CSC3150 A1 Report

P.S.

* There is also a markdown file here, which is more beautiful, but the output screenshots are only available in this PDF file.
* To run this program in your computer, you need to first change the absolute path in program2.c and my\_fork.c to the path of your file. It is very strange that I cannot use relative path in my program.
* In my program do\_wait() always returns me the exit code (sometimes larger than 100) instead of the signal. I wrote a function to convert it to signal, but I think it is caused by different environment. If the OS is somewhat different from mine, there might be some error. However, I can assure that the code runs on my computer fine, and the screenshots are attached to the end.

## Part1: Problem Brief

The project is divided into three parts. In part1, we are required to write a program(program1.c) to complete the tasks in part1.

The tasks in part1 includes: 1. Fork a child process to execute test programs (15 of them) 2. Use wait() to let the parent process receives the SIGCHLD signal 3. Print out the termination information of child process (normal or abnormal)

The tasks un part2 includes: 1. Create a kernel thread and run my\_fork function 2. Fork a process to execute test.o 3. Use do\_wait() to let the parent process wait for the child process 4. Print out pid of both parent and child processes 5. Catch the signal raised by the child process and print out related log 6. Recompile the Linux kernel source code to use its functions

The tasks in bonus includes: 1. Execute the programs in arguments, as well as handle multiple input files 2. Extend new process with the former argument as parent to run each input files 3. Print out process tree and other relevant information

## Part2: Overall Project Structure

|  |  |
| --- | --- |
| Program1 | Program2 |
| 图片包含 屏幕截图  描述已自动生成 | 图片包含 屏幕截图  描述已自动生成 |

## Part3: Function Explanation

#### Program1:

Fork the child process

pid\_t pid;  
printf("Process start to fork\n");  
pid = fork();

wait for SIGCHLD signal

/\* wait for child process terminates \*/  
waitpid(-1, &status, WUNTRACED);   
printf("Parent process receives the SIGCHLD signal\n");

Child process execute test programs

if (pid == 0) { // child process  
 int i;  
 char \*arg[argc];  
  
 for (i = 0; i < argc - 1; i++) {  
 arg[i] = argv[i + 1];  
 }  
 arg[argc - 1] = NULL;  
  
 /\* execute test program \*/  
 printf("I'm the child process, my pid = %d\n", getpid());  
 printf("Child process start to execute test program:\n");  
 // start execute the program  
 execve(arg[0], arg, NULL);  
  
 printf("Continue to run original child process!\n");  
  
 perror("execve");  
 exit(SIGCHLD);

Analyse exit status and print out info

/\* check child process' termination status \*/  
if(WIFEXITED(status)){ // normal exit  
 printf("Normal termination with EXIT STATUS = %d\n",WEXITSTATUS(status));  
}  
  
else if(WIFSIGNALED(status)){ // abnormal exit  
 int num = WTERMSIG(status);  
 switch (num){  
 case 6: // SIGABRT  
 printf("child process get SIGABRT signal\n");  
 printf("child process is abort by abort signal\n");  
 printf("CHILD EXECUTION FAILED!!\n");  
 break;  
 case 14: // SIGALRM  
 printf("child process get SIGALRM signal\n");  
 printf("child process is abort by alarm signal\n");  
 printf("CHILD EXECUTION FAILED!!\n");  
 break;  
 case 7: // SIGBUS  
 printf("child process get SIGBUS signal\n");  
 printf("child process is abort by bus error signal\n");  
 printf("CHILD EXECUTION FAILED!!\n");  
 break;  
 ......  
 }  
  
}  
else if(WIFSTOPPED(status)){ // stop signal  
 printf("child process get SIGSTOP signal\n");  
 printf("child process stopped\n");  
 printf("CHILD EXECUTION STOPPED\n"); }  
else{  
 printf("CHILD PROCESS CONTINUED\n");  
}

#### Program2

Create a kernel thread and run my\_fork

task = kthread\_create(&my\_fork, NULL, "MyThread");  
//wake up new thread if ok  
if (!IS\_ERR(task)) {  
 printk("[program2] : Module\_init kthread starts\n");  
 wake\_up\_process(task);  
}

Fork a process and print out pid

pid\_t pid;  
/\* fork a process using do\_fork \*/  
pid = \_do\_fork(SIGCHLD, (unsigned long) &my\_exec, 0, NULL, NULL, 0);  
  
printk("[program2] : The child process has pid= %d\n", pid);  
printk("[program2] : The parent process has pid= %d\n", (int) current->pid);

Execute the test program

int my\_exec(void) {  
 int result;  
 const char path[] = "/mnt/hgfs/CSC3150/Project/CSC3150\_Assignment\_1/  
 source/program2/test";  
 const char \*const argv[] = {path, NULL, NULL};  
 const char \*const envp[] = {"HOME=/", "PATH=/sbin:/user/sbin:/bin:/usr/bin", NULL};  
  
 struct filename \*my\_filename = getname(path);  
  
 /\* execute a test program in child process \*/  
 printk("[program2] : child process");  
  
 result = do\_execve(my\_filename, argv, envp);  
   
 if (!result) {  
 return 0;  
 } else {  
 do\_exit(result);  
 }  
}

Wait for child process termination

void my\_wait(pid\_t pid) {  
 struct wait\_opts wo;  
 struct pid \*wo\_pid = NULL;  
 enum pid\_type type;  
 type = PIDTYPE\_PID;  
 wo\_pid = find\_get\_pid(pid);  
  
 wo.wo\_type = type;  
 wo.wo\_pid = wo\_pid;  
 wo.wo\_flags = WEXITED;  
 wo.wo\_info = NULL;  
 wo.wo\_stat = (int \_\_user\*)&status;  
 wo.wo\_rusage = NULL;  
  
 int a;  
 a = do\_wait(&wo);  
  
 output\_info(status);  
  
 put\_pid(wo\_pid);  
 return;  
}

Catch the signal and printed out message

void output\_info(int exit){  
 switch (exit) {  
 case 1:  
 printk("[program2] : get SIGHUP signal\n");  
 printk("[program2] : child process is hung up\n");  
 printk("[program2] : The return signal is 1\n");  
 break;  
 case 2:  
 printk("[program2] : get SIGINT signal\n");  
 printk("[program2] : terminal interrupt\n");  
 printk("[program2] : The return signal is 2\n");  
 break;  
 case 131:  
 printk("[program2] : get SIGQUIT signal\n");  
 printk("[program2] : terminal quit\n");  
 printk("[program2] : The return signal is 3\n");  
 break;  
 ......  
 }  
 return;  
}

Recompile the kernel in order to use kernel function

Since I am able to declare these extern functions and use them in my program, it proves that I have recompiled the kernel and exported these symbols.

extern long do\_wait(struct wait\_opts \*wo);  
extern struct filename \* getname(const char \_\_user \* filename);  
extern long \_do\_fork(unsigned long clone\_flags,unsigned long stack\_start,  
 unsigned long stack\_size,int \_\_user \*parent\_tidptr, int \_\_user \*child\_tidptr,  
 unsigned long tls);  
extern int do\_execve(struct filename \*filename,const char \_\_user \*const \_\_user \*\_\_argv,   
 const char \_\_user \*const \_\_user \*\_\_envp);

#### Bonus

struct Node {  
 int index;  
 char filename[200];  
 pid\_t my\_pid;  
 pid\_t child\_pid;  
 struct Node \*nxt\_node;  
};

A node which includes info about the binary file to be run

struct StatusNode {  
 int code;  
 struct StatusNode \*nxt\_StatusNode;  
};

A linked list storing status info about each binary file

void execute\_file(struct Node \*node);

Execute binary file with a Node as a parameter

void fork\_node(struct Node \*parent\_node);

Fork a new process using Node as its parameter

void fork\_same(struct Node \*last\_node);

Used for fork the process for the last binary file (no new file needs to be handled so it is a seperate function)

void status\_info(int status);

Print out infomation about status of a binary file according to its exit code

void process\_tree(struct Node \*first\_node);

Print out the process tree

void add\_status(int status);  
void add\_laststatus(int status);

Add status info to the status linked list

void print\_status();

Print out all process status info of all binary files

int convert2signal(int exit\_code);

Convert a exit code to the corresponding signal

## Part4: Program Environment

Virtual machine application: VM Ware fusion 11

The program is run on a Ubuntu 16.04 LTS operation system, with kernel version 4.10.14.

Compiler: gcc version 5.4.0

(Please change the program path in my codes before running them) If there is any problem, it might be the problem with different environment. Same happens to me when I run my code on my MacBook fine, but can only run after some modification on my Ubuntu virtual machine. If my code cannot run, please contact me and I can run my code on my laptop.

## Part5: How to run my program

#### Program1:

cd ./program1  
make  
./program1 filename

#### Program2:

cd ./program2  
gcc test.c -o test  
make  
insmod program2.ko  
rmmod program2.ko  
dmesg | tail -n 10

#### Bonus:

cd ./bonus  
make  
./my\_fork hangup normal8 trap

(You might need to export functions in linux kernel and recompile first)

Appendix

图片包含 文字

描述已自动生成

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描述已自动生成

图片包含 文字

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图片包含 文字

描述已自动生成

(I don’t know why here pids are not consecutive, it is normal on my MacBook Pro)

图片包含 屏幕截图

描述已自动生成