r-- 10 ubuntu ubuntu 0 Sep 30 19:58 test.txt

-rw-rw-r-- 10 ubuntu ubuntu 0 Sep 30 19:58 hlink

-rw-rw-r-- 5 ubuntu ubuntu 0 Oct 1 18:12 d.txt

-rwxrwxr-x 5 ubuntu ubuntu 47424 Oct 2 14:03 **rec**

-rwxrwxr-x 5 ubuntu ubuntu 16272 Oct 2 14:03 **listDirC**

-rwxrwxr-x 5 ubuntu ubuntu 16696 Oct 2 14:03 **copydir**

-rwxrwxr-x 5 ubuntu ubuntu 47256 Oct 2 14:03 **copyRec**

-rw-rw-r-- 10 ubuntu ubuntu 0 Oct 2 17:05 blink

-rw-rw-r-- 10 ubuntu ubuntu 0 Oct 2 17:05 b.txt

-rw-rw-r-- 5 ubuntu ubuntu 0 Oct 2 17:07 b1.txt

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **newone**

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **new**

lrwxrwxrwx 1 ubuntu ubuntu 5 Oct 8 13:20 **linkd** -> d.txt

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **gh.txt**

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:20 **testd**

-rw-rw-r-- 1 ubuntu ubuntu 0 Oct 8 13:24 m1.txt

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:24 **octd**

/n/ has got the new directory octd and file m1.txt.

**Use Case 3 ) Sync to a completely new destination directory**

./syncpath /a/ /z/ 3

Where z/ is new directory

**Use Case 4 ) Create Soft Link and verify it is preserving or not post sync.**

cd /a/

**/a**$ sudo ln -s sync.txt s

$ ls -ltr

total 152

-rw-rw-r-- 12 ubuntu ubuntu 0 Sep 30 19:58 test.txt

-rw-rw-r-- 12 ubuntu ubuntu 0 Sep 30 19:58 hlink

-rw-rw-r-- 6 ubuntu ubuntu 0 Oct 1 18:12 d.txt

-rwxrwxr-x 6 ubuntu ubuntu 47424 Oct 2 14:03 **rec**

-rwxrwxr-x 6 ubuntu ubuntu 16272 Oct 2 14:03 **listDirC**

-rwxrwxr-x 6 ubuntu ubuntu 16696 Oct 2 14:03 **copydir**

-rwxrwxr-x 6 ubuntu ubuntu 47256 Oct 2 14:03 **copyRec**

-rw-rw-r-- 12 ubuntu ubuntu 0 Oct 2 17:05 blink

-rw-rw-r-- 12 ubuntu ubuntu 0 Oct 2 17:05 b.txt

-rw-rw-r-- 6 ubuntu ubuntu 0 Oct 2 17:07 b1.txt

drwxr-xr-x 2 root root 4096 Oct 8 13:29 **newone**

drwxr-xr-x 2 root root 4096 Oct 8 13:29 **testd**

drwxr-xr-x 2 root root 4096 Oct 8 13:29 **octd**

drwxr-xr-x 2 root root 4096 Oct 8 13:29 **new**

-rw-r--r-- 1 root root 0 Oct 8 13:29 m1.txt

lrwxrwxrwx 1 root root 5 Oct 8 13:29 **linkd** -> d.txt

drwxr-xr-x 2 root root 4096 Oct 8 13:29 **gh.txt**

lrwxrwxrwx 1 root root 8 Oct 8 13:34 **s** -> **sync.txt**

Run the Program with /a/ and /data as arguments

Check the /data and you can see **s** -> **sync.txt is preserved**

ls -ltri /data

total 48

11 drwx------ 2 root root 16384 Sep 26 19:36 **lost+found**

1048577 drwxr-xr-x 2 root root 4096 Oct 1 05:01 **test**

12 -rw-r--r-- 1 root root 0 Oct 1 14:07 orig.txt

13 lrwxrwxrwx 1 root root 14 Oct 1 14:08 **dup.txt** -> /data/orig.txt

262145 drwxr-xr-x 2 root root 4096 Oct 1 14:25 **d1**

1179649 drwxr-xr-x 10 root root 4096 Oct 2 17:12 **proc**

131073 drwxr-xr-x 2 root root 4096 Oct 8 13:35 **newone**

786433 drwxr-xr-x 2 root root 4096 Oct 8 13:35 **testd**

15 lrwxrwxrwx 1 root root 8 Oct 8 13:35 **s** -> **sync.txt**

917505 drwxr-xr-x 2 root root 4096 Oct 8 13:35 **octd**

524289 drwxr-xr-x 2 root root 4096 Oct 8 13:35 **new**

16 -rw-r--r-- 1 root root 0 Oct 8 13:35 m1.txt

14 lrwxrwxrwx 1 root root 5 Oct 8 13:35 **linkd** -> **d.txt**

393217 drwxr-xr-x 2 root root 4096 Oct 8 13:35 **gh.txt**

Since the space was limited in the device , i interrupted using control+c

But some files and folders got copied to /data from / i.e /proc

ls -ltr /data

total 28

drwx------ 2 root root 16384 Sep 26 19:36 **lost+found**

drwxr-xr-x 2 root root 4096 Oct 1 05:01 **test**

-rw-r--r-- 1 root root 0 Oct 1 14:07 orig.txt

lrwxrwxrwx 1 root root 14 Oct 1 14:08 **dup.txt** -> /data/orig.txt

drwxr-xr-x 2 root root 4096 Oct 1 14:25 **d1**

drwxr-xr-x 10 root root 4096 Oct 2 17:12 **proc**

**Use Case 5** ) **Create hard link in the source folder and then execute sync and check whether the soft link is preserved or not.**

:**~/a**$ sudo touch km.txt

:**~/a**$ sudo ln km.txt kmhlink

ls -ltri a/

total 152

258470 -rw-rw-r-- 6 ubuntu ubuntu 0 Sep 30 19:58 test.txt

258470 -rw-rw-r-- 6 ubuntu ubuntu 0 Sep 30 19:58 hlink

347100 -rw-rw-r-- 3 ubuntu ubuntu 0 Oct 1 18:12 d.txt

347103 lrwxrwxrwx 1 root root 5 Oct 1 18:12 **linkd** -> d.txt

355497 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 04:57 **testd**

347150 -rwxrwxr-x 3 ubuntu ubuntu 47424 Oct 2 14:03 **rec**

347147 -rwxrwxr-x 3 ubuntu ubuntu 16272 Oct 2 14:03 **listDirC**

347148 -rwxrwxr-x 3 ubuntu ubuntu 16696 Oct 2 14:03 **copydir**

347149 -rwxrwxr-x 3 ubuntu ubuntu 47256 Oct 2 14:03 **copyRec**

355514 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 14:38 **gh.txt**

355518 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 17:05 **new**

347194 -rw-rw-r-- 6 ubuntu ubuntu 0 Oct 2 17:05 blink

347194 -rw-rw-r-- 6 ubuntu ubuntu 0 Oct 2 17:05 b.txt

355520 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 2 17:07 **newone**

347196 -rw-rw-r-- 3 ubuntu ubuntu 0 Oct 2 17:07 b1.txt

355531 drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 13:23 **octd**

347167 -rw-rw-r-- 1 ubuntu ubuntu 0 Oct 8 13:24 m1.txt

260189 -rw-rw-r-- 4 ubuntu ubuntu 0 Oct 8 14:19 zxhlink

260189 -rw-rw-r-- 4 ubuntu ubuntu 0 Oct 8 14:19 zx.txt

260144 -rw-r--r-- 2 root root 0 Oct 8 17:17 jkhlink

260144 -rw-r--r-- 2 root root 0 Oct 8 17:17 jk.txt

259431 -rw-r--r-- 2 root root 0 Oct 8 17:22 kmhlink

259431 -rw-r--r-- 2 root root 0 Oct 8 17:22 km.txt

Run the program : Use sudo for overcoming permission issues.

sudo ./syncpath a/ data/ 3

ls -ltri data/ | grep km

259431 -rw-r--r-- 4 root root 0 Oct 8 17:22 **km**hlink

259431 -rw-r--r-- 4 root root 0 Oct 8 17:22 **km**.txt

kmhlink is preserved in this case.

Use Case 6) Create a symlink in srcPath and then Run the program again to check the sync

In SrcPath create a Soft Link and then run the sync program

sudo ln -s aaaa.txt slinka

./syncpath a data

Copying directory: "a" to "data"

Copying: "a/octd" to "data/octd"

Copying: "a/hlink" to "data/hlink"

Copying: "a/rec" to "data/rec"

Copying: "a/copydir" to "data/copydir"

Copying: "a/b.txt" to "data/b.txt"

Copying: "a/jkhlink" to "data/jkhlink"

Copying: "a/blink" to "data/blink"

Copying: "a/newone" to "data/newone"

Copying: "a/zx.txt" to "data/zx.txt"

Copying: "a/testd" to "data/testd"

Copying: "a/jk.txt" to "data/jk.txt"

Copying: "a/km.txt" to "data/km.txt"

Copying: "a/b1.txt" to "data/b1.txt"

Copying: "a/test.txt" to "data/test.txt"

Copying: "a/linkd" to "data/linkd"

Copying: "a/d.txt" to "data/d.txt"

Copying: "a/kmhlink" to "data/kmhlink"

Copying: "a/gh.txt" to "data/gh.txt"

Copying: "a/aaslink" to "data/aaslink"

Copying: "a/zxhlink" to "data/zxhlink"

Copying: "a/m1.txt" to "data/m1.txt"

Copying: "a/slinka" to "data/slinka"

Copying: "a/listDirC" to "data/listDirC"

Copying: "a/new" to "data/new"

Copying: "a/copyRec" to "data/copyRec"

Hard link already exists at destination.

Copying directory: "a/testd" to "data/testd"

Copying: "a/testd/linkg" to "data/testd/linkg"

Copying: "a/testd/g.txt" to "data/testd/g.txt"

Copying directory: "a/newone" to "data/newone"

Hard link already exists at destination.

Hard link already exists at destination.

Hard link already exists at destination.

Hard link already exists at destination.

Hard link already exists at destination.

Hard link already exists at destination.

Hard link already exists at destination.

Hard link already exists at destination.

Hard link already exists at destination.

Copying symbolic link: "a/linkd" to "data/linkd"

Hard link already exists at destination.

Hard link already exists at destination.

Copying directory: "a/gh.txt" to "data/gh.txt"

Copying symbolic link: "a/aaslink" to "data/aaslink"

Hard link already exists at destination.

Hard link already exists at destination.

Copying file: "a/m1.txt" to "data/m1.txt"

Copying symbolic link: "a/slinka" to "data/slinka"

Hard link already exists at destination.

Copying directory: "a/new" to "data/new"

Hard link already exists at destination.

Copying symbolic link: "a/testd/linkg" to "data/testd/linkg"

Hard link already exists at destination.

Copying directory: "a/octd" to "data/octd"

Path Sync Completed Successfully!!

Check the data directory:

sudo ls -ltr data

total 152

-rw-rw-r-- 6 ubuntu ubuntu 0 Sep 30 19:58 test.txt

-rw-rw-r-- 6 ubuntu ubuntu 0 Sep 30 19:58 hlink

-rw-rw-r-- 3 ubuntu ubuntu 0 Oct 1 18:12 d.txt

-rwxrwxr-x 3 ubuntu ubuntu 47424 Oct 2 14:03 rec

-rwxrwxr-x 3 ubuntu ubuntu 16272 Oct 2 14:03 listDirC

-rwxrwxr-x 3 ubuntu ubuntu 16696 Oct 2 14:03 copydir

-rwxrwxr-x 3 ubuntu ubuntu 47256 Oct 2 14:03 copyRec

-rw-rw-r-- 6 ubuntu ubuntu 0 Oct 2 17:05 blink

-rw-rw-r-- 6 ubuntu ubuntu 0 Oct 2 17:05 b.txt

-rw-rw-r-- 3 ubuntu ubuntu 0 Oct 2 17:07 b1.txt

-rw-rw-r-- 4 ubuntu ubuntu 0 Oct 8 14:19 zxhlink

-rw-rw-r-- 4 ubuntu ubuntu 0 Oct 8 14:19 zx.txt

-rw-r--r-- 4 root root 0 Oct 8 17:17 jkhlink

-rw-r--r-- 4 root root 0 Oct 8 17:17 jk.txt

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 17:22 testd

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 17:22 octd

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 17:22 newone

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 17:22 new

lrwxrwxrwx 1 ubuntu ubuntu 5 Oct 8 17:22 linkd -> d.txt

drwxrwxr-x 2 ubuntu ubuntu 4096 Oct 8 17:22 gh.txt

-rw-r--r-- 4 root root 0 Oct 8 17:22 kmhlink

-rw-r--r-- 4 root root 0 Oct 8 17:22 km.txt

lrwxrwxrwx 1 root root 8 Oct 8 17:29 slinka -> aaaa.txt

Observe the below Soft link is preserved.

slinka -> aaaa.txt

**Handling Some Unwanted Exceptions**:

./syncpath /a /data

Where /a and /data is cross file system.

Below Output:

Error creating hard link: Invalid cross-device link

Copying symbolic link: "a/testd/linkg" to "/data/testd/linkg"

Error creating hard link: Invalid cross-device link

terminate called after throwing an instance of 'std::filesystem::\_\_cxx11::filesystem\_error'

what(): filesystem error: cannot create symlink: File exists [g.txt] [/data/testd/linkg]

Aborted

Some Important Exceptions when using two different type of file system used for both the source and destination directories.

I.e /a and /data are mounted on two different partitions and two different file system.

filesystem error: cannot create hard link: Invalid cross-device link

Observation. Hardlinks cannot be created between different partitions, only symlinks can.