

Assignment 5 – Simple Shell with Pipes

Description:

This assignment was designed to help us prepare for our file system group project by practicing block operations, managing memory, tracking the information of multiple files, and generally understanding the functionality of low level files.

This program implements a simple file system interface in C using similar open, read, and close functions to Unix systems.

Approach:

I'll be breaking this assignment into two parts: opening and closing the file (`b_open` and `b_close`), and then reading the file (`b_read`).

`b_open & b_close`

To open the file, we need to fill up the File Control Board which is a struct that contains the data of the file, and return the file descriptor which is essentially the index of the file's FCB within the FCB array. We first check if the FCB array has been initialized and if there is an available FCB. We can call `get_FCB()` which will return an available FCB if it exists, and we break out if none are found i.e. they are all in use. We can then call `GetFileInfo()` to retrieve the data for that file. If the file data returns as null, the file doesn't exist and we break out. Otherwise I put the file info into the FCB for the file.

I then added some more fields to the FCB struct that will be needed for the rest of the assignment: a mediary buffer to read the file, an index of where we are in the buffer, and an index of where we are in the file.

I then went back to `b_read` to allocate memory for the buffer and set the file and buffer index to 0 since it has just been opened. If the memory allocation fails, then break out. Otherwise, return the file descriptor.

To close the file we first check if the file descriptor is valid and the file exists. If it does, we simply free the memory allocated for the buffer and set the `fi` field to null to indicate that it is free for use.

`b_read`

To read the file, we can break it into three steps:

1. If there is any data in the buffer, copy it into the caller buffer
2. If the remaining amount to be read is larger than one complete block, read the complete blocks using `LBaread` directly to the caller buffer

3. If we have any remaining bytes to be read less than a complete block, `LBARead()` in the final block to our buffer and copy the remaining amount of bytes requested to be read to the caller buffer

We first check that the system has been initialized, the file descriptor is valid, and that the FCB has valid file data. If any of these checks fail, we break out. We then initialize a pointer to access the fields of the FCB in the `FCBArray`, and a counter to track how many bytes have been read.

If the amount of bytes requested to be read is more than the remaining bytes left in the file, we set the remaining space to the requested amount so as to not go past the EOF. If the requested amount of bytes is 0, then we return 0 to indicate that no bytes were read.

We can now begin the reading process by checking if the buffer offset is greater than 0 which would indicate that there is data currently in the buffer. If the requested amount of bytes to read is more than the remaining space in the buffer, then we will copy over just enough to fill the buffer. We use `memcpy()` to copy the data into the caller buffer and update all the counters and offsets.

We then calculate if the remaining amount of bytes requested to read is larger than one complete block. If it is, we can copy an entire block/blocks directly to the caller buffer. We call `LBARead()` directly to the caller buffer with the amount of blocks that can be read and update the counters and offsets.

Lastly, if there are still bytes requested to be read, we do another `LBARead` call to our buffer with the last block of the requested amount of bytes, use `mmemcpy()` to copy over just the amount of bytes requested to the caller buffer, and increment the offsets and counters to ensure that the next `b_read()` call will start at the next available byte in the buffer. We then return the amount of bytes read.

Issues and Resolutions:

The first issue I had was that my output seemed to be skipping or rereading some portions of the data file. I wasn't sure where my error was and began drawing out my logic on paper. I realized that after reading complete blocks directly into the caller buffer I wasn't resetting my `fileOffset` correctly. I was setting it equal to the amount of bytes that I had just read in rather than adding it in case some bytes had already been read in the previous step. This was making the program think it was further back in the file and wasn't accounting for the bytes it had already read.

My second issue was very similar in that my output still appeared to be missing sections of the text within DATA. I knew my issue was either in my adjustments of my offsets and counters, or the starting position in the buffer that I was handing to `LBARead()` or `memcpy()`. With more drawing out my logic and print statements to debug I found that I wasn't handing the correct

starting position to my LBAread() call to read multiple blocks. If we had already read 30 blocks into the buffer in the previous step, these were being overwritten because I wasn't adding the bytes already read to the caller buffer's position. After adding these to the starting position of the destination, my output looked correct.

Screenshot of compilation:

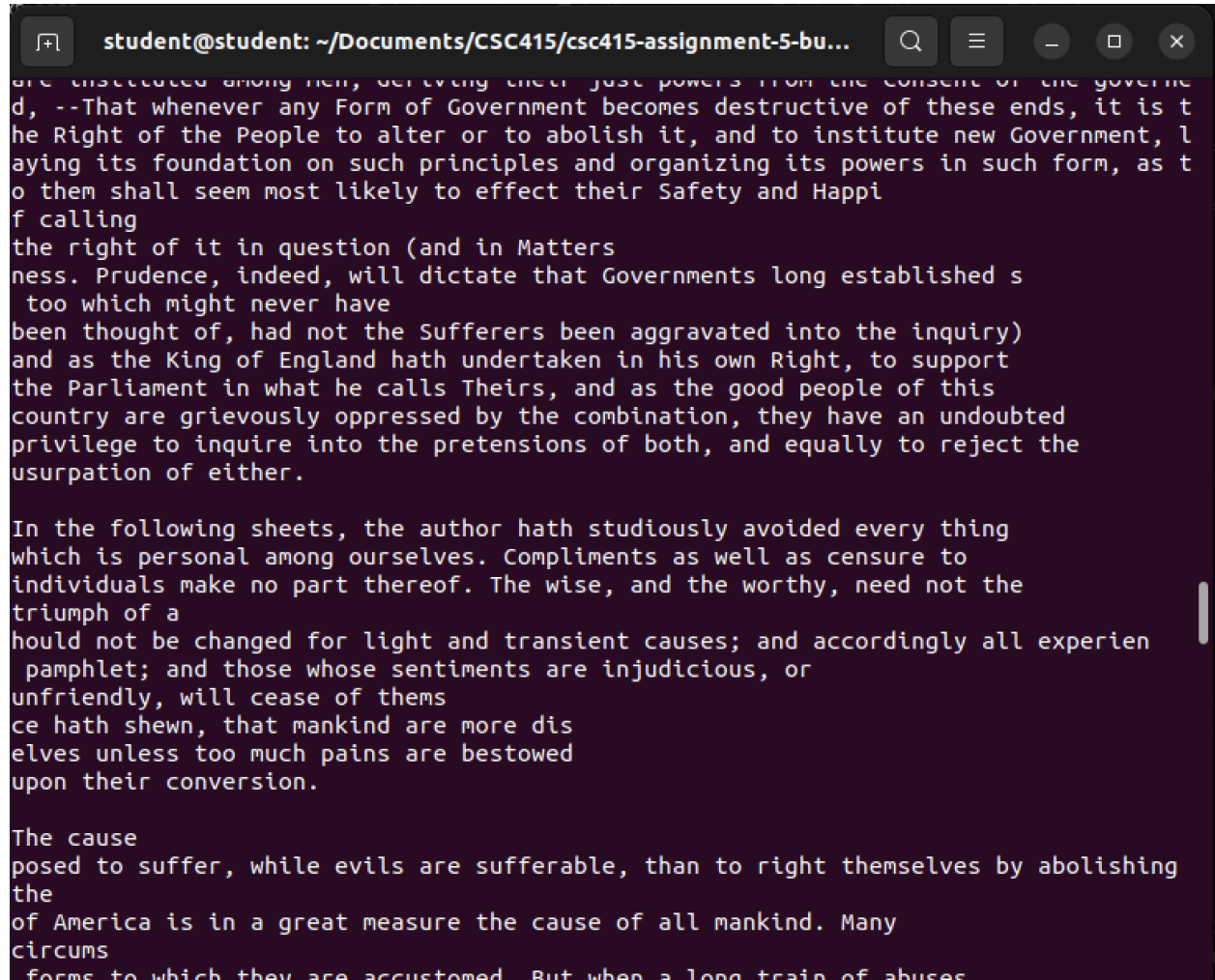
```
student@student:~/Documents/CSC415/csc415-assignment-5-buffered-io-smeerj$ make
gcc -c -o b_io.o b_io.c -g -I.
gcc -o Bhagat_Arjun_HW5_main b_io.o buffer-main.o -g -I.
student@student:~/Documents/CSC415/csc415-assignment-5-buffered-io-smeerj$
```

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

```
student@student:~/Documents/CSC415/csc415-assignment-5-buffered-io-smeerj$ make run
gcc -c -o b_io.o b_io.c -g -I.
gcc -o Bhagat_Arjun_HW5_main b_io.o buffer-main.o -g -I.
./Bhagat_Arjun_HW5_main DATA DecOfInd.txt CommonSense.txt
The unanimous Declaration of the thirteen united States of Am
Perhaps the sentiments contained in the following pa
erica, When in the Course of human events, it becomes necessary for one people to
ges, are not yet
sufficiently fashionable to procure
dissolve the political bands which have conn
them general favor; a long habit
of not thinking a thing wrong, gives it a super
ected them with another, and to assume among the powers of the earth, the separate
ficial appearance of
being right, and raises at first a formidable outcry in
and equal station to which the Laws of Nature and of Nature_
defense of
custom. But the tumult soon subside
s God _ntitle t_em, a decent respect to the opinions
s. Time makes more converts than
reason.

of mankind requires that they should declare the causes which
As a long and violent abuse of power, is generally the Means o
impel them to the separation.

We hold these truths to be self-evident, that all men are created equal, that they a
re endowed by their Creator with certain unalienable Rights, that among these are Li
fe, Liberty and the pursuit of Happiness.--That to secure these rights, Governments
are instituted among Men. deriving their iust powers from the consent of the governe
```



A screenshot of a terminal window with a dark background. The title bar at the top shows the user 'student@student:' and the file path '~/Documents/CSC415/csc415-assignment-5-bu...'. The terminal displays the text of the Declaration of Independence in a light-colored, monospaced font. The text is wrapped across multiple lines. The visible portion includes the opening lines about the consent of the governed, the right of the people to alter or abolish government, and the famous phrase 'We hold these truths to be self-evident, that all men are created equal'. The text is cut off at the bottom of the terminal window.

are instituted among men, deriving their just powers from the consent of the governed, --That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness.

If calling the right of it in question (and in Matters of Peace, Prudence, indeed, will dictate that Governments long established should not be changed for light and transient causes; and accordingly all experience hath shewn, that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed. But when a long train of abuses and usurpations, pursuing invariably the same Object evinces a design to reduce them to absolute Tyranny, it is their right, it is their duty, to throw off such Government, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness.

In the following sheets, the author hath studiously avoided every thing which is personal among ourselves. Compliments as well as censure to individuals make no part thereof. The wise, and the worthy, need not the triumph of a pamphlet; and those whose sentiments are injudicious, or unfriendly, will cease of themselves unless too much pains are bestowed upon their conversion.

The cause of America is in a great measure the cause of all mankind. Many circumstances have surrounded the colonies, which are the objects of the complaints. In some the whole community, in others a greater part, suffer under the oppressive and unalienable rights of mankind.

```
student@student: ~/Documents/CSC415/csc415-assignment-5-bu...
Circums
forms to which they are accustomed. But when a long train of abuses
tances hath, and will arise, which are not lo
and usurpations, pursuing invariably the same Object
cal, but universal, and
through which the principles of all Lover
evinces a design to reduce them under absolute Despotism, it is their right, it is t
heir
s of Mankind are affected, and in
the Event of which, their Affections are inter
duty, to throw off such Government, and to pr
ested. The laying a Country
desolate with Fire and Sword,
ovide new Guards for their future security
declaring War against the natural rights of all
Mankind, and extirpating the Defender
.--Such has been the patient sufferance of th
s thereof from the Face of the Earth,
is the Concern of every Man to wh
ese Colonies; and such is now the necessity which co
om Nature hath given the Power of feeling;
of which Class, regardless of Party Censure,
nstrains them to alter their former Systems of Government.
is the

AUTHOR
The history of the present King of Great Britain is a history of repe
ated injuries and usurpations, all having in direct
object the establishment of an absolute T
yranny over these States. To prove this, let Facts be submitted to a candid worl
d.
He has refused his Assent to Laws, the most wholesome
```

```
student@student: ~/Documents/CSC415/csc415-assignment-5-bu...
He has refused his Assent to Laws, the most wholesome
and necessary for the public good.

He has for
bidden his Governors to pass Laws of immediate and pressing importance, unless s
uspended in their operation till his Assent should be obtained;
and when so suspended, he has utterly neglected to attend to them.

He h
as refused to pass other Laws for the accommodation of lar
ge districts of people, unless those peop
le would relinquish the right of Representation in the Legislat
ure, a right inestimable to them and formidable to tyrants only.

He has called toget
her legislative bodies at places unusual, uncomfor
table, and distant from the depository o
f their public Records, for the sole purpose of fatigu
ing them into compliance with his measures.

He h
as dissolved Representative Houses repeatedl
y, for opposing with manly firmness his invasions on
the rights of the people.

He has refused for a long time,
after such dissolutions, to cause others to be elected; whereby the Legislative powe
rs, i
ncapable of Annihilation, have returned to the People at large for their exercise; t
he
State remaining in the mean time exposed to
all the dangers of invasion from without, and convulsions within.
```

```
student@student: ~/Documents/CSC415/csc415-assignment-5-bu...
has endeavoured to prevent the population of these States; for that
purpose obstructing the Laws for Naturalization of Foreigners; refusing to pass ot
hers to encourage their migrations hither, and raising the conditions of new Appropriat
ions of Lands.

He has obstructed the Administration of Justice, by refus
ing his Assent to Laws for establishing Judiciary powers.

He has made Judges dependent on his Will alone, for the tenure of their offices, and th
e amount and payment of their salaries.

He has erected a multitude of New Offices, and sent hither swarms of Officers to harrass our people, and ea
t out their substance.

He has kept among us, in times of peace, Standing Armies without the Consent of our legislatures.

He has affected to render the Military independent of and superior
to the Civil power.

He has combined with others to subject us to a jurisdiction foreign to our constitution, and una
cknowledged by our laws; giving his Assent to their Acts of pretended
Legislation:

For Quartering large bodies of armed troops among us:
```

```
student@student: ~/Documents/CSC415/csc415-assignment-5-bu...
For prot
ecting them, by a mock Trial, from punish
ment for any Murders which they should commi
t on the Inhabitants of these States:

For cutting off our Trade with all parts of the
world:

For imposing Taxes on us without our Co
nsent:

For depriving us in many cases, of the benefits o
f Trial by Jury:

For transporting us beyond Seas to be tried for pretended offences

F
or abolishing the free System of English Laws in a neighbouring Province, establis
hing therein an Arbitrary government, and enlarging its Boundarie
s so as to render it at once an example and fit instrument for i
ntroducing the same absolute rule into these Colonies:

For taking away our
Charters, abolishing our most valuable Laws, a
nd altering fundamentally the Forms of our Governments:

For suspe
nding our own Legislatures, and declaring themselves inv
ested with power to legislate for us in all
cases whatsoever.

He has abdicated Government here, by declaring u
```



```
student@student: ~/Documents/CSC415/csc415-assignment-5-bu...
He has abdicated Government here, by declaring u
s out of his Protection and waging War against us.

He has plund
ered our seas, ravaged our Coasts, burnt our towns, and destroyed the lives
of our people.

He is at this time transporting large Armies
of foreign Mercenaries to compleat the work
s of death, desolation and tyranny, already begun
with circumstances of Cruelty & perfidy scarcely paralleled in the
most barbarous ages, and totally unworthy the Head of a civilized nation.

He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms a
gai
nst their Country, to become the executione
rs of their friends and Brethren, or to fall themselves by
their Hands.

He has excited domestic insurrections amongst us, and has ende
avoured to bring on the inhabitants of our frontiers, the merciless Indian Sav
ages, whose known rule of warfare, is an undis
tinguished destruction of all ages, sexes and conditions.

In ev
ery stage of these Oppressions We have Petitioned for Redress in the most humble ter
ms
: Our repeated Petitions have been answered only by repeated injury.
A Prince whose character is thus marked by every act which may defin
e a Tyrant, is unfit to be the ruler of a free people.
```

```
student@student: ~/Documents/CSC415/csc415-assignment-5-bu...
Nor have We been wanting in atte
ntions to our Brittish brethren. We have warned them from time to time of attempts
by their legislature to extend an unwarra
ntable jurisdiction over us. We have reminded them of the cir
cumstances of our emigration and settlement here. We have appealed to t
heir native justice and magnanimity, and we have conjured them by the ties of our co
m
mon kindred to disavow these usurpations, which, would inevitably interrupt ou
r connections and correspondence. They t
oo have been deaf to the voice of justice and of
consanguinity. We must, therefore, acquiesce in the necessity, which
denounces our Separation, and hold them, as we hold the rest of mankind, Enemies in
War, i
n Peace Friends.

We, therefore, the Representatives of the unite
d States of America, in General Congress, Assembled, appeali
ng to the Supreme Judge of the world for the rectitude of our intentions, do, in the
Name
, and by Authority of the good People of these Colonies, solemnly publish and d
eclare, That these United Colonies are, and of Right ought to be Free and
Independent States; that they are Absolved from all Allegiance to
the British Crown, and that all political connection between them and the S
tate of Great Britain, is and ought to be totally dissolved; and t
hat as Free and Independent States, they h
ave full Power to levy War, conclude Peace, contract Alliances, establish Co
mmerce, and to do all other Acts and Things which Independent States may of
right do. And for the support of this Declaration, with a
firm reliance on the protection of divine Providence, we mutually p
ledge to each other our Lives, our Fortunes and our sacred Honor.
We have read 8120 characters from file DecOfInd.txt
We have read 1877 characters from file CommonSense.txt
student@student:~/Documents/CSC415/csc415-assignment-5-buffered-io-smeerj$
```