CSC3150 A1 Report

Part1: Problem Brief

The project is divided into two parts.

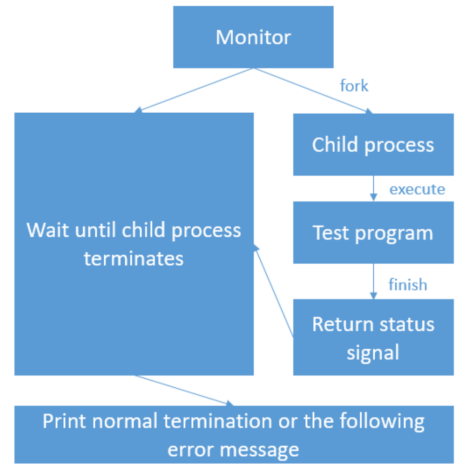
The tasks in part1 includes:

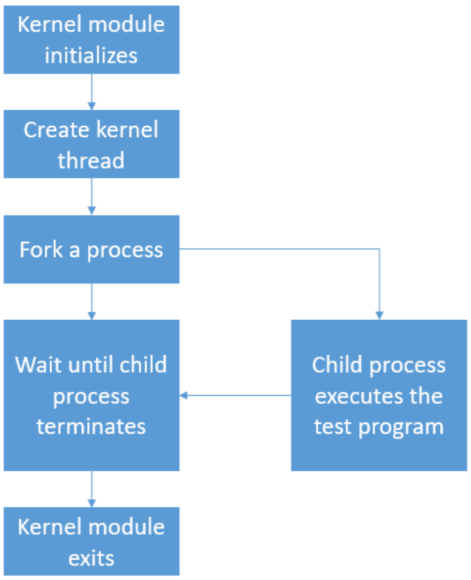
1. Fork a child process to execute test programs (15 of them)
2. Use wait() to let the parent process receives the SIGCHLD signal
3. Print out the termination information of child process (normal or abnormal)

The tasks in part2 includes:

1. Create a kernel thread and run my_fork function
2. Fork a process to execute test.
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

Part2: Overall Project Structure





Part3: Program Design

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(pid, &status, WUNTRACED);
        printf("Parent process receives the SIGCHLD signal\n");
```

> Parent process analyses exit status and print out info

```
        void output_info(int status)
        {
            switch (status) {
            case 1:
                printf("child process get SIGUP signal");
                break;
            case 2:
                printf("child process get SIGINT signal");
                break;
            case 131:
                printf("child process get SIGQUIT signal");
                break;
            case 132:
                printf("child process get SIGILL signal");
                break;
            case 133:
                printf("child process get SIGTRAP signal");
                break;
            case 134:
                printf("child process get SIGABRT signal");
                break;
            case 135:
                printf("child process get SIGBUS signal");
                break;
            case 136:
                printf("child process get SIGFPE signal");
                break;
            case 9:
                printf("child process get SIGKILL signal");
                break;
            case 139:
                printf("child process get SIGSEGV signal");
                break;
            case 13:
                printf("child process get SIGPIPE signal");
                break;
```

```
            case 14:
                printf("child process get SIGALRM signal");
                break;
            case 15:
                printf("child process get SIGTERM signal");
                break;
            case 0:
                printf("Normal termination with EXIT STATUS = 0");
                break;
            case 4991:
                printf("child process get SIGSTOP signal");
                break;
            default:
                printf("[program2] : a signal not contained in the signal
list\n");
                printf("[program2] : The return signal is %d", status);
                break;
            }
            printf("\n");
            return;
        }
```

Child process execute the test program

```
        printf("I am the child ");
        printf("my pid: %d\n", getpid());
        printf("Child process start to execute test program:\n");

        /* execute test program */
        execve(arg[0], arg, NULL);

        printf("Continue to run original child process!\n");
        perror("execve");
        exit(SIGCHLD);
```

```
vagrant@csc3150:~/CSC3150_2022FALL/Assignment1/source/program1$ ./program1 ./stop
Process start to fork
I am the parent my pid: 11016
I am the child my pid: 11017
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGSTOP program

Parent process receives SIGCHLD signal
child process get SIGSTOP signal
vagrant@csc3150:~/CSC3150_2022FALL/Assignment1/source/program1$
 vagrant@csc3150:~/CSC3150_2022FALL/Assignment1/source/program1$ ./program1 ./normal
 Process start to fork
 I am the parent my pid: 11077
 I am the child my pid: 11078
 Child process start to execute test program:
 ------------CHILD PROCESS START------------
 This is the normal program

 ------------CHILD PROCESS END------------
 Parent process receives SIGCHLD signal
 Normal termination with EXIT STATUS = 0
 vagrant@csc3150:~/CSC3150_2022FALL/Assignment1/source/program1$
```

Program2

Create a kernel thread and run my_fork

```
        task = kthread_create(&my_fork, NULL, "MyThread");

        if (!IS_ERR(task)) {
            printk("Kthread starts\n");
            wake_up_process(task);
        }
```

Fork a process and print out pid

```
        pid_t pid;
        pid = kernel_clone(&args);

        if (pid == -1) {
            printk("fork failed");
            return -1;
        }

        printk("[program2] : The child process has pid = %d\n", pid);
        printk("[program2] : This is the parent process, pid = %d\n", (int)
current->pid);
```

Execute the test program

```
        int my_exec(void) {
            int result;
            const char __user path[] = "/tmp/test";

            /* execute a test program in child process */
            printk("[program2] : child process");

            result = do_execve(getname_kernel(path), NULL, NULL);

            if (!result) {
                return 0;
            } else {
                do_exit(result);
            }
        }
```

Wait for child process termination

```
        void my_wait(pid_t pid) {
            int a;
            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 | WUNTRACED;
            wo.wo_info = NULL;
            wo.wo_rusage = NULL;


            a = do_wait(&wo);

            my_output(wo.wo_stat);
            put_pid(wo_pid);

            return;
        }
```

Catch the signal and printed out message

```
void my_output(int signal) {
    switch (signal) {
        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;
        case 132:
            printk("[program2] : get SIGILL signal\n");
            printk("[program2] : child process has illegal instruction
error\n");
            printk("[program2] : The return signal is 4\n");
            break;
        ......

        default:
            printk("[program2] : a signal not contained in the signal
list");
            printk("[program2] : The return signal is %d\n", signal);
            break;
    }
    return;
}
```

Recompile the kernel in order to use kernel function

```
extern struct filename *getname_kernel(const char *filename);
extern pid_t kernel_clone(struct kernel_clone_args *args);
extern int do_execve(struct filename *filename,
                     const char __user *const __user *__argv,
                     const char __user *const __user *__envp);
extern long do_wait(struct wait_opts *wo);
```

```
[18692.387446] [program2] : Module_init Jiakun Fan
[18692.387448] [program2] : Module_init create kthread start
[18692.387519] Kthread starts
[18692.387844] [program2] : The child process has pid = 10776
[18692.387846] [program2] : This is the parent process, pid = 10773
[18692.387864] [program2] : child process
[18692.524679] [program2] : get SIGBUS signal
[18692.524681] [program2] : child process has bus error
[18692.524682] [program2] : The return signal is 7
[18773.128452] [program2] : Module_exit
```

Part4: Program Environment

Virtual machine application: virtual box 6.1.32

The program is run on a Ubuntu 16.04 LTS operation system, with kernel version 5.10.146.

Compiler: gcc version 5.4.0

Before run the program2, rewrite the kernel source code.

Find these four functions in the kernel source code:

1. getname_kernel in ./fs/namie.c
2. do_execve in ./fs/exec.c
3. do_wait in ./kernel/exit.c
4. do_fork in ./kernel/fork.c

Add `EXPORT_SYMBOL(*Function_name*);` below the corresponding function implementations.

Then recompile the kernel.

Part5: How to run my program

Program1:

```
cd ./program1
make
./program1 ./filename
```

Program2:

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

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