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CSC415 Operating Systems

Assignment 3 – Simple Shell

Description:
This assignment is to write a C program to create a simple shell on top of the Linux shell which accepts Linux commands from our program.

Approach / What I Did:
I first read the description in the ReadMe file present in GitHub repository. After completely understanding the steps that we need to implement, I started researching on various functions that exist in c to assist in my program. After I have read man pages of multiple functions and other resources, I have shortlisted the useful functions and read more about them. I have then started coding the program in parts. The line "Your shell should read lines of user input, then parse and execute the commands by forking/creating new processes." made me split the entire work in 3 major parts. First, I focused working on reading the lines part. I have used fgets function to get each line from the stdin and stored it in an array. I have then removed the newline character if present in the array and replaced it with null character.
For the parsing command part, I have used strtok function to split the taken line of code into tokens so that it can be used in execvp function to execute the read command.
Later after splitting the command into tokens, I used fork() to create a child process. Once the fork() is successful, I called the execvp function from the child process we created and executed the command. After the execution, we exit the child process and print the child process ID and exit code to the console.
Apart from the above major steps, I took few measures to detect the errors such as empty line input or exit command or invalid command.

Helpful resources:
https://man7.org/linux/man-pages/man3/strtok.3.html
https://www.tutorialspoint.com/c_standard_library/c_function_strtok.htm
https://man7.org/linux/man-pages/man3/fgets.3p.html
https://linux.die.net/man/2/fork
https://stackoverflow.com/questions/7265718/fork-child-and-parent-processes (very useful in understanding the return value of fork() depending on the process we are in, like child or parent process)
https://www.programiz.com/c-programming/library-function/string.h/strcmp
https://www.geeksforgeeks.org/getppid-getpid-linux/
https://linuxhint.com/waitpid-syscall-in-c/
https://man7.org/linux/man-pages/man3/strerror.3.html
https://man7.org/linux/man-pages/man3/errno.3.html

Issues and Resolutions:

First Issue: commands not getting executed and could not exit the shell with exit command

Resolution:
Initially, when I have finished the first draft of my program, I have realized that the output of commands is not printed as expected. Also, once I enter the shell, I could not exit it with the exit command. I started to use printf statements to analyze the commands but could not fully understand what was going wrong.
I started reading more about functions such as fork, execvp and fgets to understand if I have been using any function in the wrong way. I have then found this page of stackoverflow "https://stackoverflow.com/questions/21679063/return-value-of-fgets", where the top comment mentioned that fgets adds the newline character and stores it into the pointed buffer. This made me figure out a way to remove the newline character and replace it with the null character so that the commands can be executed.

Second Issue: Child process not being exited

Resolution:
Realized that I was missing the exit statement which is needed to exit the child process. After adding it, it was working as expected

Third Issue: Not able to print the exit status of the child process

Resolution:
It was asked to print the exit status of the child process, but I could not understand where I would get the exit status. I have then researched about it, and found the resolution in the following man page: https://linux.die.net/man/3/waitpid
It seems like WEXITSTATUS(stat_val) will have the required exit status of the child process. Once, I have included it, I could see the exit status.

Analysis:

No analysis as suggested by professor.

Screen shot of compilation:

```
student@student-VirtualBox:~/Documents/csc415-assignment3-simpleshell-anudeepkatukojwala$ make
gcc -c -o katukojwala_anudeep_HW3_main.o katukojwala_anudeep_HW3_main.c -g -I.
gcc -o katukojwala_anudeep_HW3_main katukojwala_anudeep_HW3_main.o -g -I. -l pthread
student@student-VirtualBox:~/Documents/csc415-assignment3-simpleshell-anudeepkatukojwala$
```

Screen shot(s) of the execution of the program:

```
student@student-VirtualBox:~/Documents/csc415-assignment3-simpleshell-anudeepkatukojwala$ make run
./katukojwala_anudeep_HW3_main "Prompt> "

Prompt>   ls

commands.txt                 katukojwala_anudeep_HW3_main.c  Makefile
katukojwala_anudeep_HW3_main  katukojwala_anudeep_HW3_main.o  README.md

Child 29086, exited with 0

Prompt>   pwd

/home/student/Documents/csc415-assignment3-simpleshell-anudeepkatukojwala

Child 29106, exited with 0

Prompt>   exit
exit command entered. SHELL exited
student@student-VirtualBox:~/Documents/csc415-assignment3-simpleshell-anudeepkatukojwala$
```

Execution Screenshot with commands.txt script:

```
student@student-VirtualBox:~/Documents/csc415-assignment3-simpleshell-anudeepkatukojwala$ make run < commands.txt
./katukojwala_anudeep_HW3_main "Prompt> "

Prompt>
commands.txt  katukojwala_anudeep_HW3_main  katukojwala_anudeep_HW3_main.c  katukojwala_anudeep_HW3_main.o  Makefile  README.md
Prompt>
Child 29370, exited with 0

Prompt>
"Hello World"
Prompt>
Child 29371, exited with 0

Prompt>
total 68
drwxrwxr-x 3 student student  4096 Sep 22 19:43 .
drwxr-xr-x 3 student student  4096 Sep  9 17:32 ..
-rw-rw-r-- 1 student student    42 Sep  9 17:33 commands.txt
drwxrwxr-x 8 student student  4096 Sep  9 17:33 .git
-rwxrwxr-x 1 student student 16920 Sep 22 19:43 katukojwala_anudeep_HW3_main
-rw-rw-r-- 1 student student  4921 Sep 22 19:37 katukojwala_anudeep_HW3_main.c
-rw-rw-r-- 1 student student 10688 Sep 22 19:43 katukojwala_anudeep_HW3_main.o
-rw-rw-r-- 1 student student  1872 Sep 20 13:24 Makefile
-rw-rw-r-- 1 student student  5058 Sep  9 17:33 README.md
Prompt>
Child 29372, exited with 0

Prompt>
  PID TTY          TIME CMD
23983 pts/0    00:00:00 bash
29367 pts/0    00:00:00 make
29368 pts/0    00:00:00 sh
29369 pts/0    00:00:00 katukojwala_anu
29373 pts/0    00:00:00 ps
Prompt>
Child 29373, exited with 0

Prompt>
ls: cannot access 'foo': No such file or directory
Prompt>
Child 29374, exited with 2

Prompt>   Error: Empty line entered. Please enter a valid command

Prompt>   Error: While reading the line from stdin
student@student-VirtualBox:~/Documents/csc415-assignment3-simpleshell-anudeepkatukojwala$
```