

Digital imaging & free fall of immersed sphere with wall effects

May 14-18, 2012

Objective: This week's lab work has two parts: (1) how to record digital video and convert it into an image sequence; (2) to capture the transient descend of a free falling sphere with or without the influence of a nearby solid wall. *An extension reading regarding video formats is given in the back.

不用抄實驗步驟，但有兩題預報問題要繳交。因小步驟多，請務必在實驗前看完講義。結報問題和實驗步驟及觀察結果相關，所以步驟中(Qx)代表相關的結報問題。

由於實驗組件有限，請同學輪流合作操作實驗。大家實驗愉快。謝謝助教幫忙。

Part I Operation of a digital video

1. Open the software “ComproDTV4”.
2. Adjust image quality: “選項”→“視訊/音訊”：調整視訊亮度、色調、對比、銳利度. 確定照相機對焦
3. Set up the video format:
“選項”→“視訊/音訊”：格式→NTSC_M; select your own resolution; 音訊→靜音 (Q1 結報問題)
“選項”→“錄影”：品質→SW MC Encode; 自訂→進階選項：格式選 MPEG-I; 畫格速率(影像格式)→29.97(NTSC) 按確定儲存影像存取格式設定
4. “Record/Stop” initiates and terminates a recording.



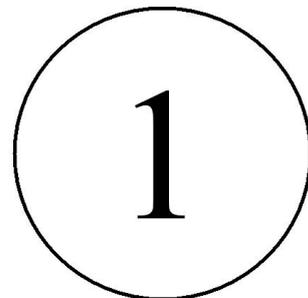
A MPEG-file will be generated on the desktop with a default name: “COMP_mmdd_time.mpg”, in which mmdd_time indicates the time the video was generated.

Play the video in **Quicktime** to ensure that you succeeded in capturing a digital video.

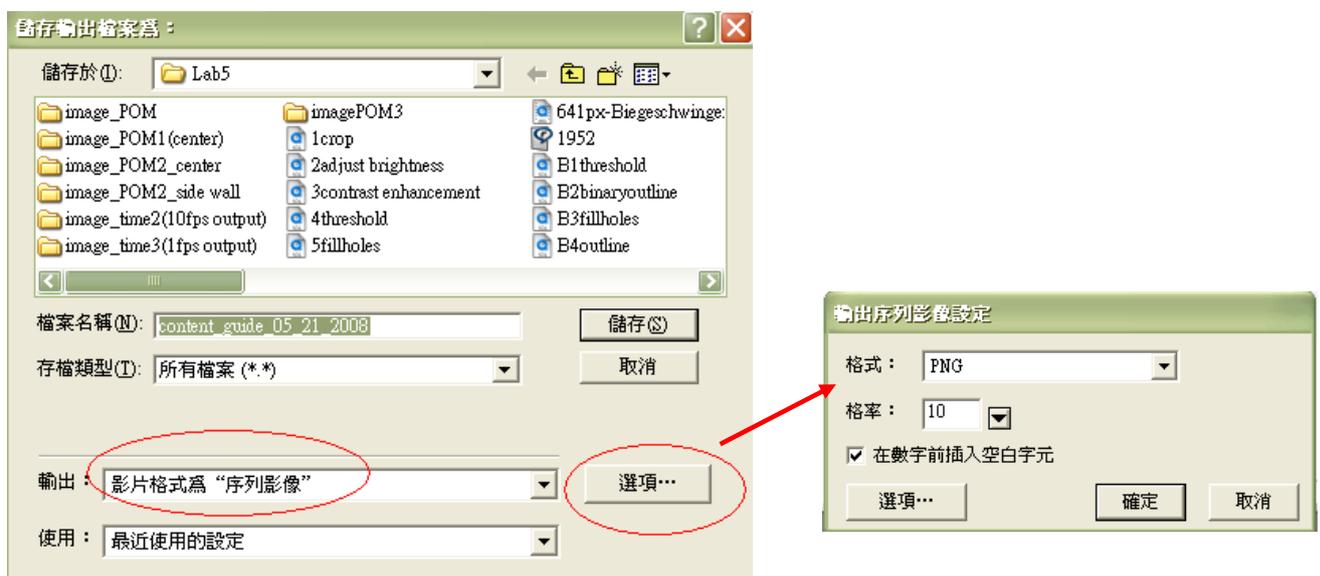
Delete the file.

Procedures

1. Open in “123.avi” in Quicktime. Use left/Right key(動左右鍵) to scroll through the movie and double check that each number, from 1 to 30, is flipped over at a constant rate within a second 1-30 號碼以等速在一秒鐘跑過一次(00:00:00→00:00:01)，再重複。



2. Hit “Capture” and play the AVI.
3. Open the MPEG image file in **QuickTime**. Play the movie to ensure that you’ve recorded for at least 2 seconds.
4. In **QuickTime**, go to “File 檔案” → “Export 匯出” → 影片格式選“序列影像” → 選項 Set image format to “PNG”; set 格率(frequency) to “30 (or 29.97)” (fps) → 確定.
Pay attention to the time it takes to convert the video.
5. **Create a folder** to save the image sequence.
6. Open the folder and examine the exported images: Count how many “number image” you obtained. What is the number sequence? Could you explain it? (Q2)



7. Export again but now change the 格率 to “5” (fps). Repeat step 6. (Q2)
8. Export again but now change the 格率 to “1” (fps). Repeat step 6. (Q2)
9. Export again but now change the 格率 to “60” (fps). Repeat step 6. (Q2)
10. Export again but now change the 格率 to “45” (fps). Repeat step 6. (Q2, Q3)
11. Export again but now change the 格率 to “4” (fps). Repeat step 6. (Q2, Q3)

*Pay attention to the time it takes to convert the video (Q4)

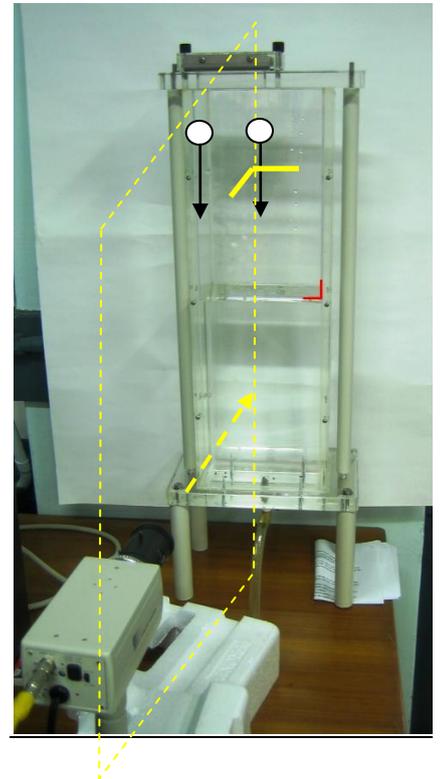
After you’re done with your clock images, delete them to save disk space for others.

Part2 Wall influence on the free-fall of an immersed sphere

Facility: a transparent square tank filled with pure glycerol, test POM sphere, digital camera;

Procedures

1. Glue black paper to the back of the tank
2. Set up the camera: adjust position, alignment, focus, aperture,...etc until a clear image is obtained. Try to cover the liquid column of 20-25cm high from the free surface.
3. Measure the sphere diameter and the width (front face)
4. Start recording and release one sphere near the center of the tank (use a straw to guide and try to hold your straw steady and upright).
5. Repeat 3 but now release the sphere near the wall. (Q5)
6. Convert both videos into image sequences.



預報問題 (part II experiment)

- [P1] Since gravity is the only driving force in the experiment, we want to make sure that the tank is leveled. Instead of using a level meter (水平儀), come up a method to ensure that the tank is leveled.
- [P2] Camera alignment: The best situation is the camera focus point lies on the plane formed by the object trajectory and the surface normal of the front wall—as indicated by the dashed plane shown in the picture. Can you explain why we want the camera to be vertical to the tank front wall? Think of a method that can help you to align the camera.
- [P3] Consider a single sphere of radius a and density ρ_s that descends in an unbounded viscous fluid of dynamic viscosity and density μ and ρ_f . Assume that the sphere motion is at low Reynolds number and has reached a steady state—reached its **terminal velocity** U_T . Use force balance to obtain an expression for U_T . (Hint: For a solid sphere that falls at a constant velocity U_T at low Reynolds number flow condition, the quasi-steady viscous drag can be described by **Stokes' drag law** $F_D=6\pi\mu aU_T$).

結報問題

Q1: Could you guess why we want to mute the program?

Q2: For each the five export rates (29.97, 5, 1, 60, 45 fps), fill out the following table.

Export frame rate (FPS)	Total frame number	Number sequence	Time interval between two consecutive exported images (sec)
30			
5			
1			
60			
45*			
4*			

Q3: When you export the images at 45 or 4fps, you get funny number sequences and uneven time intervals. Explain why those sequences and time intervals were generated.

Q4: Did you notice that it takes a longer time to export the images at a higher frame rate?

Q5: In which case the sphere descends faster? Can you conclude if the wall decelerates or accelerates the free fall?

Q6: From the reading material (given separately) or your own search and knowledge, explain the difference between QuickTime and AVI videos.

Video Format Conversion: AVI, QuickTime, and MPEG

Douglas Dixon

I make AVI video files on my PC, but you want QuickTime files on your Mac. And what's this about MPEG? It's a "standard" file format that older PC's don't even know how to handle? What's going on here anyway? As usual in the PC world, different systems were designed to do very similar things in contradictory ways, and now we're trying to deal with the mess. Digital video is complicated enough on a PC, with a wide range of formats with different pixel depths, color representations, and compression algorithms. But even the file formats used to store the video data on disk are different too.

File Formats: The Package

Basically, AVI and QuickTime are file formats, a collection of file headers and control information wrapped around some video (and audio) data to define the contents of a video file. In order to play a video file, you first need to know what it contains. The file can have one stream of video, or an audio stream (mono or stereo), or both, or even more than one of each. Each stream can then be stored in different ways: with different video resolutions and compression formats, and different audio formats and quality.

The AVI and QuickTime file formats define the contents of a video file -- the number of streams, their type, and format. Along with the stream descriptions, the file formats also contain timing information for synchronizing the streams, particularly so the video and audio can be played in sync. The file formats also provide different mechanisms for interleaving the video and audio data within the file so that they can be processed efficiently and played, in sync, in real time.

Playing AVI and QuickTime files requires system software on the Windows and Mac platforms that can read and play video files in their supported formats. In order for your system to play a file, it's not enough for the file format to describe how to separate out the data for each video and audio stream; it also needs to provide information about the format of the data in the stream. Video data can be stored at different resolutions, with different amounts of color information, and with different compression algorithms. The compression algorithms squish down and mix up the video so that it can be incomprehensible without the corresponding decompression algorithm. AVI and QuickTime provide extensible architectures for adding new compression algorithms to your system. These are called "codecs," for compressor-decompressor.

AVI and QuickTime and MPEG

Apple originally developed the QuickTime Movie (.MOV) video file format for the Macintosh, but then extended it into a cross-platform video data format that also can be used on the PC. As a result, QuickTime has been widely adopted as a portable format for cross-platform applications;

an application can be shipped on one CD-ROM and contain a single set of video files which will play on both Mac and PC. The QuickTime format is also commonly used for posting video files on the Web for downloading. The QuickTime file format also has been selected as the basis for MPEG-4, the next-generation audio/video standard.

Audio Video Interleave (.AVI) format is Microsoft's counter to Apple's QuickTime. AVI is the file format used by Microsoft's first video system, Video for Windows (VfW), and now used by its successor architectures, ActiveMovie and DirectShow. The big advantage to AVI on the PC is that it is built in to Windows. To use QuickTime on the PC, you need to first install it, which requires an additional step when you install a new application that uses QuickTime, or a rather large download from the Internet.

Theoretically, AVI should mean an end to file format worries for PC users: If you create AVI files using the built-in compression formats, you can be sure that any other Windows user can play the file. However, this only works if you stick to the built-in compression formats. Once you start using newer, better compression algorithms to get higher quality or smaller file sizes, the file will not play on other machines unless you provide the corresponding codec to be installed along with the file.

Meanwhile, the MPEG (Motion Picture Experts Group) standard is becoming more popular, especially for high-end video applications. Support for the first version of MPEG, the MPEG-1 format, is now built in to Windows and QuickTime. MPEG video is typically stored in its own common MPEG file format (.MPG). The second version of MPEG, the MPEG-2 format, provides better quality and smaller file sizes, and is starting to be supported in some video tools. As a result, in order to play a "MPEG" file, you may need to check further to see if it contains MPEG-1 or MPEG-2 format video.