CSC3150 Assignment1 Report
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Design:

Program 1 includes these steps:

1. Fork a child process to execute test programs.
2. The parent process receives the SIGCHLD signal when child process finishes execution.
3. Print out the termination information of child process.

I fork a process using fork(). Then print out the information of child process and execute the file. In parent process, use waitpid() to wait child process finish. Then get status returned by child process. Judge the signal using switch-case and print out proper information about signal, termination and exit status.

Program 2 includes these steps:

1. Create a kernel thread and run my_fork function.
2. Fork a process to execute the test program.
3. The parent process will wait until child process terminates.
4. Catch the signal and print out related message in kernel log.

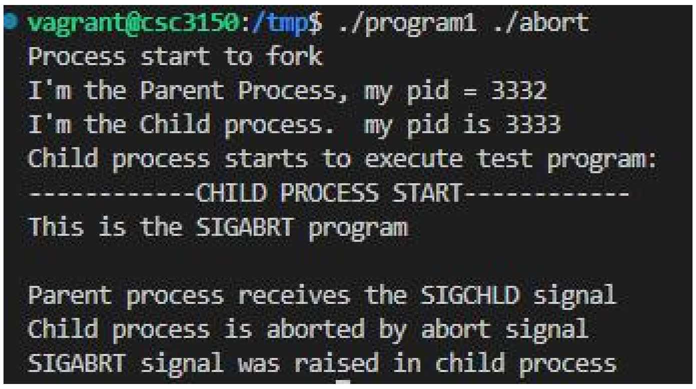
I first create kernel thread using kthread_create() and run my_fork(). Then fork a process using kernel_thread() and run my_exec to execute a test program in child process. in my_exec, run the test file. Then we get pid. Print out the information about pid of child and parent process. Wait until child process terminates using my_wait(). In my_wait(), use struct wait_opts wo and call do_wait() to do the waiting action. Then get status wo.wo_stat and judge the signal and print information about it. Finally, exit the module.

Set up development environment:

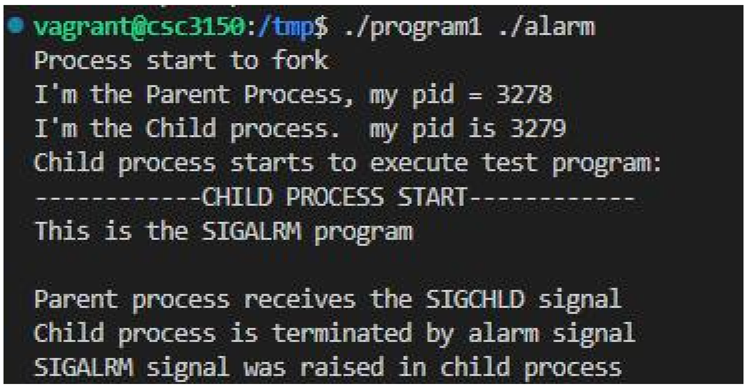
I installed vitrualbox and vagrant, and configured and installed vagrant virtual machine. Set up vscode remote SSH plugin. Connect to virtual machine using vscode. For compile kernel, I install and decompress the Linux kernel source code. Enter the commands that starting with "make" to clean previous setting and start configure, and build kernel Image and module. Then install kernel module and kernel. Then reboot. I select and found the functions which used in program2(do_execve, do_wait, getname_kernel, kernel_thread) and add EXPORT_SYMBOL() after the function's definition in source code's .c files. Then I recompile kernel starting from the step "make bzImage". Set up finished.

Screenshot of program output:

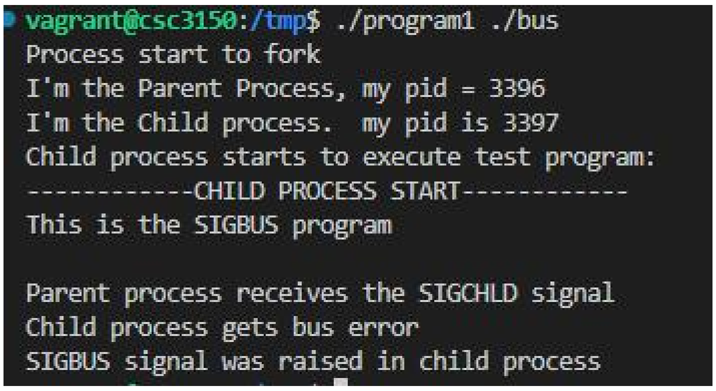
Program1:



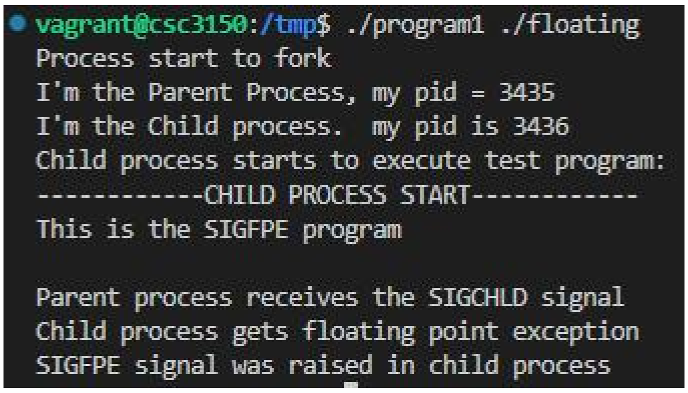
```
vagrant@csc3150:/tmp$ ./program1 ./abort
Process start to fork
I'm the Parent Process, my pid = 3332
I'm the Child process.  my pid is 3333
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGABRT program

Parent process receives the SIGCHLD signal
Child process is aborted by abort signal
SIGABRT signal was raised in child process
```



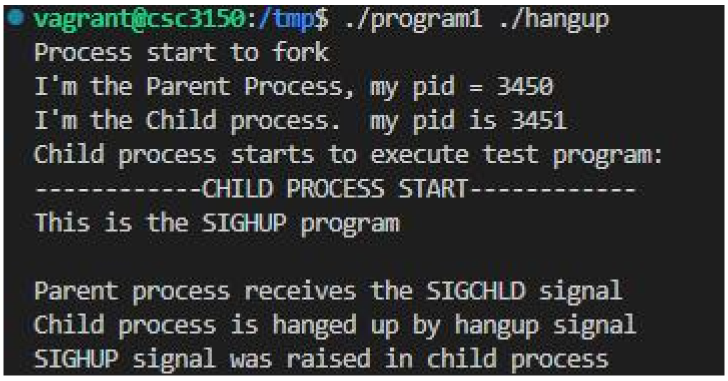
```
vagrant@csc3150:/tmp$ ./program1 ./alarm
Process start to fork
I'm the Parent Process, my pid = 3278
I'm the Child process.  my pid is 3279
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGALRM program

Parent process receives the SIGCHLD signal
Child process is terminated by alarm signal
SIGALRM signal was raised in child process
```



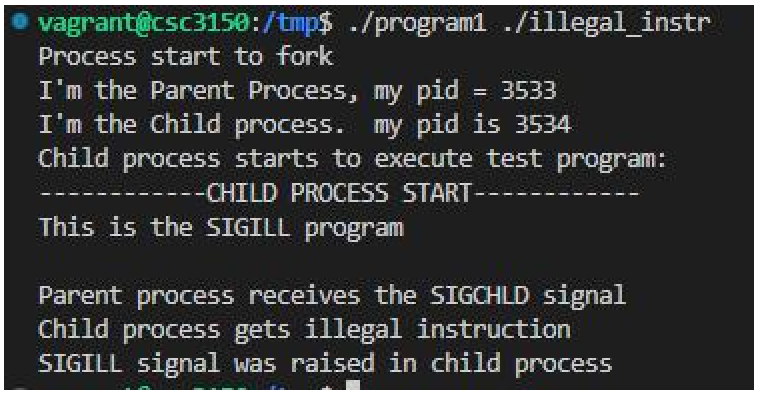
```
vagrant@csc3150:/tmp$ ./program1 ./bus
Process start to fork
I'm the Parent Process, my pid = 3396
I'm the Child process.  my pid is 3397
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGBUS program

Parent process receives the SIGCHLD signal
Child process gets bus error
SIGBUS signal was raised in child process
```



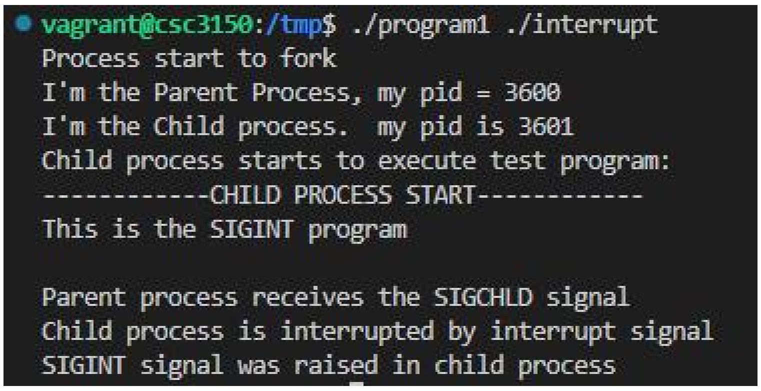
```
vagrant@csc3150:/tmp$ ./program1 ./floating
Process start to fork
I'm the Parent Process, my pid = 3435
I'm the Child process.  my pid is 3436
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGFPE program

Parent process receives the SIGCHLD signal
Child process gets floating point exception
SIGFPE signal was raised in child process
```



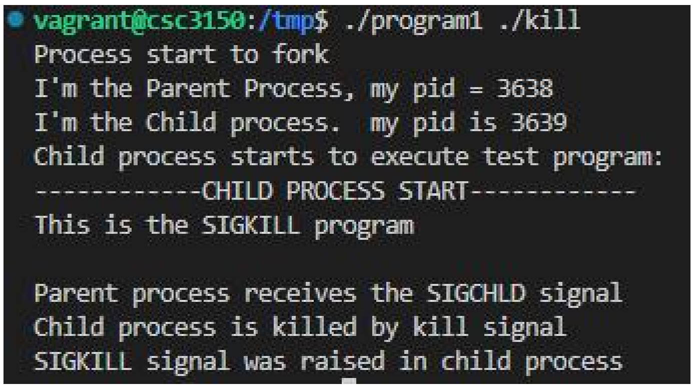
```
vagrant@csc3150:/tmp$ ./program1 ./hangup
Process start to fork
I'm the Parent Process, my pid = 3450
I'm the Child process.  my pid is 3451
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGHUP program

Parent process receives the SIGCHLD signal
Child process is hanged up by hangup signal
SIGHUP signal was raised in child process
```



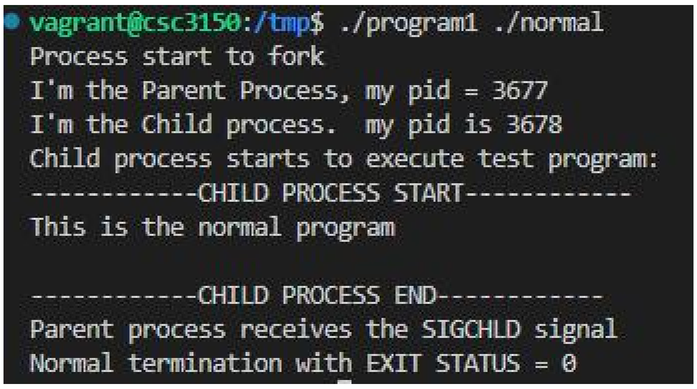
```
vagrant@csc3150:/tmp$ ./program1 ./illegal_instr
Process start to fork
I'm the Parent Process, my pid = 3533
I'm the Child process.  my pid is 3534
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGILL program

Parent process receives the SIGCHLD signal
Child process gets illegal instruction
SIGILL signal was raised in child process
```



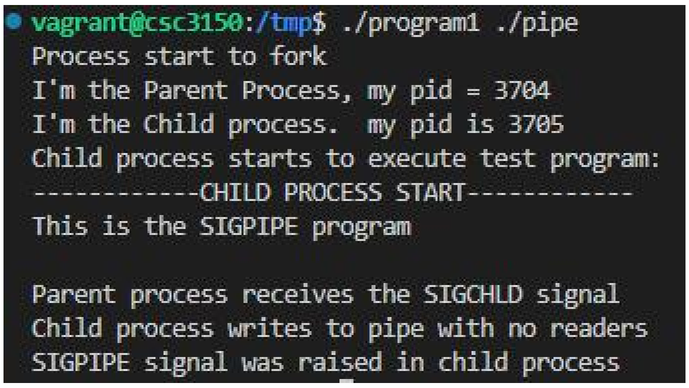
```
vagrant@csc3150:/tmp$ ./program1 ./interrupt
Process start to fork
I'm the Parent Process, my pid = 3600
I'm the Child process.  my pid is 3601
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGINT program

Parent process receives the SIGCHLD signal
Child process is interrupted by interrupt signal
SIGINT signal was raised in child process
```



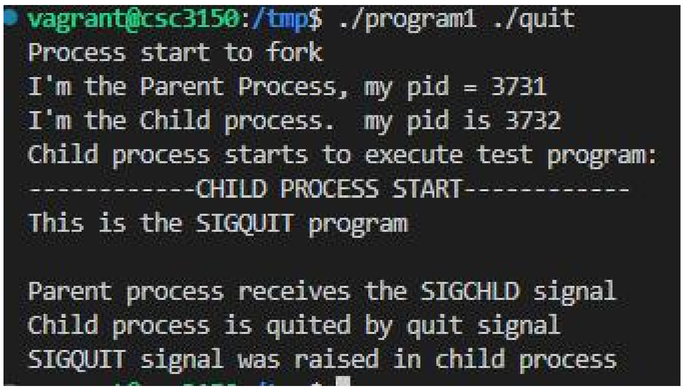
```
vagrant@csc3150:/tmp$ ./program1 ./kill
Process start to fork
I'm the Parent Process, my pid = 3638
I'm the Child process.  my pid is 3639
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGKILL program

Parent process receives the SIGCHLD signal
Child process is killed by kill signal
SIGKILL signal was raised in child process
```



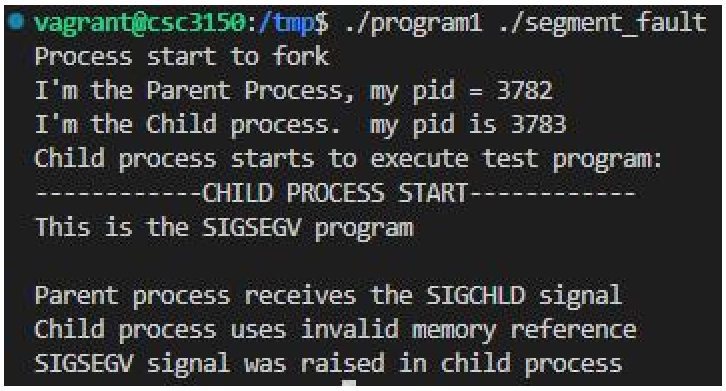
```
vagrant@csc3150:/tmp$ ./program1 ./normal
Process start to fork
I'm the Parent Process, my pid = 3677
I'm the Child process.  my pid is 3678
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the normal program

------------CHILD PROCESS END------------
Parent process receives the SIGCHLD signal
Normal termination with EXIT STATUS = 0
```



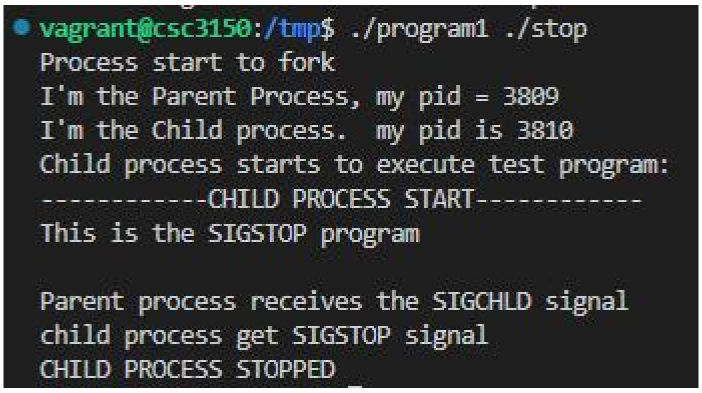
```
vagrant@csc3150:/tmp$ ./program1 ./pipe
Process start to fork
I'm the Parent Process, my pid = 3704
I'm the Child process.  my pid is 3705
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGPIPE program

Parent process receives the SIGCHLD signal
Child process writes to pipe with no readers
SIGPIPE signal was raised in child process
```



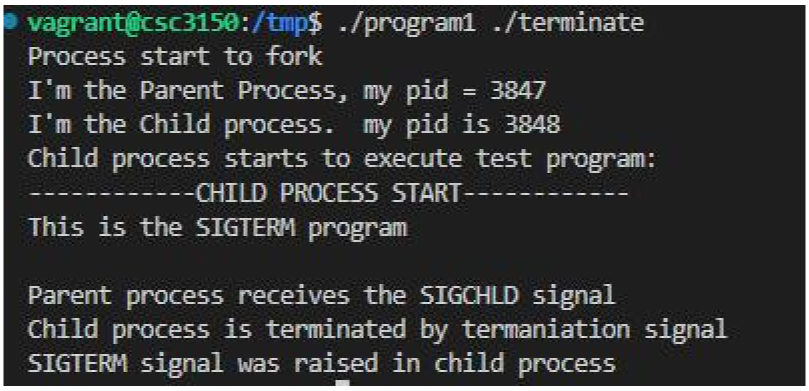
```
vagrant@csc3150:/tmp$ ./program1 ./quit
Process start to fork
I'm the Parent Process, my pid = 3731
I'm the Child process.  my pid is 3732
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGQUIT program

Parent process receives the SIGCHLD signal
Child process is quited by quit signal
SIGQUIT signal was raised in child process
```



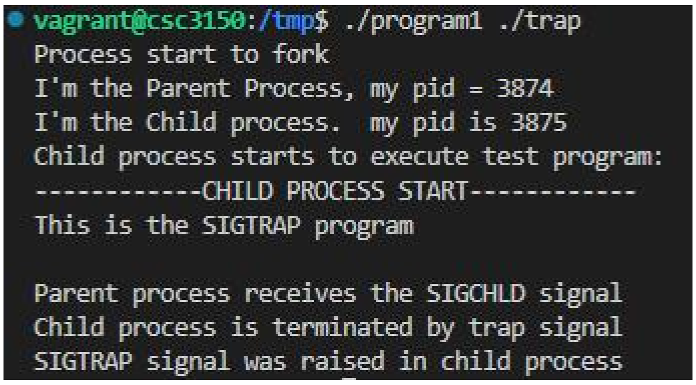
```
vagrant@csc3150:/tmp$ ./program1 ./segment_fault
Process start to fork
I'm the Parent Process, my pid = 3782
I'm the Child process.  my pid is 3783
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGSEGV program

Parent process receives the SIGCHLD signal
Child process uses invalid memory reference
SIGSEGV signal was raised in child process
```



```
vagrant@csc3150:/tmp$ ./program1 ./stop
Process start to fork
I'm the Parent Process, my pid = 3809
I'm the Child process.  my pid is 3810
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGSTOP program

Parent process receives the SIGCHLD signal
child process get SIGSTOP signal
CHILD PROCESS STOPPED
```

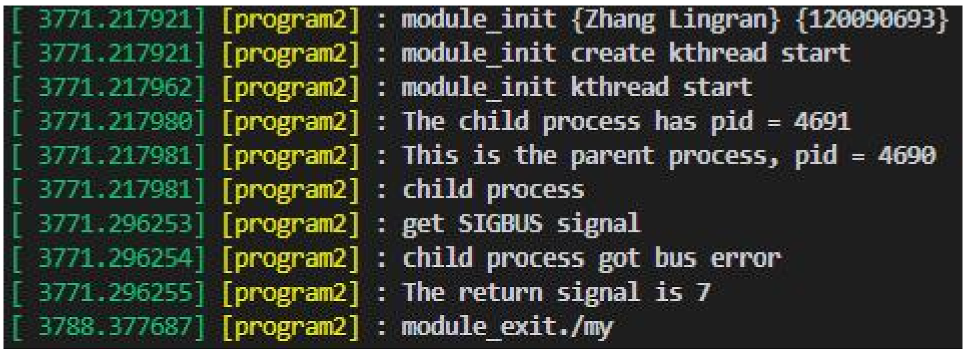


```
vagrant@csc3150:/tmp$ ./program1 ./terminate
Process start to fork
I'm the Parent Process, my pid = 3847
I'm the Child process.  my pid is 3848
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGTERM program

Parent process receives the SIGCHLD signal
Child process is terminated by termaniation signal
SIGTERM signal was raised in child process
```

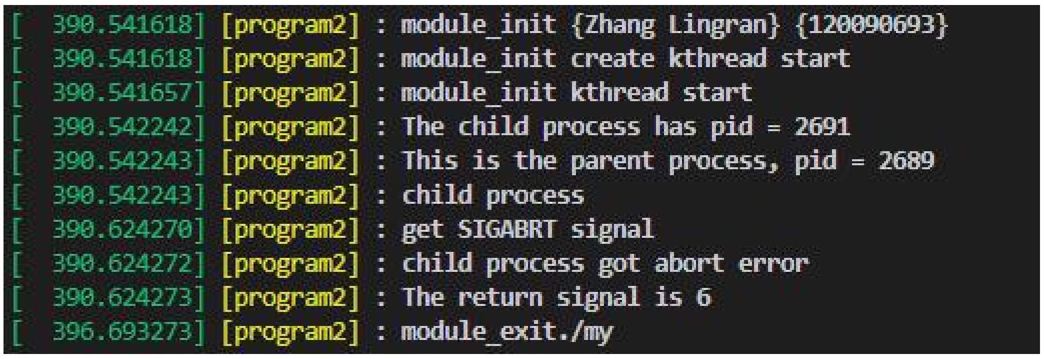


```
vagrant@csc3150:/tmp$ ./program1 ./trap
Process start to fork
I'm the Parent Process, my pid = 3874
I'm the Child process.  my pid is 3875
Child process starts to execute test program:
------------CHILD PROCESS START------------
This is the SIGTRAP program

Parent process receives the SIGCHLD signal
Child process is terminated by trap signal
SIGTRAP signal was raised in child process
```

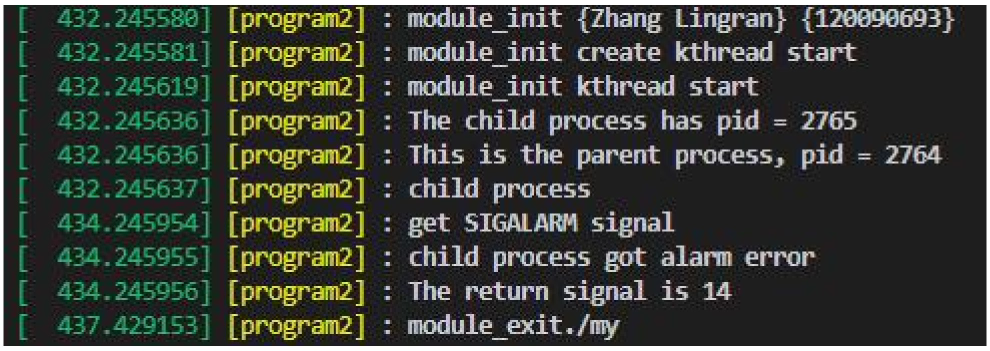
Program2:



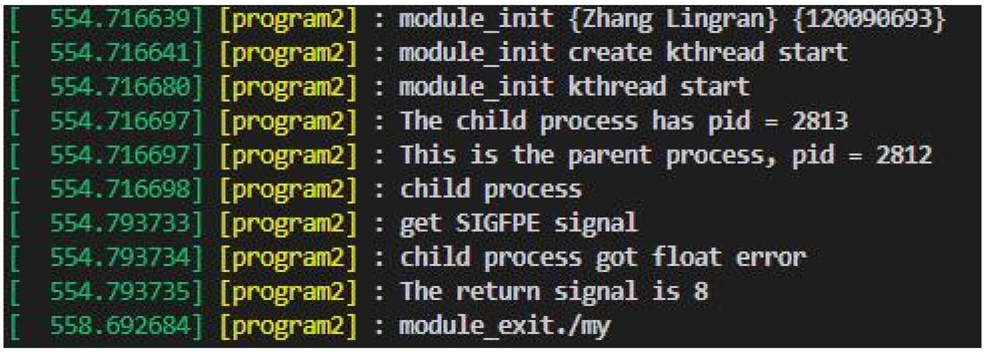
```
[ 3771.217921] [program2] : module_init {Zhang Lingran} {120090693}
[ 3771.217921] [program2] : module_init create kthread start
[ 3771.217962] [program2] : module_init kthread start
[ 3771.217980] [program2] : The child process has pid = 4691
[ 3771.217981] [program2] : This is the parent process, pid = 4690
[ 3771.217981] [program2] : child process
[ 3771.296253] [program2] : get SIGBUS signal
[ 3771.296254] [program2] : child process got bus error
[ 3771.296255] [program2] : The return signal is 7
[ 3788.377687] [program2] : module_exit./my
```



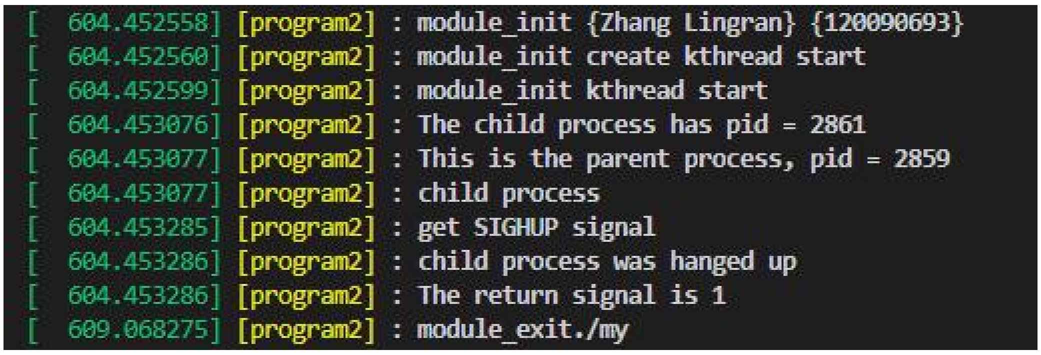
```
[  390.541618] [program2] : module_init {Zhang Lingran} {120090693}
[  390.541618] [program2] : module_init create kthread start
[  390.541657] [program2] : module_init kthread start
[  390.542242] [program2] : The child process has pid = 2691
[  390.542243] [program2] : This is the parent process, pid = 2689
[  390.542243] [program2] : child process
[  390.624270] [program2] : get SIGABRT signal
[  390.624272] [program2] : child process got abort error
[  390.624273] [program2] : The return signal is 6
[  396.693273] [program2] : module_exit./my
```



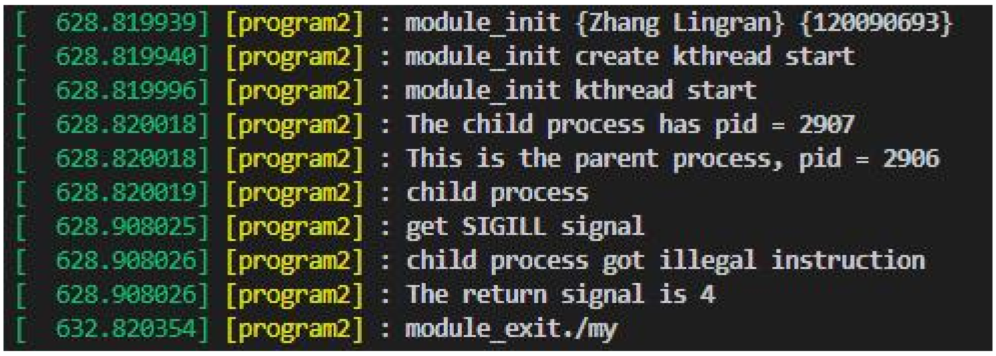
```
[  432.245580] [program2] : module_init {Zhang Lingran} {120090693}
[  432.245581] [program2] : module_init create kthread start
[  432.245619] [program2] : module_init kthread start
[  432.245636] [program2] : The child process has pid = 2765
[  432.245636] [program2] : This is the parent process, pid = 2764
[  432.245637] [program2] : child process
[  434.245954] [program2] : get SIGALARM signal
[  434.245955] [program2] : child process got alarm error
[  434.245956] [program2] : The return signal is 14
[  437.429153] [program2] : module_exit./my
```



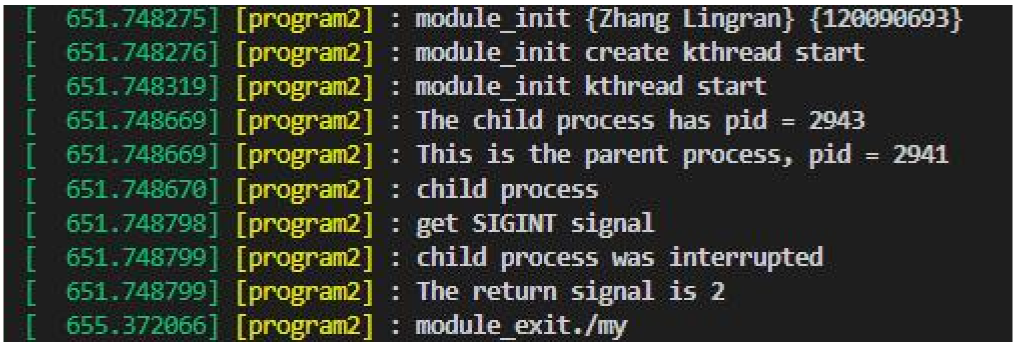
```
[  554.716639] [program2] : module_init {Zhang Lingran} {120090693}
[  554.716641] [program2] : module_init create kthread start
[  554.716680] [program2] : module_init kthread start
[  554.716697] [program2] : The child process has pid = 2813
[  554.716697] [program2] : This is the parent process, pid = 2812
[  554.716698] [program2] : child process
[  554.793733] [program2] : get SIGFPE signal
[  554.793734] [program2] : child process got float error
[  554.793735] [program2] : The return signal is 8
[  558.692684] [program2] : module_exit./my
```



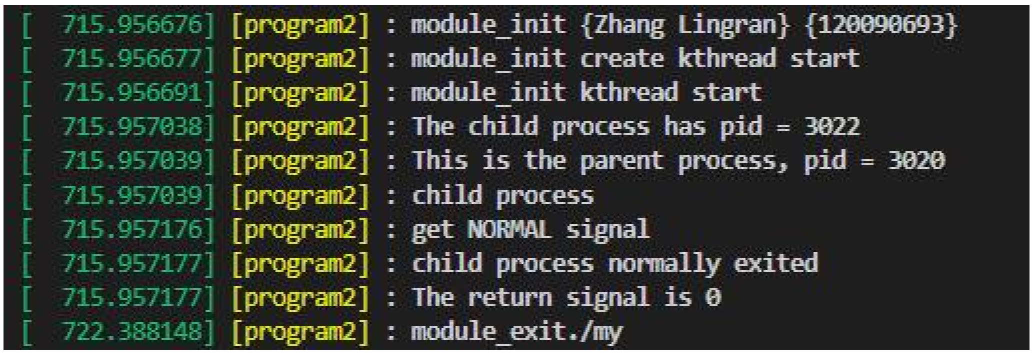
```
[  604.452558] [program2] : module_init {Zhang Lingran} {120090693}
[  604.452560] [program2] : module_init create kthread start
[  604.452599] [program2] : module_init kthread start
[  604.453076] [program2] : The child process has pid = 2861
[  604.453077] [program2] : This is the parent process, pid = 2859
[  604.453077] [program2] : child process
[  604.453285] [program2] : get SIGHUP signal
[  604.453286] [program2] : child process was hanged up
[  604.453286] [program2] : The return signal is 1
[  609.068275] [program2] : module_exit./my
```



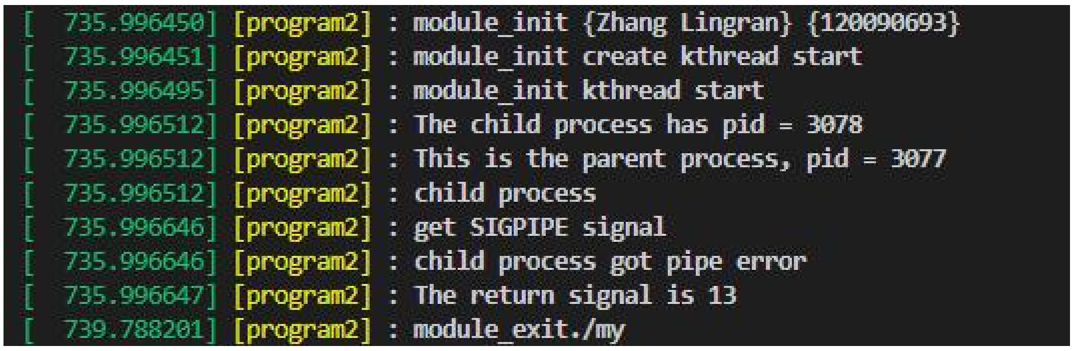
```
[  628.819939] [program2] : module_init {Zhang Lingran} {120090693}
[  628.819940] [program2] : module_init create kthread start
[  628.819996] [program2] : module_init kthread start
[  628.820018] [program2] : The child process has pid = 2907
[  628.820018] [program2] : This is the parent process, pid = 2906
[  628.820019] [program2] : child process
[  628.908025] [program2] : get SIGILL signal
[  628.908026] [program2] : child process got illegal instruction
[  628.908026] [program2] : The return signal is 4
[  632.820354] [program2] : module_exit./my
```



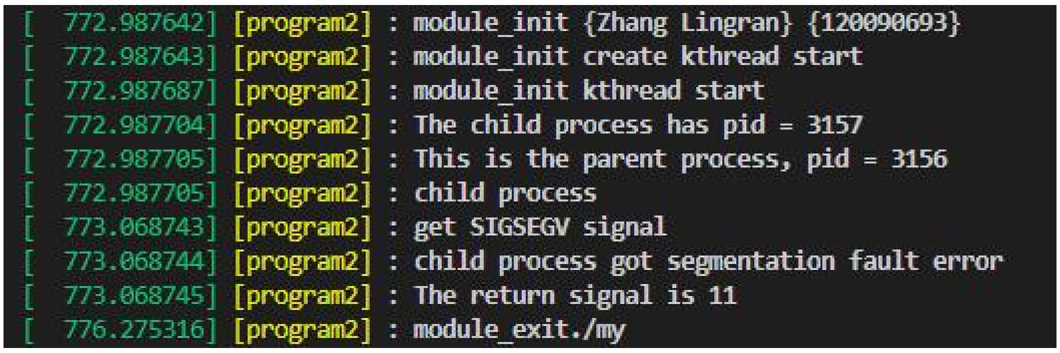
```
[  651.748275] [program2] : module_init {Zhang Lingran} {120090693}
[  651.748276] [program2] : module_init create kthread start
[  651.748319] [program2] : module_init kthread start
[  651.748669] [program2] : The child process has pid = 2943
[  651.748669] [program2] : This is the parent process, pid = 2941
[  651.748670] [program2] : child process
[  651.748798] [program2] : get SIGINT signal
[  651.748799] [program2] : child process was interrupted
[  651.748799] [program2] : The return signal is 2
[  655.372066] [program2] : module_exit./my
```



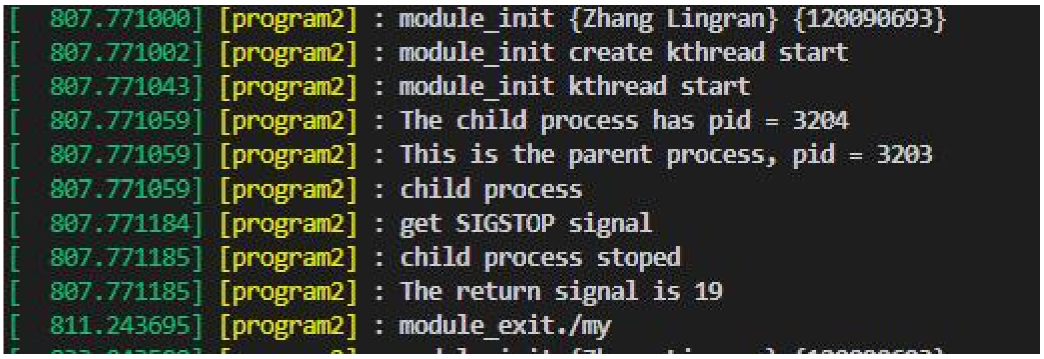
```
[  715.956676] [program2] : module_init {Zhang Lingran} {120090693}
[  715.956677] [program2] : module_init create kthread start
[  715.956691] [program2] : module_init kthread start
[  715.957038] [program2] : The child process has pid = 3022
[  715.957039] [program2] : This is the parent process, pid = 3020
[  715.957039] [program2] : child process
[  715.957176] [program2] : get NORMAL signal
[  715.957177] [program2] : child process normally exited
[  715.957177] [program2] : The return signal is 0
[  722.388148] [program2] : module_exit./my
```



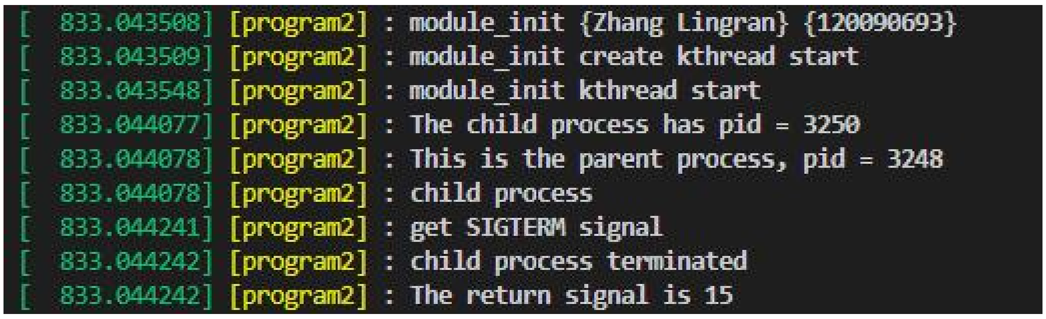
```
[  735.996450] [program2] : module_init {Zhang Lingran} {120090693}
[  735.996451] [program2] : module_init create kthread start
[  735.996495] [program2] : module_init kthread start
[  735.996512] [program2] : The child process has pid = 3078
[  735.996512] [program2] : This is the parent process, pid = 3077
[  735.996512] [program2] : child process
[  735.996646] [program2] : get SIGPIPE signal
[  735.996646] [program2] : child process got pipe error
[  735.996647] [program2] : The return signal is 13
[  739.788201] [program2] : module_exit./my
```



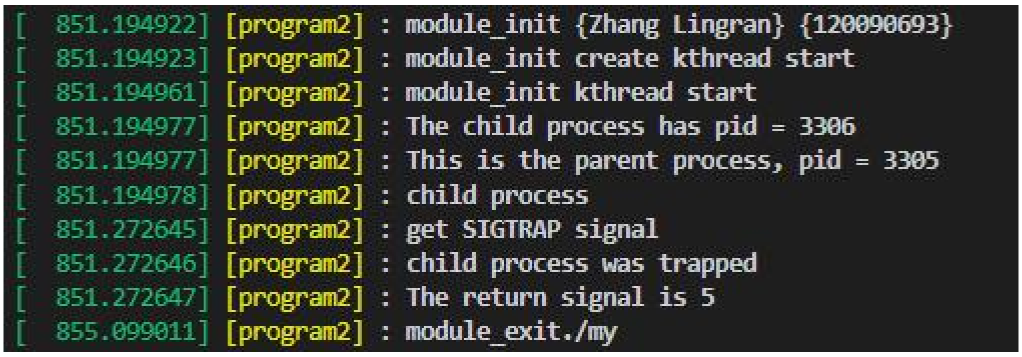
```
[  772.987642] [program2] : module_init {Zhang Lingran} {120090693}
[  772.987643] [program2] : module_init create kthread start
[  772.987687] [program2] : module_init kthread start
[  772.987704] [program2] : The child process has pid = 3157
[  772.987705] [program2] : This is the parent process, pid = 3156
[  772.987705] [program2] : child process
[  773.068743] [program2] : get SIGSEGV signal
[  773.068744] [program2] : child process got segmentation fault error
[  773.068745] [program2] : The return signal is 11
[  776.275316] [program2] : module_exit./my
```



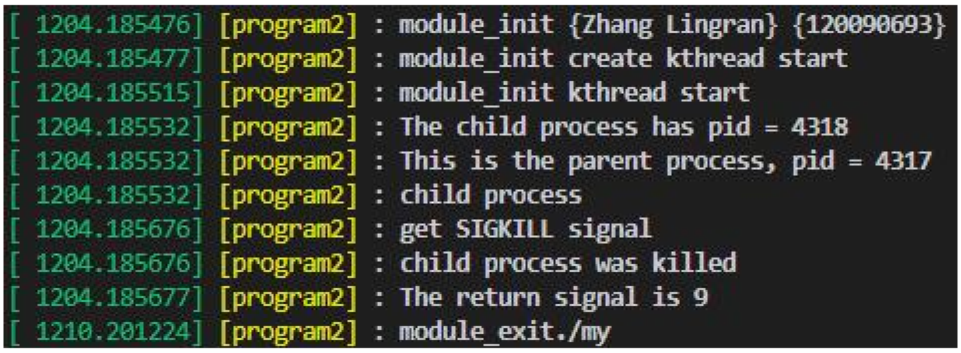
```
[  807.771000] [program2] : module_init {Zhang Lingran} {120090693}
[  807.771002] [program2] : module_init create kthread start
[  807.771043] [program2] : module_init kthread start
[  807.771059] [program2] : The child process has pid = 3204
[  807.771059] [program2] : This is the parent process, pid = 3203
[  807.771059] [program2] : child process
[  807.771184] [program2] : get SIGSTOP signal
[  807.771185] [program2] : child process stoped
[  807.771185] [program2] : The return signal is 19
[  811.243695] [program2] : module_exit./my
```



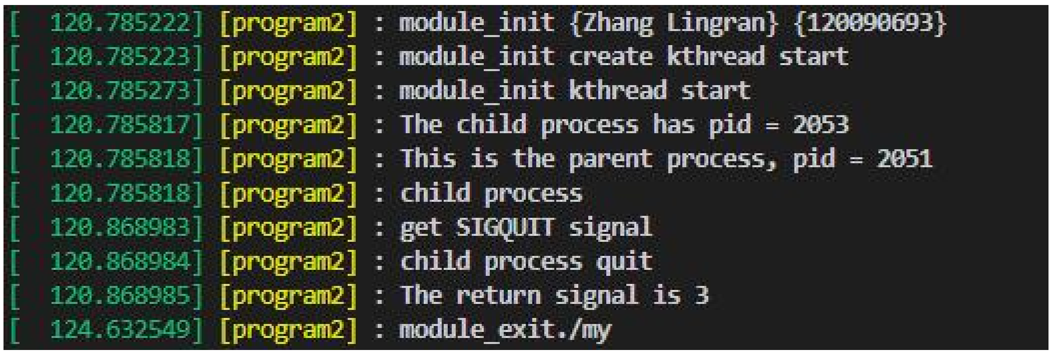
```
[  833.043508] [program2] : module_init {Zhang Lingran} {120090693}
[  833.043509] [program2] : module_init create kthread start
[  833.043548] [program2] : module_init kthread start
[  833.044077] [program2] : The child process has pid = 3250
[  833.044078] [program2] : This is the parent process, pid = 3248
[  833.044078] [program2] : child process
[  833.044241] [program2] : get SIGTERM signal
[  833.044242] [program2] : child process terminated
[  833.044242] [program2] : The return signal is 15
```



```
[  851.194922] [program2] : module_init {Zhang Lingran} {120090693}
[  851.194923] [program2] : module_init create kthread start
[  851.194961] [program2] : module_init kthread start
[  851.194977] [program2] : The child process has pid = 3306
[  851.194977] [program2] : This is the parent process, pid = 3305
[  851.194978] [program2] : child process
[  851.272645] [program2] : get SIGTRAP signal
[  851.272646] [program2] : child process was trapped
[  851.272647] [program2] : The return signal is 5
[  855.099011] [program2] : module_exit./my
```



```
[ 1204.185476] [program2] : module_init {Zhang Lingran} {120090693}
[ 1204.185477] [program2] : module_init create kthread start
[ 1204.185515] [program2] : module_init kthread start
[ 1204.185532] [program2] : The child process has pid = 4318
[ 1204.185532] [program2] : This is the parent process, pid = 4317
[ 1204.185532] [program2] : child process
[ 1204.185676] [program2] : get SIGKILL signal
[ 1204.185676] [program2] : child process was killed
[ 1204.185677] [program2] : The return signal is 9
[ 1210.201224] [program2] : module_exit./my
```



```
[  120.785222] [program2] : module_init {Zhang Lingran} {120090693}
[  120.785223] [program2] : module_init create kthread start
[  120.785273] [program2] : module_init kthread start
[  120.785817] [program2] : The child process has pid = 2053
[  120.785818] [program2] : This is the parent process, pid = 2051
[  120.785818] [program2] : child process
[  120.868983] [program2] : get SIGQUIT signal
[  120.868984] [program2] : child process quit
[  120.868985] [program2] : The return signal is 3
[  124.632549] [program2] : module_exit./my
```

Learn from the tasks:

In setting up the development environment, I learned how to configure and use virtual machines, as well as the basic operation techniques of the Linux system. I read relevant materials learned how to call and use various package functions required by the assignment. In program1, I learned how to use C language to fork processes, execute test program, get status signal, wait until child process terminates, and print out termination or error message. In program2, I learned how to use C language to initialize kernel modules, create kernel thread, fork process, let child process execute the test program, wait until child process terminates and print out related information, and exit kernel modules. In general, I have a deeper understanding of process, kernel, thread, signal, etc.