PA1 – Jetson's Audio Playback

Student Information

Integrity Policy: All university integrity and class syllabus policies have been followed. I have neither given, nor received, nor have I tolerated others' use of unauthorized aid.

I understand and followed these policies: (•) Yes ( ) No

Name: Joey Domino

Date: 11/2/2022

Submission Details

Final ***Changelist*** number: 159661

Verified build: ( ) Yes ( ) No

Required Configurations: 2: { Debug/Release | x86 }

Part A: YouTube Link: https://youtu.be/YfQFafzzkoM

Part B: YouTube Link: https://youtu.be/E9tvWHlem_Q

Part B: PDF perforce loc: C:\Users\playd\Perforce\Multithreading C++ 562\jdomino_MT_PA1_E

Additional Discussion (What did you learn):

I learned how to communicate between threads to play some songs

Verify Builds

- Follow the Piazza procedure on submission
  - Verify your submission compiles and works at the changelist number.
- Verify that only MINIMUM files are submitted
  - No – Generated files
    - *.pdb, *.suo, *.sdf, *.user, *.obj, *.exe, *.log, *.pdb, *.db
    - Anything that is generated by the compiler should not be included
  - No – Generated directories
    - /Debug, /Release, /Log, /ipch, /.vs
- Typical files project files that are required
  - *.sln, *.suo,
  - *.vcxproj, *.vcxproj.filters, *.vcxproj.user
  - *.cpp, *.h
  - CleanMe.bat

Standard Rules

Submit multiple times to Perforce

- Submit your work as you go to perforce several times (at least 5)
  - As soon as you get something working, submit to perforce
  - Have reasonable check-in comments
    - Seriously, I'm checking

Write all programs in cross-platform C++

- Optimize for execution speed and robustness
- Working code doesn't mean full credit

Submission Report

- Fill out the submission Report
  - No report, no grade

Code and project needs to compile and run

- Make sure that your program compiles and runs
  - Warning level 4
  - NO Warnings or ERRORS
    - Your code should be squeaky clean.
  - Code needs to work "as-is".
    - No modifications to files or deleting files necessary to compile or run.

- All your code must compile from perforce with no modifications.
  - Otherwise it's a 0, no exceptions

Project needs to run to completion

- If it crashes for any reason…
  - It will not be graded and you get a 0

Leave Project Settings

- Do NOT change the project or warning level
  - Any changing of level or suppression of warnings is an integrity issue

Leaking Memory

- If the program leaks memory
  - There is a deduction of 20% of grade
- If a class creates an object using new/malloc
  - It is responsible for its deletion
- Any ***MEMORY*** dynamically allocated that isn't freed up is ***LEAKING***
  - Leaking is ***HORRIBLE***, so you lose points

No Debug code or files disabled

- Make sure the program is returned to the original state
  - If you added debug code, please return to original state
- If you disabled file, you need to re-enable the files
  - All files must be active to get credit.
  - Better to lose points for unit tests than to disable and lose all points
- Disable your debug printing otherwise you will lose points

Due Dates

- See Piazza for due date and time
  - Submit program perforce in your student directory assignment supplied.
- Fill out your this ***Submission Report*** and commit to perforce
  - ***ONLY*** use Adobe Reader to fill out form, all others will be rejected.
  - Fill out the form and discussion for full credit
- Assignment See Piazza for Date and Time
  - Due in two weeks before 8th week class session on Thursday.
  - Grading synchronized to this time
    - ----- ABSOLUTELY NO EXTENSIONS ----------
  - Date cannot be moved

Goals

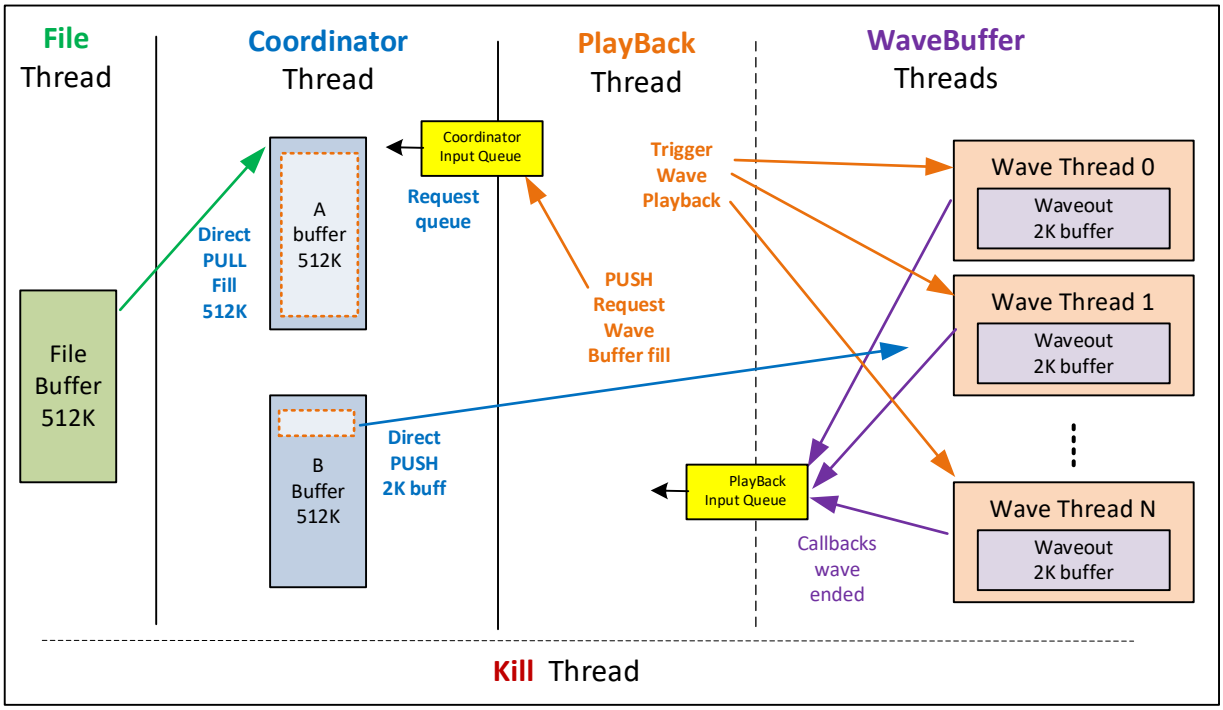
- Required:
  - Simplified Threading program - Using C++ 11 threading model
    - Program using basic multithreading primitives
    - Several fixed threads, Mutexes, Callbacks, Critical Sections
    - Material from Chapter 1-4 of book - only
      - No Atomics or advanced features allowed
    - Must follow the spirit of the problem
  - **Part-A** 10% - Grade
    - Do working in /student/**PA1_A**
    - File <-> Coordinator Thread Simulation
    - Video Demo - max 10 min
      - Design / code show and tell
      - Demo of the code working with prints
      - Show off the File <-> Coordinator requirements
    - Submit PA1 pdf with links (leave Part_B empty)
  - **Part-B** 20% - Grade
    - Do work in /student/**PA1_B**
    - Complete application working
    - Video Demo max 10 min
      - Code review…
        - no Music playing..
        - just design / code show and tell
        - show the code show off all the design requirements
    - Working Code
      - Will be compiled and tested
      - Checking for pops/clicks and clean shutdown in Debug/Release
    - 4-5 page pdf write-up
    - Submit PA1 pdf with links (leave Part_A section empty)

Assignments

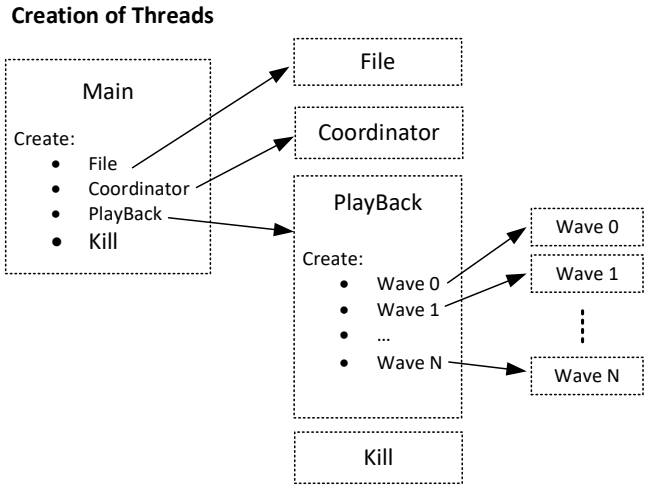
1. Summary
    a. Playback the Jetson's theme song using 5 large threads {**Main**, **File**, **Coordinator**, **PlayBack**, **Kill**} with 20 subordinate **WaveBuffer** threads plus the main thread.
        i. 25 threads in total (Can be more)
            - **Main** Thread
                a. All threads "context" classes created in **Main** thread
                b. They are launched from main
                    i. Invoking the thread begin as a method call
            - **File**, **Coordinator**, **PlayBack**, **Kill**
            - 20 - **WaveBuffer** threads
        ii. Once created they stay alive for the duration of the application
            - (until termination of the application)
            - NO - KEY PRESS allowed… should terminate at end of song
    b. Source wave data is raw wave data
        i. Headerless, just raw data
        ii. Broken into 23 separate files
            - wave_0.wav - wave_22.wav
            - Sizes of files vary between 512K to 128K bytes
        iii. Sample rate: 22050, PCM, 16 bit, stereo wav file format
        iv. Hard coding of names permitted, but not the file size
            - There is a pattern… easy to generate the names
    c. Goal:
        i. Play the stereo sound track without any clicks or pops
        ii. Should be seamless, playback should sound as if it plays
        iii. Only sleep allowed is in the File Thread
        iv. No spin locks… use the proper (async,condition variables, future, or promises)
    d. Communication
        i. **Unlimited** use:
            - Mutex, Condition_Variables, Async, Future, Promise, Locks
            - anything from Chapter 1-4
        ii. Only **one** timing sleep related allowed in the whole application
            - *sleep_for(), wait_for(), wait_until()* – for 200ms in **File** Thread ONLY
            - No extra sleep related allowed anywhere
                a. If you need extra sleep your design is wrong - lose 50% of trade
        iii. **Restricted** use (2 input Circular Queues)
            - **Coordinator** Thread: ***Input Queue***
                a. Request in order coming in **PlayBack** Thread

b. Cannot be used for anything else… only request from the PlayBack thread

- **PlayBack** Thread: ***Input Queue***
  a. Request coming in from **WaveBuffer** threads (20 of them)
  b. Cannot be used for anything else… only request from the **WaveBuffer** threads through corresponding **WaveBuffer** callback functionality.



2. Thread creation spawning hierarchy



3. **File** thread
    a. Single Buffer - 512K
    b. Only one dynamic buffer allocation.
        i. At beginning, then everything is out of that buffer
    c. Some type of flag, living in the thread to communicated that it is filled
    d. Need a mutex for access
        i. Will sleep for 200 ms, then check flag
    e. Refill buffer with SYNCHRONOUS file loads using FileSlow library
        i. FileSlow::Open(), Read(),Seek(),Tell(),Close()
        ii. You cannot use any other file system

4. **Coordinator** Thread
    a. Double buffer
        i. A/B buffer or Front/Back buffer
    b. Two separate buffers each 512K, dynamically allocated in beginning once
    c. Two major roles of the coordinator thread:
        i. Pull data mode
            - Retrieves data from the **File** thread, places in the A/B buffer
        ii. Push data mode
            - Copies data from A/B to the wave buffer thread
            - Initiated by a trigger from the **PlayBack** thread
    d. There is an input Circular Queue to the **Coordinator** thread
        i. Only the **PlayBack** thread can feed this queue
5. **PlayBack** thread
    a. General Description:
        i. This thread keeps music playing between all of its wave buffers
        ii. When a **WaveBuffer** thread is done playing
            - It sends a callback to the **PlayBack** thread
        iii. This thread then points to the next Waveout buffer and continues playing
    b. **PlayBack** thread cycles indefinitely between all the Waveout buffers in a continuous circular buffer fashion
        i. Playing music without pops or clicks
    c. Creates 20 **WaveBuffer** threads
        i. Created in beginning
        ii. Need to stay alive for the duration of the program
    d. **PlayBack** thread communication
        i. PlayBack get's message from waveout buffer threads
            - A callback from the waveout buffer player
            - Feeds the input CircularQueue to the **PlayBack** thread
                a. Only the **WaveBuffer** callback can feed this queue
        ii. **PlayBack** doesn't do the loading – it delegates
            - **Coordinator** thread refills the wave buffer threads

- **PlayBack** communicates to the **Coordinator** which buffer needs filling
    a. It signals to coordinator to do the dirty business

e. In order to play sounds cleanly
    i. We may need to have the wave buffers (20 of them) in individual threads
        - 2K buffers each
        - 20 separate (waveout) **WaveBuffer** threads
        - These threads will be created once, and then reused

6. Paper
    a. 4-5 page pdf paper
    b. Necessary items to cover:
        i. Description of the application
        ii. Thread creation process
            - Who creates the threads
            - Names you use in code
            - Each thread responsibilities
        iii. Communication between different threads
            - What is signaling, callbacks, mutexes, synchronization operations
        iv. Complete Data movement from Reading to playback
            - Follow the data through the whole process to the actual playing
            - Diagrams please in your discussion
        v. Challenges you had and what you learned
7. Videos
    a. See above for Part_A and Part_B video code/design discussion

Validation

Simple checklist to make sure that everything is submitted correctly

- Program compiles and runs without crashing?
    - Program warning free?
    - Memory leak free and clean closing
        - Severe deduction for leaking and shutting down properly
    - No Additional sleeping mechanism
    - Make sure program build without errors or level warnings
        - Project should be able to run without crashing
        - In Debug/Release
- Did you write your pdf file?
- Did you do the Videos? Part_A and Part_B

Hints

Most assignments will have hints in a section like this.

- Focus on small problems…(prototype for learning)
    - Focus on waveout playback: Single thread
        - Next add several buffers
        - Next separate into several threads
    - File thread
        - Mutex coordination with xxx ms sleep
    - Coordinator thread
        - A/B buffer switching
        - Loading
        - Queuing requests from playback thread
    - Playback thread
        - Triggering wave out buffer/threads
        - Callbacks
        - Circular indexing
        - Communicating to Coordinator thread
        - Synchronization primitives

Troubleshooting

- Baby steps
    - You'll be in trouble if you don't
- This is so slow and painful, takes forever to get working.
    - You cannot escape the agony of this part
    - Just do it.
- Hard to debug -> use Debug::out() for this project
- Have you BEEN studying and doing experiments over the last several weeks?
    - If not… this assignment is virtually impossible
    - If you have… PIECE of CAKE