Oscar Galvez ID: 911813414
Github: gojilikeog CSC415 Operating Systems

Assignment 5 – Buffered I/O

Description:
This assignment is to write a C program that handles buffered IO, where the program does buffering rather than standard Linux functions. Doing so requires creating a set of routines similar to the ones Linux uses (open, read, close) to perform the operations required.

Approach / What I Did:
First step was to outline what the assignment was requiring from the writeup, including reviewing the recorded video lecture in an attempt to clear up any misunderstanding I may have had with the requirements. This resulted in a three page document that will be attached at the end of this document (also uploaded into the Github repo).

Each identified requirement was broken down into :
- The bare-bone requirement for the function - what was it basically asking us to do
- What steps need to be taken in order to create what we are being asked of
    - Ended up being formatted as a bullet point list, which I would check off as progress was made in the assignment.

With this assignment, there was less digging through man pages and textbook. But conversely, there was more logical planning with how to actually execute what was being asked of us.
The challenge with this assignment ended up being the confusion on the discrepancy I was receiving with my results, and the results expected in the README. Comparing where the block was initially reading, and comparing the end result never made it make sense.

Issues and Resolutions:

The bulk of the problems with this assignment stemmed from implementing b_read

My first issue was the main issue of the assignment: Implementation of buffer trackers within my algorithm.

I resolved it by determining which variables I would need to create, not only within the b_fcb variable, but also within the read function. The difference being which ones needed to be continuously tracked and retained between function calls, and which ones needed to be reset to function properly for their intended purposes.

My second issue was similarly to assignment #2, the design of a while loop to continuously pass though the function for large ‘count’ requests of bytes chewed up most of the time.

I resolved this issue by revisiting the planning phase of the assignment. This included having to rewatch the lecture videos to obtain another perspective on how to interpret the requirements from the specifications. On the other hand, working the logic to the point of a convoluted mess motivated me to delete the entire thing and restart working the algorithm. This ironically led to the successful implementation submitted.

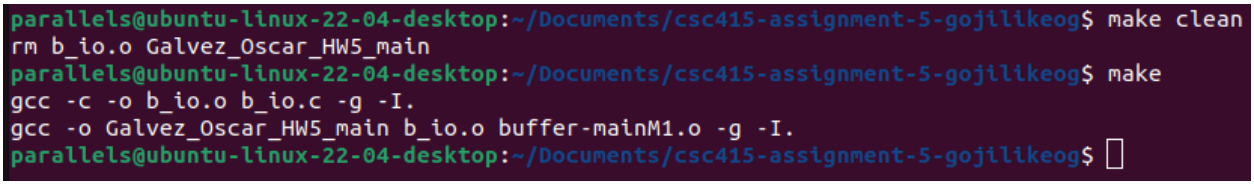
Next issue encountered is related to the buffer tracker, but not necessarily the same. My failure to implement a counter for the total file size led to misdiagnosing the problem. Wild goose chases eat up time, and this ate up almost two days worth of progress.

This was solved by understanding the value LBAread returns is not related to the end of each individual text file, it is related to the end of the entire text file provided for the assignment. My initial thought was to use that value to indicate when to start aborting the program. This mistake led to a fixation on the implementation of LBAread with a complete disregard of just counting the number of bytes copied into the user buffer and comparing it to the file size provided in the b_open function.

My final issue would be diagnosing a valgrind error code. Similar to assignment #4, there was a 'conditional jump or move depends on uninitialized value(s)' related to a str function.

This was solved by understanding what was going on thanks to the in-class explanation, and a lab exercise worksheet provided by Stanford. This worksheet basically reiterated what was explain to us in class, and it led me to make the decision to call calloc in place of malloc for the allocation of memory being set to zero. Doing so fixed the error being pointed out by valgrind.

Screen shot of compilation:



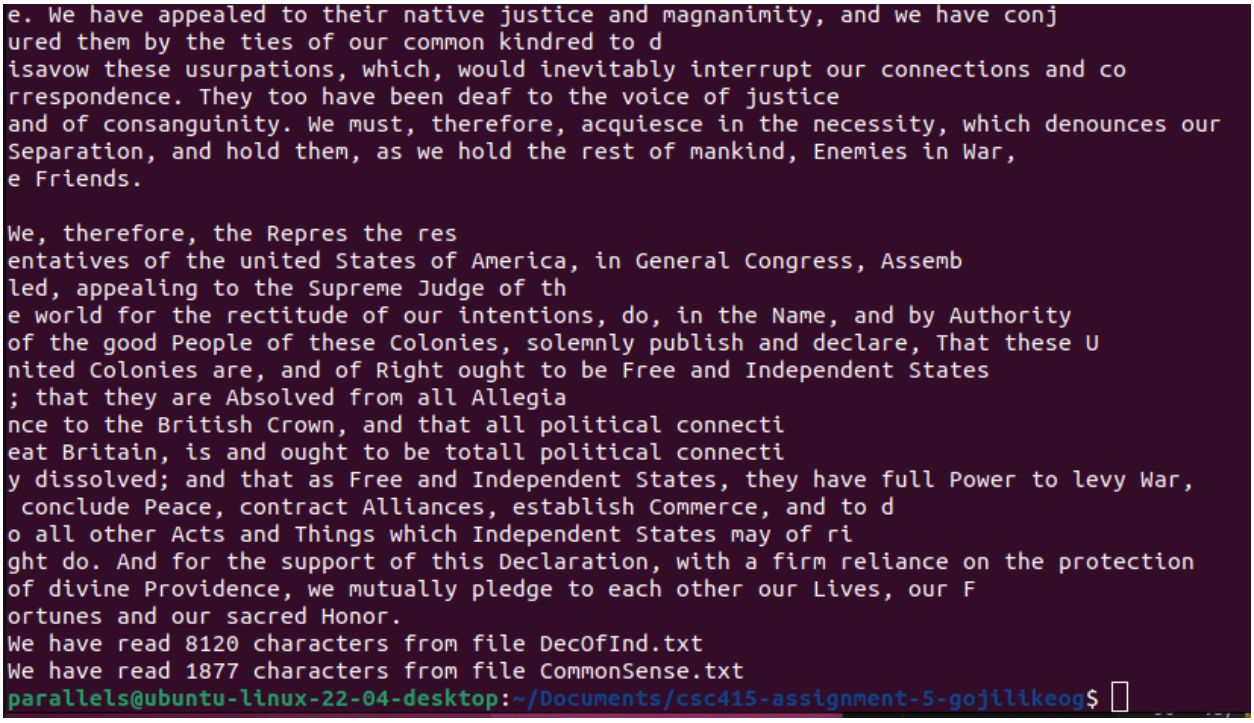
Screen shot(s) of the execution of the program:

```
parallels@ubuntu-linux-22-04-desktop:~/Documents/csc415-assignment-5-gojilikeog$ make run
./Galvez_Oscar_HW5_main DATA DecOfInd.txt CommonSense.txt
The unanimous Declaration of the thirteen united States of America, When in the Co
Perhaps the sentiments contained in the following pages, are not yet

urse of human events, it becomes necessary for one people to
sufficiently fashionable to procure them general favor; a long habit
of
dissolve the political bands which have connected them
not thinking a thing wrong, gives it a superficial appearance of
bei
 with another, and to assume among the pow
ng right, and raises at first a formidable outcry in defense of
cus
ers of the earth, the separate and equal station to which
tom. But the tumult soon subsides. Time makes more conve
 the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions o
rts than
reason.

As a long and violent abuse of power, is generally the Means of c
f mankind requires that they should declare the ca
alling
the right of it in question (and in
organizing its powers in such form, as to them shall seem most likely to effect their Safety and ble Rights,
 that among these are Life, Liberty and the pursuit of Happiness.--That to secure these rights, Governments
are instituted among Men, deriving their just powers from the consent of the governed, --That whenever any F
orm 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
 as censure to
individuals make no part thereof. The wise, and the worthy, need not the
triumph of a pamphlet; an Right, to support
the Parliament in what he calls Theirs, and as the good people of this
country are grievously oppressed by the combination, they have an undoubted
privilege to inquire into the pretensions of both, and equally to reject the
usurpation of either.

In the following sheets, the author hath studiously avoided every thing
which is personal among ourselves. Compliments as well
Happiness. Prudence, indeed, will dictate that Governments long established should not be
d those whose sentiments are injudicious, or
unfriendly, will cease of th
changed for light and transient causes; and accordingly a
emselves unless too much pains are besto
ll experience hath shewn, that mankind are more disp
wed
upon their conversion.

The cause of America is in a great measure the cause
osed to suffer, while evils are sufferable, than to ri
 of all mankind. Many
circumstances hath, and will arise, which are not lo
```

```
ght themselves by abolishing the forms to which they are accustomed. But when a
cal, but universal, and
through which t
long train of abuses and usurpations, pursuing invari
he principles of all Lovers of Mankind are
a design to reduce them under absolute Desp
Affections are intehe Event of which, their ng invari
otism, it is their right, it is their duty, to throw off such Government, and to provide n
rested. The laying a Country
desolate with Fire and Sword, declaring War against the na
ew Guards for their future security.--Such has been the patient suf
tural rights of all
Mankind, and extirpating the Defenders
ferance of these Colonies; and such is now t
thereof from the Face of the Earth,
is the Concern of
he necessity which constrains them to alter their former Systems of Government. The histor
every Man to whom Nature hath given the Power o
y of the present King of Great Britain is a history of repeated injuries and usurpat
f feeling;
of which Class, regardless of Party Censure, is the

AUTHOR
ions, all having in direct object the establishment of an absolute Tyranny over these St
To prove this, let Facts be submitted to a candid world.

He has refyranny
used his Assent to Laws, the most wholesome and necessary
for the public good.

He has forbidden his Go
vernors to pass Laws of immediate and pressing importance, unless
suspended in their operation till his Assent should be ob
tained; and when so suspended, he has utterly neglect
ed to attend to them.

He has refused to pass other Laws for t
he accommodation of large districts of people,
entation in thpeople would relinquish the right of Represfor t
e Legislature, a right inestimable to them and
formidable to tyrants only.

He has called togethe
r legislative bodies at places unusual, uncomfortable, and distan
t from the depository of their public Records, for the sole purpose of fatiguing them into
 compliance with his measures.

He has dissolved Representativ
e Houses repeatedly, for opposing with manly firmness his invasions on the righ
ts of the people.
```

```
He has refused for a long time, after such dissolutio
; wherecause others to be elected for a
by the Legislative powers, incapable of Annihilation, h
ave returned to the People at large for their exercise; the State remaining in th
e mean time exposed to all the dangers of
invasion from without, and convulsions with
in.

He has endeavoured to prevent the population of these States; for that pu
rpose obstructing the Laws for Naturalization of Foreigne
rs; refusing to pass others to encourage their mig
rations hither, and raising the conditions of n
dministration ons of Lands.

He has obstructed the Aeignez Stazes;
of Justice, by refusing his Assent to Laws for establishing Judic
iary powers.

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

He has erected a m
ultitude of New Offices, and sent hither swarms of Offi
cers to harrass our people, and eat out their substance.

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

He has affected to render the Militar
erior to the Civil power.

He has combinedrender the Militar
 with others to subject us to a jurisdiction foreign
to our constitution, and unacknowledged by our laws; givi
ng his Assent to their Acts of pretended Legislation:

For
 Quartering large bodies of armed troops among us:

For protecting them, by a mock
 Trial, from punishment for any Murders which they should commi
t on the Inhabitants of these States:

For cu
tting off our Trade with all parts of the world:

For imposing Taxes on us without
s in many cases, of the benefits of Trial by Jury:
```

```
For traing Taxes on us without
nsporting us beyond Seas to be tried for pret
ended offences

For abolishing the free System of English Laws in a neighbouring
Province, establishing therein an Arbitrary go
vernment, and enlarging its Boundaries so as to rende
r it at once an example and fit instrument for introducing the same
 absolute rule into these Colonies:

For taking away our Chart
ers, abolishing our most valuable Laws, and altering fundamentally the Forms of our
or suspending our own Legislatule Laws, and al
res, and declaring themselves invested with power to legislate f
or us in all cases whatsoever.

He has abdicated Government he
re, by declaring us out of his Protection
 and waging War against us.

He has plundered our seas, ravaged o
ur Coasts, burnt our towns, and destroyed the lives of our people.

He is at th
is time transporting large Armies of foreign Mercenaries to compleat
the works of death, desolation and tyranny, alread
rcely paralleled in the most barbarou & perfidy scaaries to compleat
s 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 agains
t their Country, to become the executioners of their frie
nds and Brethren, or to fall themselves by their H
ands.

He has excited domestic insurrections amongst us, and has
endeavoured to bring on the inhabitants of our frontiers, the merciless Indian S
avages, whose known rule of warfare, is an undistinguished destructi
f all ages, sexes and conditions.

In every stage of these Ozstr
ppressions We have Petitioned for Redress in the most hum
ble terms: Our repeated Petitions have been answered only
by repeated injury. A Prince whose character is thus marked by every act w
hich may define a Tyrant, is unfit to be the ruler of a f
ree people.

Nor have We been wanting in attentions to our Bri
ttish brethren. We have warned them from time to time of attempts by
 their legislature to extend an unwarrantable jurisdiction ov
reminded them of the circumstances of our emigration and settlement hert w
```


e. We have appealed to their native justice and magnanimity, and we have conj
ured them by the ties of our common kindred to d
isavow these usurpations, which, would inevitably interrupt our connections and co
rrespondence. They too 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,
e Friends.
We, therefore, the Repres the res
entatives of the united States of America, in General Congress, Assemb
led, appealing to the Supreme Judge of th
e world for the rectitude of our intentions, do, in the Name, and by Authority
of the good People of these Colonies, solemnly publish and declare, That these U
nited Colonies are, and of Right ought to be Free and Independent States
; that they are Absolved from all Allegia
nce to the British Crown, and that all political connecti
eat Britain, is and ought to be totall political connecti
y dissolved; and that as Free and Independent States, they have full Power to levy War,
conclude Peace, contract Alliances, establish Commerce, and to d
o all other Acts and Things which Independent States may of ri
ght do. And for the support of this Declaration, with a firm reliance on the protection
of divine Providence, we mutually pledge to each other our Lives, our F
ortunes and our sacred Honor.
We have read 8120 characters from file DecOfInd.txt
We have read 1877 characters from file CommonSense.txt
parallels@ubuntu-linux-22-04-desktop:~/Documents/csc415-assignment-5-gojilikeog$

Assignment #3 - Buffered I/O

- Assignment: Handle buffered I/O where you do the buffering
  - Create a set of routines in the file b_io.c
    - Prototypes are contained in b_io.h
      - ↳ The functions will only use the supplied low level API's (LBAread, and GetFileInfo)

    - b_open - Should return a integer file descriptor (a number that you can track the file)
    - ✓ · May want to allocate the 512 (B_CHUNK_SIZE) byte buffer for read operations
    - ✓ · Return a negative number if there is an error
    - ✓ · You will call GetFileInfo to find the filesize and location of the desired file.
      - ↳ See the structure fileInfo (contained in fsLowSmall.h)
    - ✓ · GetFileInfo returns a pointer to fileInfo (this pointer does NOT need to be freed)
      - The structure has the starting block number for the file and the files actual block length
    - Error identified: Can't handle opening more than 9 files at the moment 7/7 04:01 AM
    - b_read - Takes a file descriptor, a buffer and the number of bytes desired.
    - ✓ · The operation of your b_read function must only read B_CHUNK_SIZE bytes at a time from LBAread into your own buffer
    - ✓ · You will then copy the appropriate bytes from your buffer to the caller's buffer
      - (Do not copy one byte at a time. Treat the data as binary data)
      - This means you may not even need to do read of the actual file if your buffer already has the data needed.
      - Or... it may mean that you have some bytes in the buffer, but not enough and have to transfer what you have, read the next B_CHUNK_SIZE bytes, then copy the remaining needed bytes to the caller's buffer
    - ✓ · The return value is the number of bytes you have transferred to the caller's buffer.
      - ✓ - When it is positive but less than the request, it means you have reached the end of the file.
      - HINT: You may need to track between calls where in your buffer you left off, and which block your file you are at.
    - ✓ · Be able to handle if the read request is greater than B_CHUNK_SIZE, meaning that you may have to directly fill the caller's buffer from a B_CHUNK_SIZE byte read (no need to buffer) then buffer just any amount needed to complete the caller's read request.
    - ✓ · You are responsible for keeping track of the file size, and once you reach the end of the file, return 0 indicating there are no more bytes to read.

    - b_close - Should free any resources you are using
    - You can write any additional helper routines as needed.

- Limits
  - You can assume no more than 20 files open at a time ✓ b_open
    - Assuming multiple files can be open at one time, this means the buffer you have for a file can not be global, but must be associated with that open file. (b_getFCB) A function to get an available FCB is provided in b_io.c

- How it works)
  - Uses the command line arguments to specify data file and the desired target file(s).
    - The main program uses b_open,
    - reads some variable number of characters at a time from the file using b_read
    - prints those characters to the screen (ended in a newline character)
    - loops until it has read the entire file
    - b_close the file and exit

IHaveADream.txt - 1521 bytes
CommonSense.txt - 1877 bytes

Oscar Galvez
Github: gojilikeog

ID: 911813414
CSC415 Operating Systems

Lecture Review: File System is a block operation - Learn to read and write blocks
- Implement versions of the open, read, close functions used in assignment 4

b_open: Return a file descriptor (Index into an array of file control blocks)
- May want to allocate buffer here
- Learn how to track a buffer for each individual file

b_read: Takes file descriptor, buffer and number of bytes desired.
Example: Read 10 bytes with nothing in buffer
- Read the first block of the file (LBAread (buffer, 1, x))
  - This loads the data into the buffer
- Take the 10 bytes and copy it into their buffer
  - You will then return - Index is at 10 of the current file

Read 500 bytes
- Take the next 500 bytes and copy it into their buffer
- Buffer should be at 510
- You will then return

Read 10 more bytes
- Take the next 2 bytes and copy it into their buffer
- Read the next block of data - this overwrites everything
- Position should now be at 0

  Take the next 8 bytes to reach the 10 bytes requested
- You will then return

Read 200 more byts - but file is only 600 byts so only 80 left to read
- You must be able to detect the end of file
  - If you give them less than asked, it indicates the end of file
- Return number of bytes put into buffer (0 if none put in)

Hint for end of file: There is an easy way.
LBAread is the only way to get data into your buffer (No linux open or read)
- Hint: You may also need to track between calls where you are in the buffer like assignment 2

- How do we find a file?
  - Call getFileInfo to find the fileSize and location. Returns a pointer. (Does not need to be freed)
    The structure has a starting block number (all files are contiguously allocated) for the file and the files actual byte length.

- Your responsibility of keeping track of the file size, and returning 0 indicating there are no more bytes to read.

- The main program uses 'b_open'
  - reads some variable number of characters at a time from the file using 'b_read'
  - Prints those characters to the screen (ending in a newline character)
  - Loops until it reads the entire file
  - Calls 'b_close' and exits
- Every run will be different since it pulls a random character to read each time

Look at files: fsLoads

- getFileInfo - NULL if can't open - Returns pointer with info
  - Given fn, returns number of blocks

Calculating blocks

- int getBlocks (int length of file)

```
int n = (lengthOfFile / 512) + 1      (m + n - 1) / n
3 = 1024 / 512 + 1
```

- LBAread - takes the pointer, takes how many blocks you want to read, and which block #

b_io.h

- Prototypes

b_io.c

- Put the buffer in b_fcb struct - Probably pointer to not waste space
- b_open:
  - Call getFileInfo at b_getFCB
- b_read:
  - Take fd to open, Takes a user buffer, Takes how many bytes the user wants to read
- b_close
  - Close the resources

b_read: Default case - memcpy into user buffer
change buffer position
return bytes commited to buffer (in this case count)

w/ Count: 11394
2773

w/ actual Count: 11363
2688

if (

LBA read: Returns '1' if successful load
Return '0' if block number is invalid? Is this end of file?
- Means nothing new was loaded into buffer - End of file reached

fillCount:
count: 70
textLeft = 28
currentPos = 484

while (textLeft >= tempLeft)
memcpy (28)
tempLeft = 70 - 28 = 42
currentPos = 0
textLeft = 13

28
+
15

while (textLeft < tempLeft)
memcpy (13)
tempLeft = 42 - 15
currentPos =
textLeft =

else (textLeft > tempLeft)
memcpy
currentPos =
textLeft =