Project 3 Report

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1. 구현 방법

RAID 5를 구현하기 위해 다음 사항들을 구현했다.

a. bio.c

bread()	다음 과정을 통해 buffer block b를 return한다. 1. 이미 caching된 buffer block이면 return한다 2. Caching 된 block이 아니라면 우선 해당 block이 몇번 disk에 있는지와 상응하는 parity block의 disk 위치를 구한다. 이때, block number에서 천의 자리 수를 뺀 나머지를 block_offset이라 정의하고, 이 block_offset을 3으로 modular 연산 한 결과를 parity block이 위치한 disk로 정의했다. 3. 만약 읽어오고자 하는 disk가 BROKEN_DISK이면, parity block을 구할 때 사용하는 다른 block b2와 parity block을 이용해 XOR 연산으로 데이터를 복구하고, 복구된 데이터를 b에 넣어 return한다. 4. 만약 읽어오고자 하는 데이터가 disk에 있다면, 해당 데이터를 읽어서 b에 넣은 후 return한다.
bwrite()	다음 과정을 통해 buffer block b를 disk에 기록한다. 1. 우선, 쓰고자 하는 block이 쓰여야 하는 disk 위치와 parity block의 위치를 구한다. Parity block을 구하는 규칙은 bread()와 동일하다 2. 이후 네가지 경우로 나누어 disk에 block을 기록한다 A. parity block이 BROKEN_DISK에 위치한 경우: 따로 parity block을 계산해서 기록할 필요 없이 block을 disk에 기록한다. B. Parity block을 구할 때 사용하는 다른 block b2가 BROKEN_DISK에 있는 경우: disk에 있는 update 되지 않은 b인 b′을 불러온 다음, b2를 parity block과 b′를 이용해 복구한다. 이후, 복구된 b2와 b를 이용해 parity block을 새로 계산한 후, parity block과 b를 disk에 기록한다. C. b가 BROKEN_DISK에 위치한 경우: b2와 parity block을 disk에서 불러온 다음, b와 b2를 이용해 parity block을 구한 다음, parity block만 disk에 기록한다. D. 모든 disk가 정상적이다: b2와 parity block을 disk에서 불러 온 다음 parity block을 다시 계산해서 b와 parity block을 disk에 기록한다.

b. mkfs_2.c

tmp.img에 저장된 데이터를 block 단위로 parity block을 만든 다음, bread()와 bwrite()에서 사용된 parity block 규칙을 이용해서 fs.img에 기록한다. 이때, tmp.img는 총 1000개의 block을 최초에 가지고 있으므로 1000~1999에 해당하는 내용은 모두 0으로 간주한 다음 parity block을 계산했다. 또한, fs.img의 size 3000에 맞춰서 ftruncate 함수에 (FSSIZE * 3) * BSIZE를 넣었다.

c. param.h, ide.c

param.h에 있는 FSSIZE는 기존과 동일하게 1000으로 두었다. mkfs_2.c, ide.c에서 physical disk을 초기화할 때는 FSSIZE * 3을 이용하고, logical disk의 범위는 FSSIZE * 2로 고려해 코드를 작성했다. 또한, disk block cache의 크기를 정하는 NBUF를 기존 (MAXOPBLOCKS*3)에서 (MAXOPBLOCKS*30)으로 키웠다.

2. usertests 결과

Usertests를 BROKEN_DISK 값을 -1, 0, 1, 2로 두고 실행했을 때, 모든 test를 통과했다. 결과 사진은 밑에 첨부되어 있다.

param.h에서 disk block cache의 크기를 기존의 10배인 MAXOPBLOCKS*30으로 키웠다. 이는 기존 disk block cache의 크기를 유지한 채 usertest를 실행하면 test 도중 buffer의 크기가 부족하다는 kernel panic이 일어났기 때문이다. 현재 구현에서는 bread()와 bwrite() 내부에서 parity block을 계산하는 과정에서 buffer를 추가로 할당받는다. 이때, bread()의 경우 기존 buffer b 이외에도 parity block과 복구를 위해 필요한 다른 block b2를 추가로 사용하면 buffer 속 block을 최대 3개 사용하고, bwrite()의 경우에는 최대 4개의 buffer block이 사용된다. 이는 기존 RAID 1에서 각각 최대 2개의 buffer block을 사용하는 것과 차이가 있다. Test 과정에서 buffer io가 과도하게 많이 사용된다면, 기존 disk block cache로는 buffer io를 모두 처리할 수 없는 것으로 생각한다. 이 때문에 buffer의 size를 기존의 10배로 늘렸다.

```
SeaBIOS (version 1.15.0-1)


iPXE (https://ipxe.org) 00:03.0 CA00 PCI2.10 PnP PMM+1FF8B4A0+1FECB4A0 CA00



Booting from Hard Disk..xv6...
RAID: broken disk is 0
cpu0: starting 0
sb: size 1000 nblocks 941 ninodes 200 nlog 30 logstart 2 inodestart 32 bmap start 58
init: starting sh
$ usertests
usertests starting
arg test passed
createdelete test
createdelete ok
linkunlink test
linkunlink ok
concreate test
concreate ok
fourfiles test
fourfiles ok
sharedfd test
sharedfd ok
bigarg test
bigarg test ok
bigwrite test
bigwrite ok
bigarg test
bigarg test ok
bss test
bss test ok
sbrk test
pid 97 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80000000--kill proc
pid 98 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8000c350--kill proc
pid 99 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800186a0--kill proc
pid 100 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800249f0--kill proc
pid 101 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80030d40--kill proc
pid 102 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8003d090--kill proc
pid 103 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800493e0--kill proc
pid 104 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80055730--kill proc
pid 105 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80061a80--kill proc
pid 106 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8006ddd0--kill proc
pid 107 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8007a120--kill proc
pid 108 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80086470--kill proc
pid 109 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800927c0--kill proc
pid 110 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8009eb10--kill proc
pid 111 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800aae60--kill proc
pid 112 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800b71b0--kill proc
pid 113 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800c3500--kill proc
pid 114 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800cf850--kill proc
pid 115 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800dbba0--kill proc
pid 116 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800e7ef0--kill proc
pid 117 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800f4240--kill proc
```

Figure 1-1 : BROKEN_DISK=0, SEED=1일 때 uesrtests

```
pid 117 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800f4240--kill proc
pid 118 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80100590--kill proc
pid 119 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8010c8e0--kill proc
pid 120 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80118c30--kill proc
pid 121 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80124f80--kill proc
pid 122 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801312d0--kill proc
pid 123 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8013d620--kill proc
pid 124 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80149970--kill proc
pid 125 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80155cc0--kill proc
pid 126 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80162010--kill proc
pid 127 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8016e360--kill proc
pid 128 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8017a6b0--kill proc
pid 129 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80186a00--kill proc
pid 130 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80192d50--kill proc
pid 131 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8019f0a0--kill proc
pid 132 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801ab3f0--kill proc
pid 133 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801b7740--kill proc
pid 134 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801c3a90--kill proc
pid 135 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801cfde0--kill proc
pid 136 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801dc130--kill proc
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
sbrk test OK
validate test
validate ok
open test
open test ok
small file test
creat small succeeded; ok
writes ok
open small succeeded ok
read succeeded ok
small file test ok
big files test
big files ok
many creates, followed by unlink test
many creates, followed by unlink; ok
openiput test
openiput test ok
exitiput test
exitiput test ok
iput test
iput test ok
mem test
allocuvm out of memory
mem ok
pipe1 ok
preempt: kill... wait... preempt ok
```

Figure 1-2 : BROKEN_DISK=0, SEED=1일 때 usertests

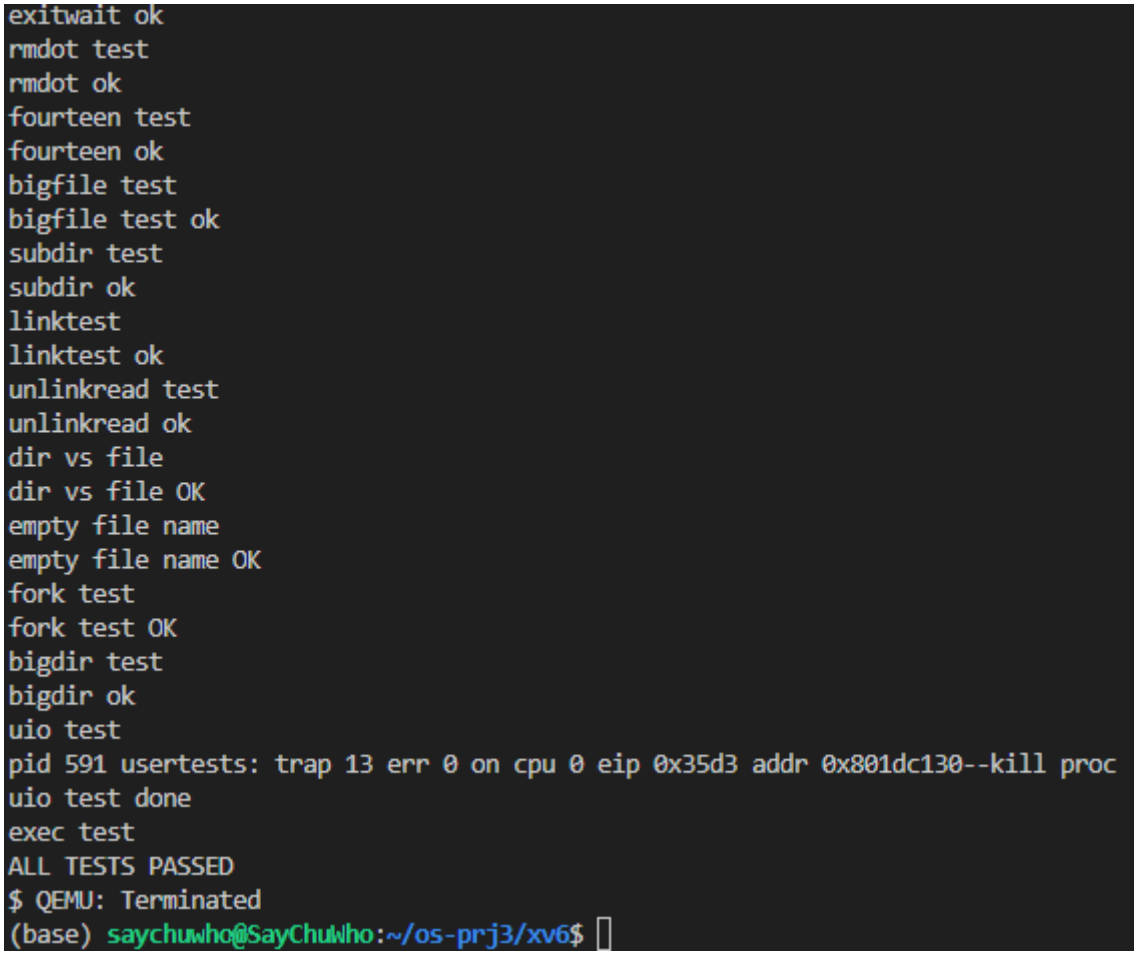

Figure 1-3 : BROKEN_DISKS=0 SEED=1일 때 usertests

```
SeaBIOS (version 1.15.0-1)


iPXE (https://ipxe.org) 00:03.0 CA00 PCI2.10 PnP PMM+1FF8B4A0+1FECB4A0 CA00



Booting from Hard Disk..xv6...
RAID: broken disk is 1
cpu0: starting 0
sb: size 1000 nblocks 941 ninodes 200 nlog 30 logstart 2 inodestart 32 bmap start 58
init: starting sh
$ usertests
usertests starting
arg test passed
createdelete test
createdelete ok
linkunlink test
linkunlink ok
concreate test
concreate ok
fourfiles test
fourfiles ok
sharedfd test
sharedfd ok
bigarg test
bigarg test ok
bigwrite test
bigwrite ok
bigarg test
bigarg test ok
bss test
bss test ok
sbrk test
pid 97 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80000000--kill proc
pid 98 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8000c350--kill proc
pid 99 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800186a0--kill proc
pid 100 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800249f0--kill proc
pid 101 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80030d40--kill proc
pid 102 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8003d090--kill proc
pid 103 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800493e0--kill proc
pid 104 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80055730--kill proc
pid 105 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80061a80--kill proc
pid 106 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8006ddd0--kill proc
pid 107 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8007a120--kill proc
pid 108 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80086470--kill proc
pid 109 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800927c0--kill proc
pid 110 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8009eb10--kill proc
pid 111 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800aae60--kill proc
pid 112 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800b71b0--kill proc
pid 113 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800c3500--kill proc
pid 114 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800cf850--kill proc
pid 115 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800dbba0--kill proc
pid 116 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800e7ef0--kill proc
pid 117 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800f4240--kill proc
```

Figure 2 : BROKEN_DISK=1, SEED=1일 때 usertests

```
pid 118 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80100590--kill proc
pid 119 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8010c8e0--kill proc
pid 120 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80118c30--kill proc
pid 121 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80124f80--kill proc
pid 122 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801312d0--kill proc
pid 123 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8013d620--kill proc
pid 124 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80149970--kill proc
pid 125 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80155cc0--kill proc
pid 126 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80162010--kill proc
pid 127 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8016e360--kill proc
pid 128 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8017a6b0--kill proc
pid 129 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80186a00--kill proc
pid 130 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80192d50--kill proc
pid 131 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8019f0a0--kill proc
pid 132 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801ab3f0--kill proc
pid 133 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801b7740--kill proc
pid 134 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801c3a90--kill proc
pid 135 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801cfde0--kill proc
pid 136 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801dc130--kill proc
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
sbrk test OK
validate test
validate ok
open test
open test ok
small file test
creat small succeeded; ok
writes ok
open small succeeded ok
read succeeded ok
small file test ok
big files test
big files ok
many creates, followed by unlink test
many creates, followed by unlink; ok
openiput test
openiput test ok
exitiput test
exitiput test ok
iput test
iput test ok
mem test
allocuvm out of memory
mem ok
pipe1 ok
preempt: kill... wait... preempt ok
```

Figure 2-2 : BROKEN_DISK=1, SEED=1일 때 usertests

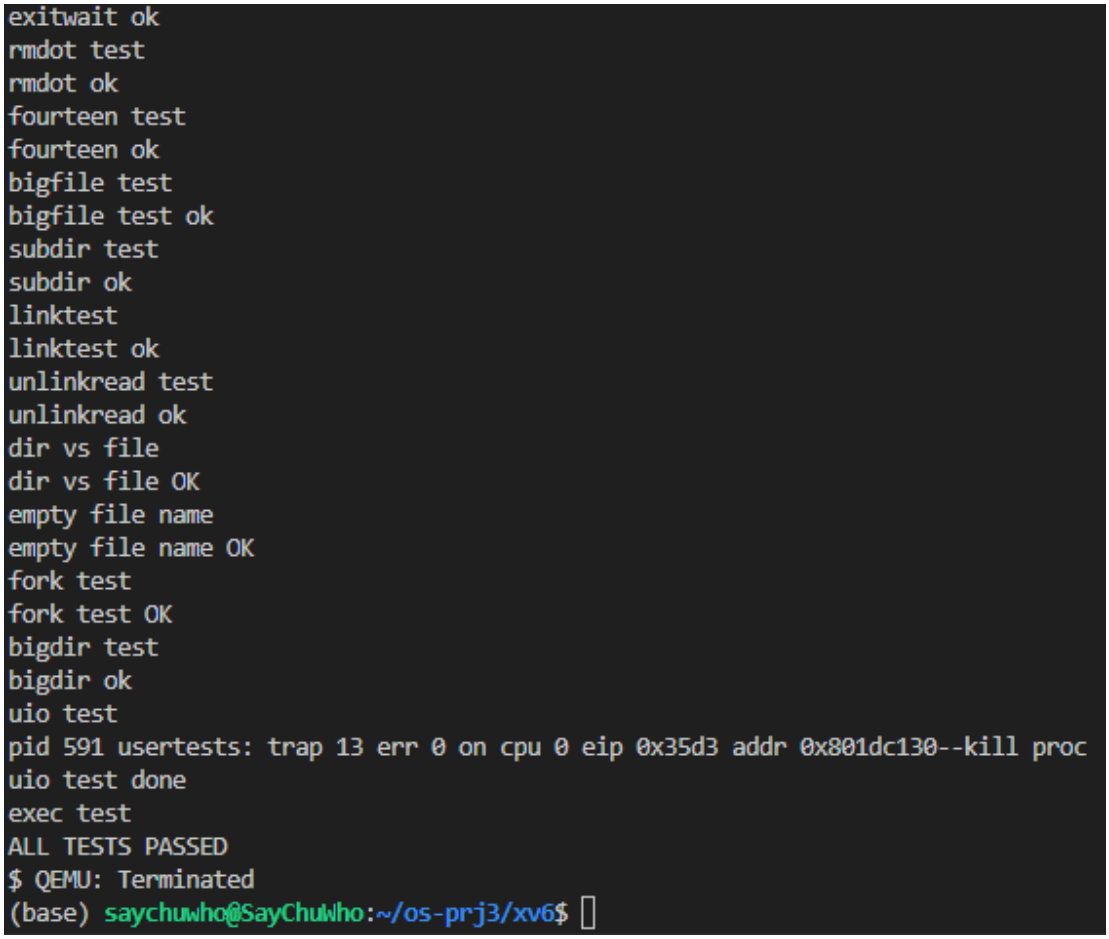

Figure 2-3 : BROKEN_DISK=1, SEED=1일 때 usertests

```
SeaBIOS (version 1.15.0-1)


iPXE (https://ipxe.org) 00:03.0 CA00 PCI2.10 PnP PMM+1FF8B4A0+1FECB4A0 CA00



Booting from Hard Disk..xv6...
RAID: broken disk is 2
cpu0: starting 0
sb: size 1000 nblocks 941 ninodes 200 nlog 30 logstart 2 inodestart 32 bmap start 58
init: starting sh
$ usertests
usertests starting
arg test passed
createdelete test
createdelete ok
linkunlink test
linkunlink ok
concreate test
concreate ok
fourfiles test
fourfiles ok
sharedfd test
sharedfd ok
bigarg test
bigarg test ok
bigwrite test
bigwrite ok
bigarg test
bigarg test ok
bss test
bss test ok
sbrk test
pid 97 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80000000--kill proc
pid 98 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8000c350--kill proc
pid 99 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800186a0--kill proc
pid 100 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800249f0--kill proc
pid 101 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80030d40--kill proc
pid 102 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8003d090--kill proc
pid 103 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800493e0--kill proc
pid 104 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80055730--kill proc
pid 105 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80061a80--kill proc
pid 106 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8006ddd0--kill proc
pid 107 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8007a120--kill proc
pid 108 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80086470--kill proc
pid 109 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800927c0--kill proc
pid 110 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8009eb10--kill proc
pid 111 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800aae60--kill proc
pid 112 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800b71b0--kill proc
pid 113 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800c3500--kill proc
pid 114 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800cf850--kill proc
pid 115 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800dbba0--kill proc
pid 116 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800e7ef0--kill proc
pid 117 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800f4240--kill proc
```

Figure 3-1 : BROKEN_DISK=2, SEED=1일 때 usertests

```
pid 118 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80100590--kill proc
pid 119 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8010c8e0--kill proc
pid 120 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80118c30--kill proc
pid 121 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80124f80--kill proc
pid 122 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801312d0--kill proc
pid 123 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8013d620--kill proc
pid 124 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80149970--kill proc
pid 125 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80155cc0--kill proc
pid 126 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80162010--kill proc
pid 127 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8016e360--kill proc
pid 128 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8017a6b0--kill proc
pid 129 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80186a00--kill proc
pid 130 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80192d50--kill proc
pid 131 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8019f0a0--kill proc
pid 132 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801ab3f0--kill proc
pid 133 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801b7740--kill proc
pid 134 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801c3a90--kill proc
pid 135 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801cfde0--kill proc
pid 136 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801dc130--kill proc
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
sbrk test OK
validate test
validate ok
open test
open test ok
small file test
creat small succeeded; ok
writes ok
open small succeeded ok
read succeeded ok
small file test ok
big files test
big files ok
many creates, followed by unlink test
many creates, followed by unlink; ok
openiput test
openiput test ok
exitiput test
exitiput test ok
iput test
iput test ok
mem test
allocuvm out of memory
mem ok
pipe1 ok
preempt: kill... wait... preempt ok
```

Figure 3-2 : BROKEN_DISK=2, SEED=1일 때 usertests

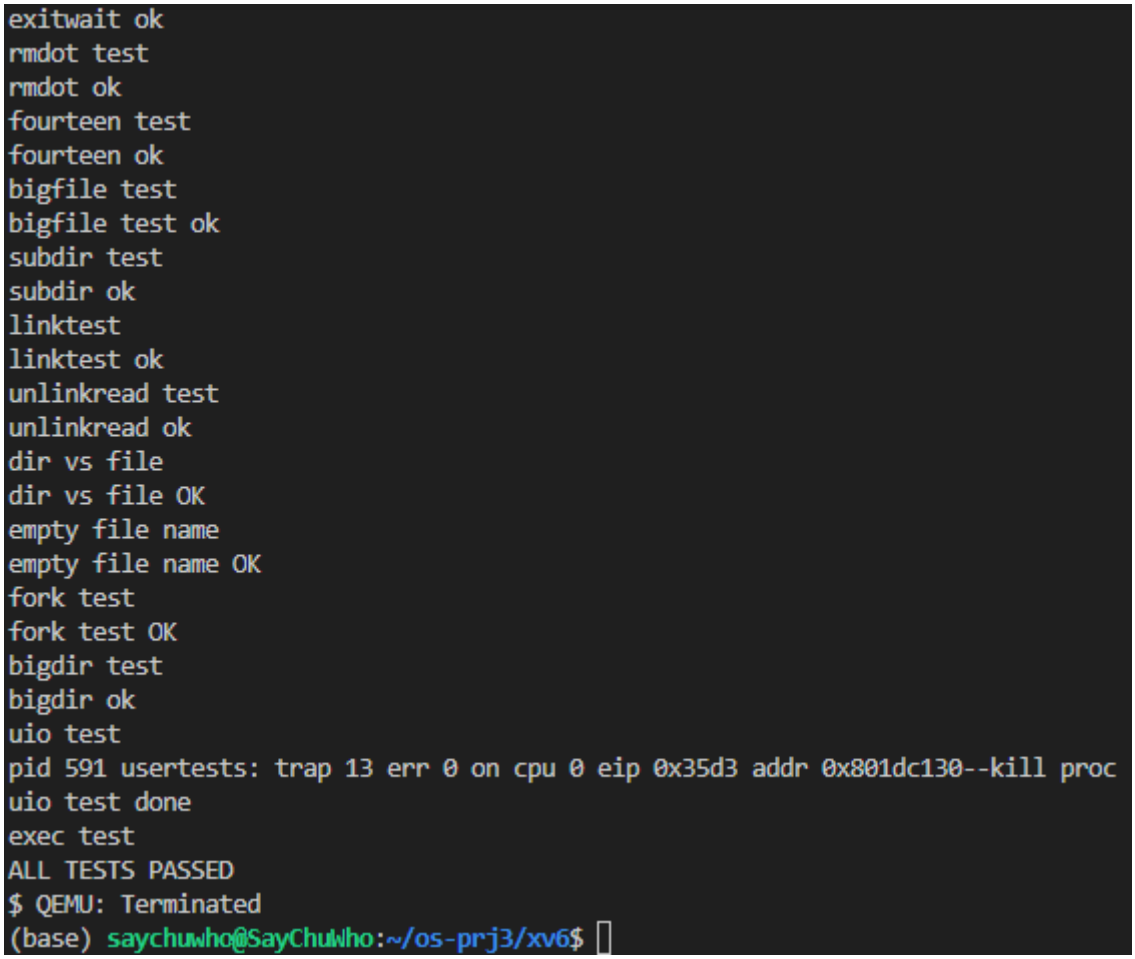

Figure 3-3 : BROKEN_DISK=2, SEED=1일 때 usertests

```
SeaBIOS (version 1.15.0-1)


iPXE (https://ipxe.org) 00:03.0 CA00 PCI2.10 PnP PMM+1FF8B4A0+1FECB4A0 CA00



Booting from Hard Disk..xv6...
RAID: broken disk is -1
cpu0: starting 0
sb: size 1000 nblocks 941 ninodes 200 nlog 30 logstart 2 inodestart 32 bmap start 58
init: starting sh
$ usertests
usertests starting
arg test passed
createdelete test
createdelete ok
linkunlink test
linkunlink ok
concreate test
concreate ok
fourfiles test
fourfiles ok
sharedfd test
sharedfd ok
bigarg test
bigarg test ok
bigwrite test
bigwrite ok
bigarg test
bigarg test ok
bss test
bss test ok
sbrk test
pid 97 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80000000--kill proc
pid 98 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8000c350--kill proc
pid 99 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800186a0--kill proc
pid 100 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800249f0--kill proc
pid 101 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80030d40--kill proc
pid 102 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8003d090--kill proc
```

Figure 4-1 : BROKEN_DISK=-1, SEED=1일 때 usertests

```
pid 103 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800493e0--kill proc
pid 104 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80055730--kill proc
pid 105 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80061a80--kill proc
pid 106 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8006ddd0--kill proc
pid 107 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8007a120--kill proc
pid 108 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80086470--kill proc
pid 109 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800927c0--kill proc
pid 110 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8009eb10--kill proc
pid 111 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800aae60--kill proc
pid 112 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800b71b0--kill proc
pid 113 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800c3500--kill proc
pid 114 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800cf850--kill proc
pid 115 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800dbba0--kill proc
pid 116 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800e7ef0--kill proc
pid 117 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x800f4240--kill proc
pid 118 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80100590--kill proc
pid 119 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8010c8e0--kill proc
pid 120 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80118c30--kill proc
pid 121 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80124f80--kill proc
pid 122 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801312d0--kill proc
pid 123 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8013d620--kill proc
pid 124 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80149970--kill proc
pid 125 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80155cc0--kill proc
pid 126 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80162010--kill proc
pid 127 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8016e360--kill proc
pid 128 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8017a6b0--kill proc
pid 129 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80186a00--kill proc
pid 130 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x80192d50--kill proc
pid 131 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x8019f0a0--kill proc
pid 132 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801ab3f0--kill proc
pid 133 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801b7740--kill proc
pid 134 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801c3a90--kill proc
pid 135 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801cfde0--kill proc
pid 136 usertests: trap 14 err 5 on cpu 0 eip 0x3079 addr 0x801dc130--kill proc
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
allocuvm out of memory
sbrk test OK
validate test
validate ok
```

Figure 4-2 : BROKEN_DISK=-1, SEED=1일 때 usertests

```
open test
open test ok
small file test
creat small succeeded; ok
writes ok
open small succeeded ok
read succeeded ok
small file test ok
big files test
big files ok
many creates, followed by unlink test
many creates, followed by unlink; ok
openiput test
openiput test ok
exitiput test
exitiput test ok
iput test
iput test ok
mem test
allocuvm out of memory
mem ok
pipe1 ok
preempt: kill... wait... preempt ok
exitwait ok
rmdot test
rmdot ok
fourteen test
fourteen ok
bigfile test
bigfile test ok
subdir test
subdir ok
linktest
linktest ok
unlinkread test
unlinkread ok
dir vs file
dir vs file OK
empty file name
empty file name OK
fork test
fork test OK
bigdir test
bigdir ok
uio test
pid 591 usertests: trap 13 err 0 on cpu 0 eip 0x35d3 addr 0x801dc130--kill proc
uio test done
exec test
ALL TESTS PASSED
$ QEMU: Terminated
(base) saychuwho@SayChuWho:~/os-prj3/xv6$
```

Figure 4-3 : BROKEN_DISK=-1, SEED=1일 때 usertests