

3D 그래픽스, 셰이더, OpenGL

3D Graphics Programming with OpenGL Shaders

biztripcru@gmail.com

© 2022–2024. biztripcru@gmail.com. All rights reserved.
모든 저작권은 biztripcru@gmail.com 에게 있습니다.

OpenGL 인스톨

OpenGL installation

Contents 내용

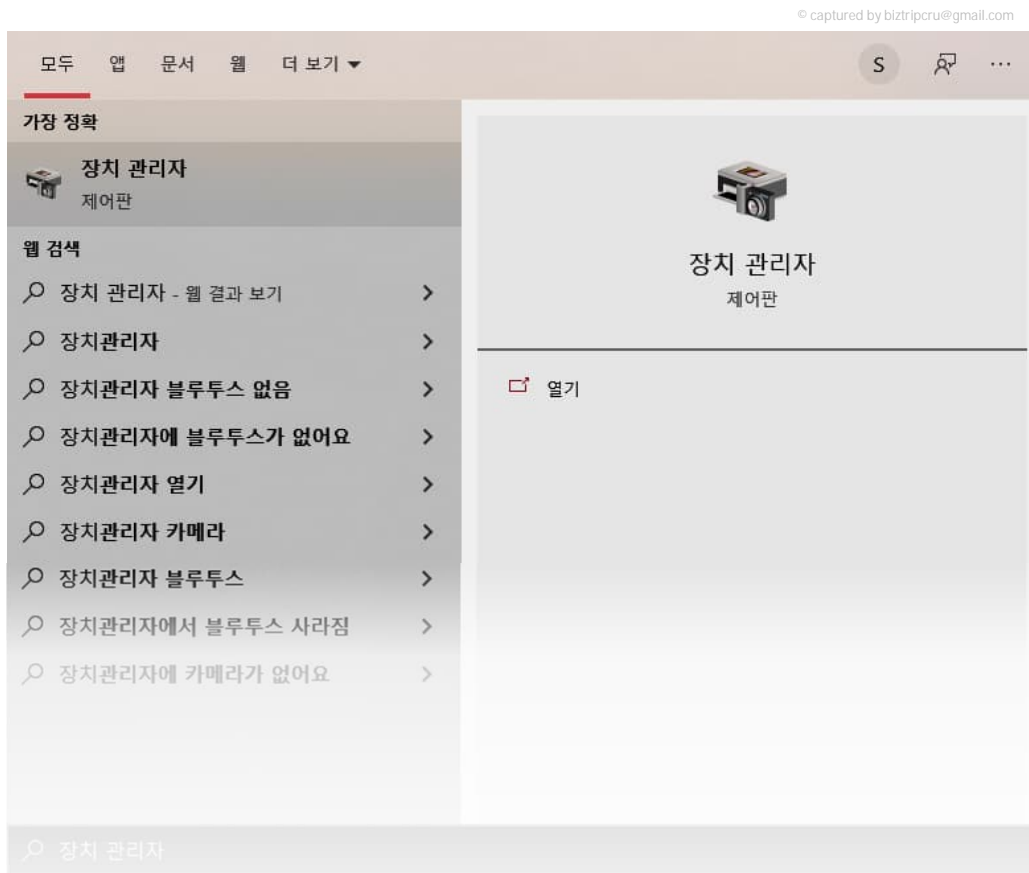
- OpenGL, GLFW 설치
- Hello, GLFW
- GLEW 설치
- Linux 에서 OpenGL 컴파일

OpenGL, GLFW 설치

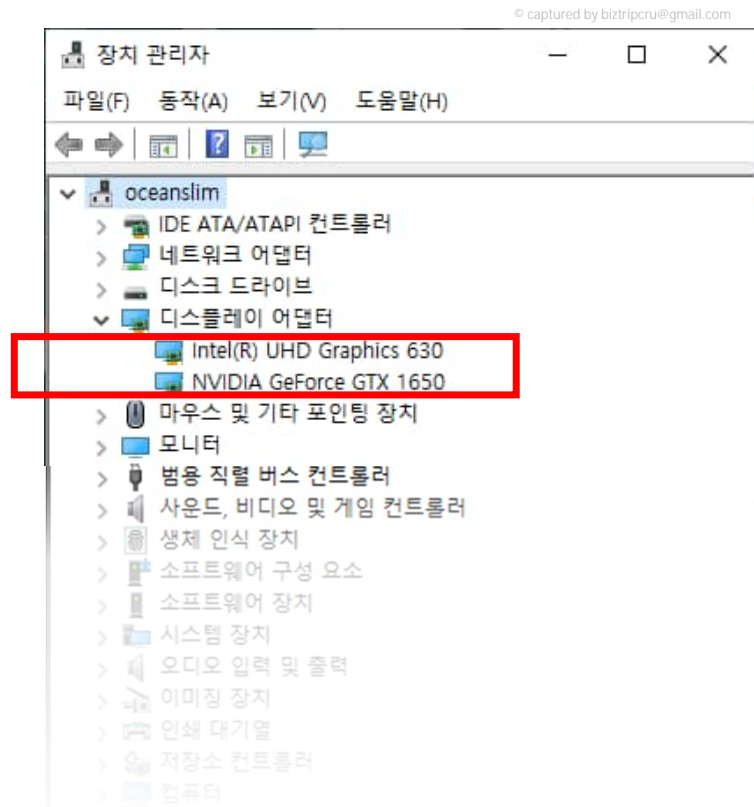
Installing OpenGL programming libraries

그래픽 카드 제조사 확인

- 윈도우 → 찾기 →
"장치 관리자" (제어판)

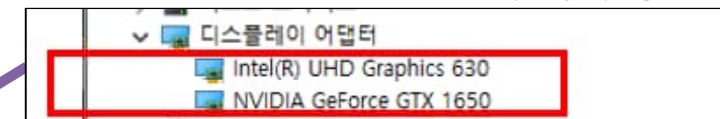
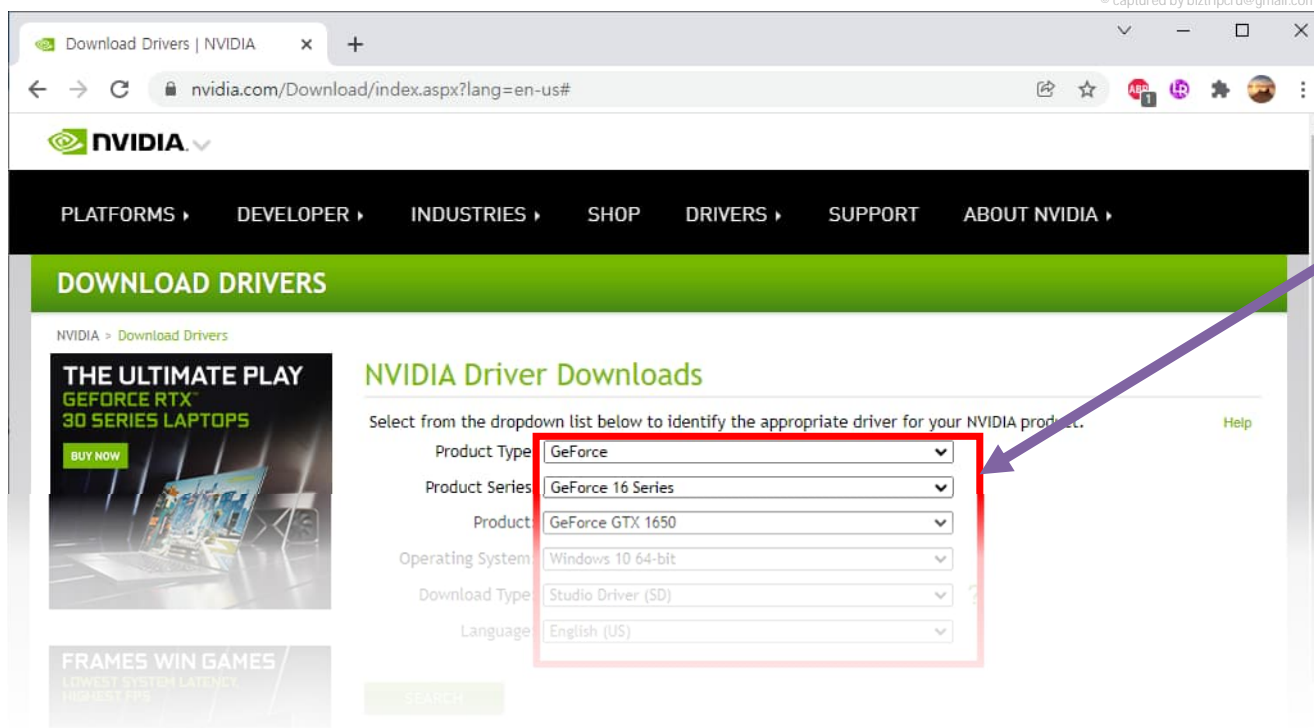


- "디스플레이 어댑터" (그래픽 카드)
 - 그래픽 카드 제조사, 모델 확인
 - ▶ Intel Graphics 는 내장형 ...



그래픽 카드 드라이버 업데이트

- NVIDIA / AMD 방문
 - OpenGL 4.x 지원 드라이버 선택 → 업데이트
 - 업데이트 후에는 윈도우 시스템의 "OpenGL32.dll" 등이 모두 업데이트됨
 - ▶ 이후는 OpenGL 4.x 기능 사용 가능



C/C++ 컴파일러 설치, GLFW 설치

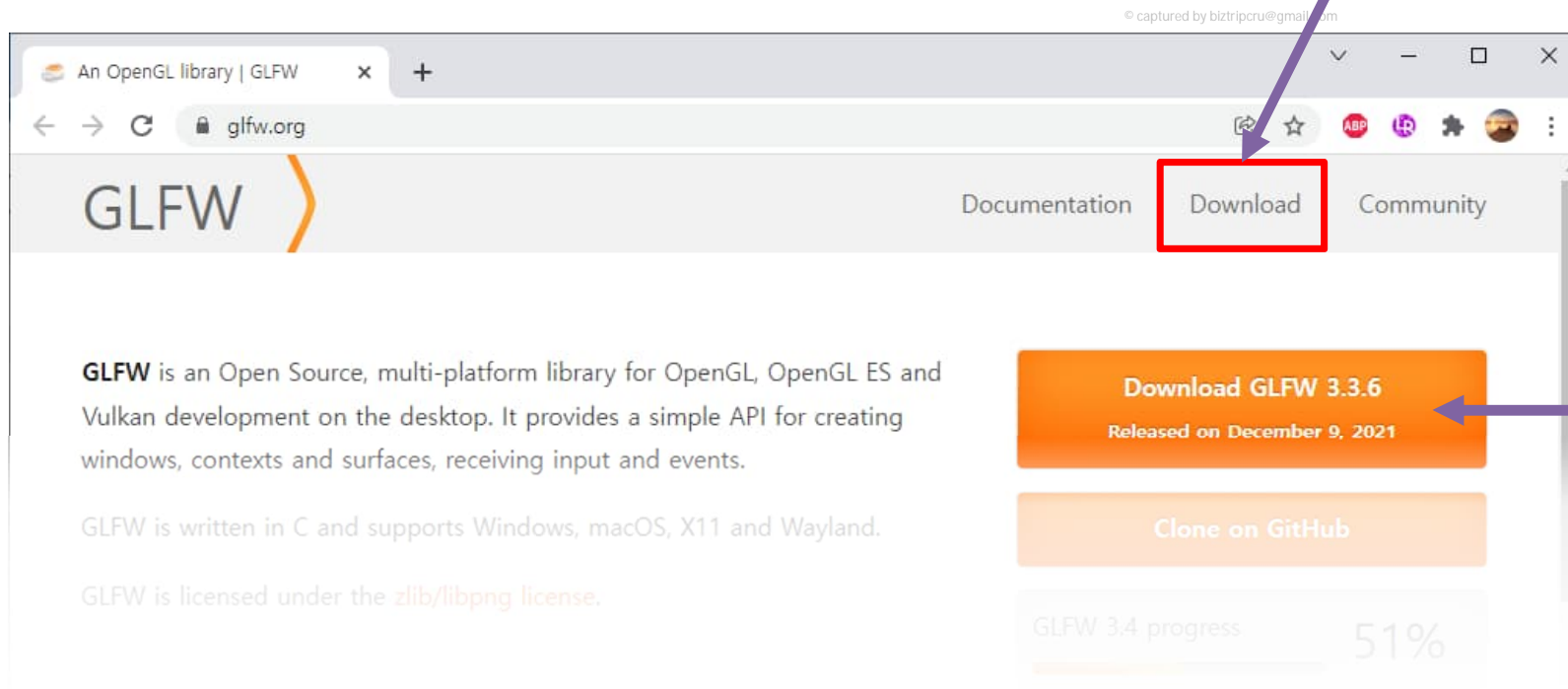
- C/C++ 컴파일러 필요

- 비주얼 스튜디오 Visual Studio 2022 사용

- GLFW 설치

- 구글에서 "GLFW" 검색, 방문, 다운로드, 설치

여기를 눌러서,
pre-compiled binary 사용

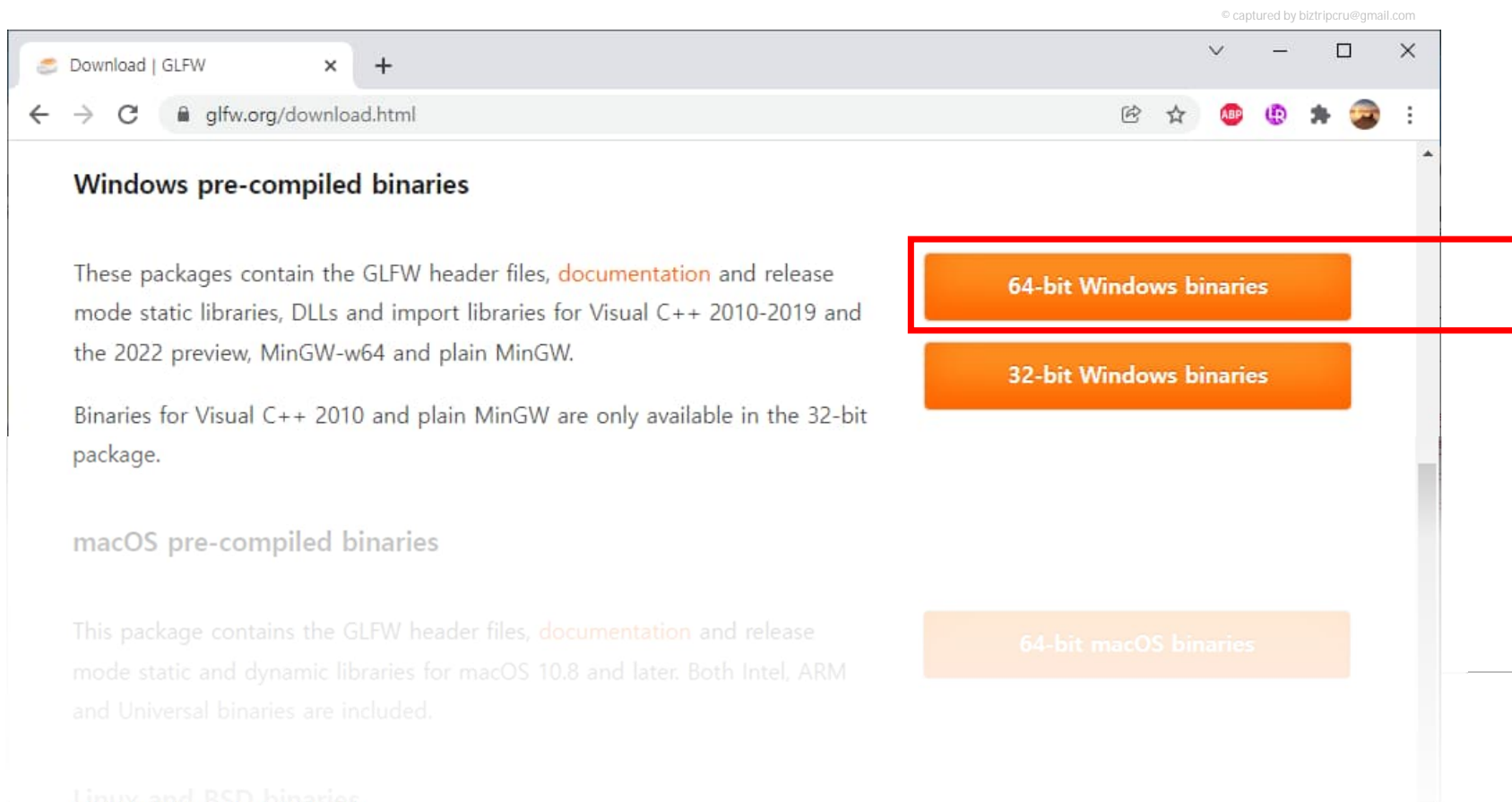


소스 코드가 필요하다면...

© Illustration by biztripcru@gmail.com

GLFW 설치

- GLFW 설치
 - 대부분, "64-bit Windows binaries" 를 사용



GLFW 설치

- unzip "glfw-x.y.z.bin.WIN64.zip"
 - 적합한 컴파일러 버전 선택

© captured by biztripcru@gmail.com

<input type="checkbox"/> 이름	수정된 날짜	유형	크기
docs	2021-12-09 오후 10:13	파일 폴더	
include	2021-12-09 오후 10:12	파일 폴더	
lib-mingw-w64	2022-01-03 오전 10:12	파일 폴더	
lib-static-ucrt	2022-01-03 오전 10:12	파일 폴더	
lib-vc2012	2022-01-03 오전 10:12	파일 폴더	
lib-vc2013	2022-01-03 오전 10:12	파일 폴더	
lib-vc2015	2022-01-03 오전 10:12	파일 폴더	
lib-vc2017	2022-01-03 오전 10:12	파일 폴더	
lib-vc2019	2022-01-03 오전 10:12	파일 폴더	
lib-vc2022	2022-01-03 오전 10:12	파일 폴더	
LICENSE.md	2022-01-03 오전 10:12	MD 파일	1KB
README.md	2022-01-03 오전 10:12	MD 파일	3KB

GLFW 설치

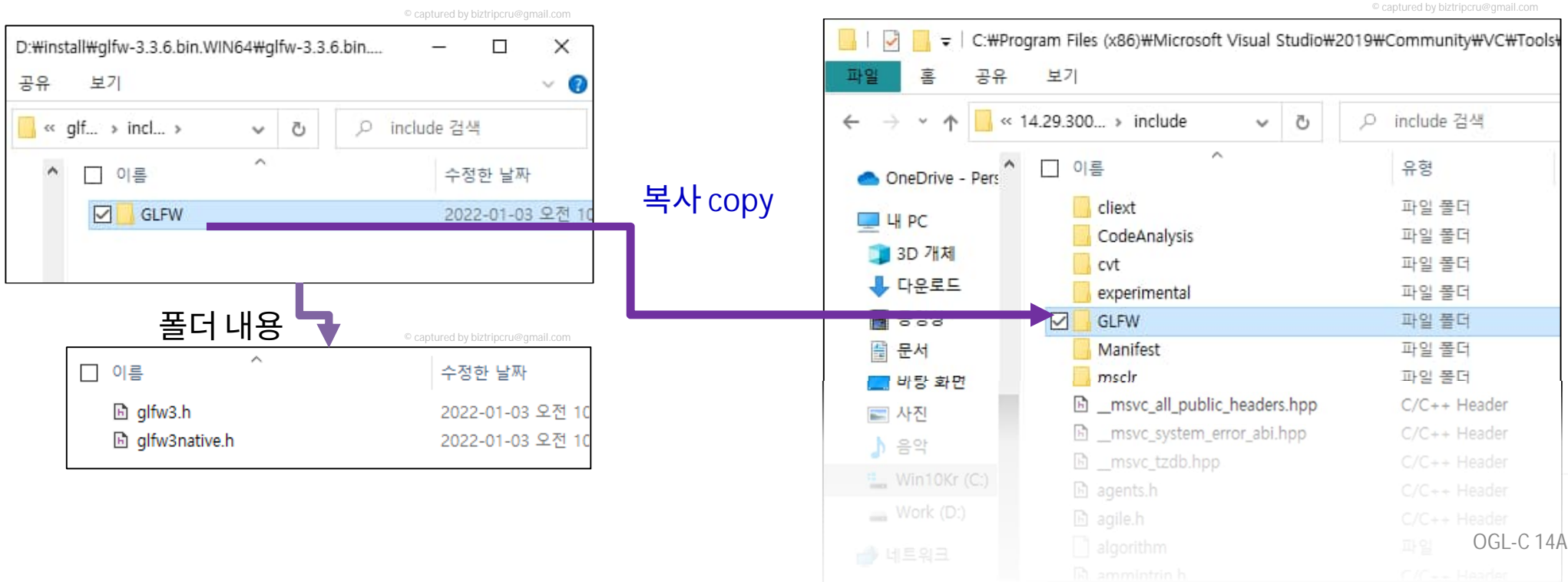
- 컴파일러 폴더/디렉토리 확인
- MS-Visual Studio 2017/2019/2022:
 - C:/Program Files (x86)/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzzz/
 - C:/Program Files/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzzz/

© captured by biztripcru@gmail.com

<input type="checkbox"/> 이름	수정한 날짜	유형	크기
atlmfc	2021-06-07 오전 11:08	파일 폴더	
Auxiliary	2021-06-07 오전 11:08	파일 폴더	
bin	2021-06-07 오전 11:06	파일 폴더	
crt	2021-06-07 오전 11:06	파일 폴더	
include	2021-06-07 오전 11:06	파일 폴더	
lib	2021-06-07 오전 11:06	파일 폴더	

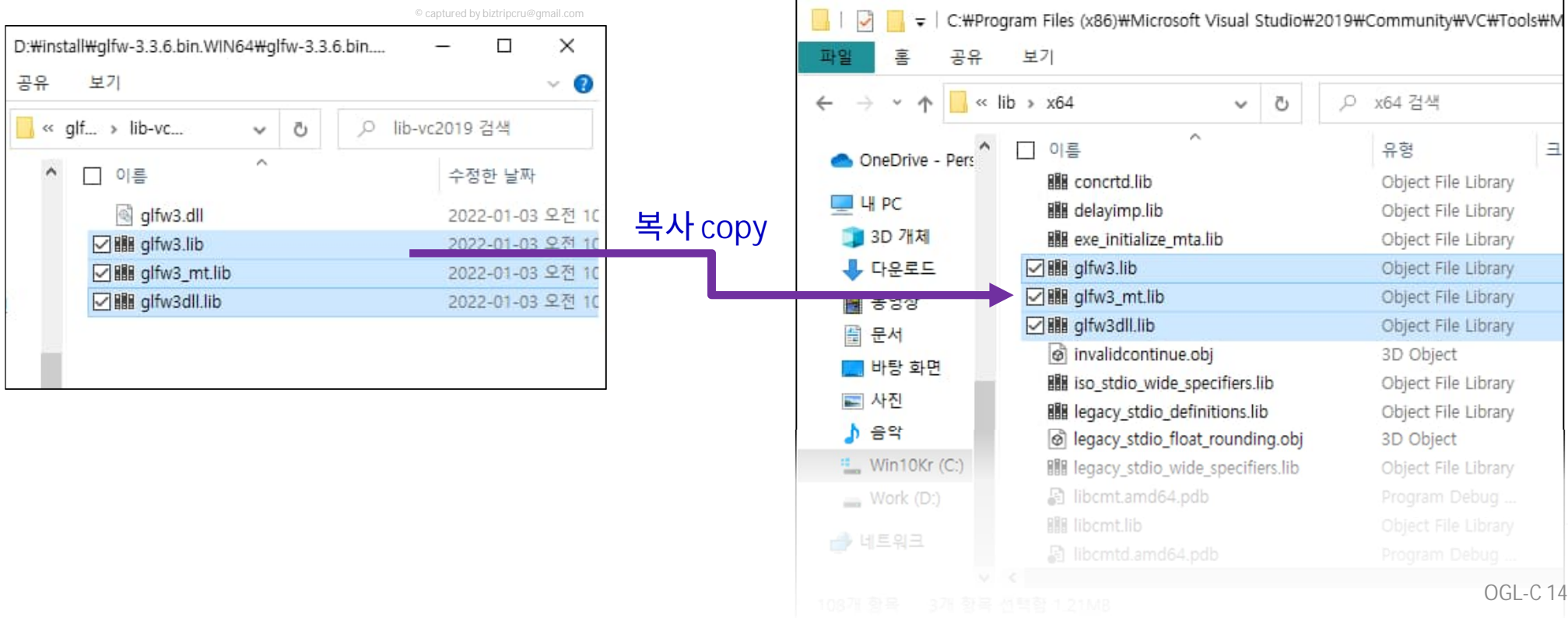
GLFW 설치

- copy "glfw-x.y.z.bin.WIN64/include/GLFW" header files to
 - C:/Program Files (x86)/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/include
 - C:/Program Files/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/include
- #include <GLFW/glfw3.h> 가능 !



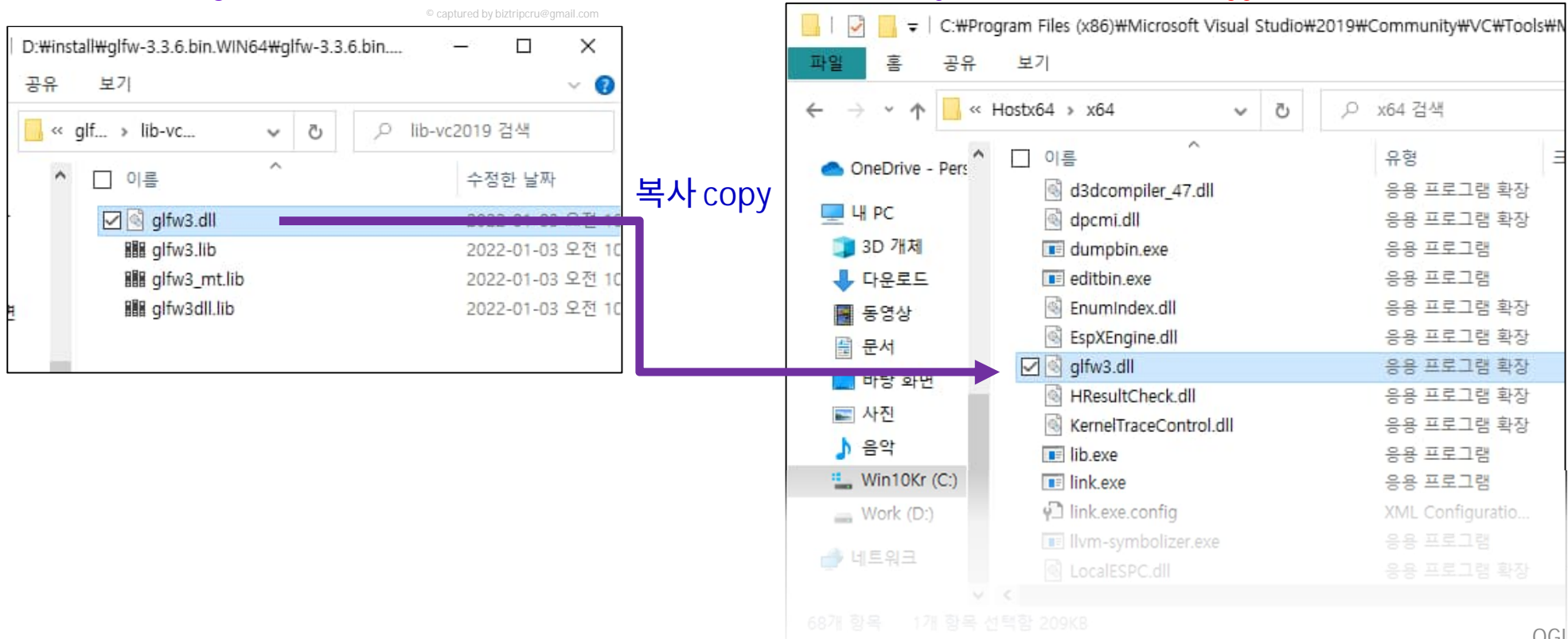
GLFW 설치

- copy "glfw-x.y.z.bin.WIN64/lib-vc20xx" static lib files to
 - C:/Program Files (x86)/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/lib/x64
 - C:/Program Files/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/lib/x64



GLFW 설치

- copy "glfw-x.y.z.bin.WIN64/lib-vc20xx" DLL files to
 - C:/Program Files (x86)/Microsoft Visual Studio/ 20xx /Community/VC/Tools/MSVC/xx.yy.zzzz/bin/Hostx64/x64
 - C:/Program Files/Microsoft Visual Studio/ 20xx /Community/VC/Tools/MSVC/xx.yy.zzzz/bin/Hostx64/x64



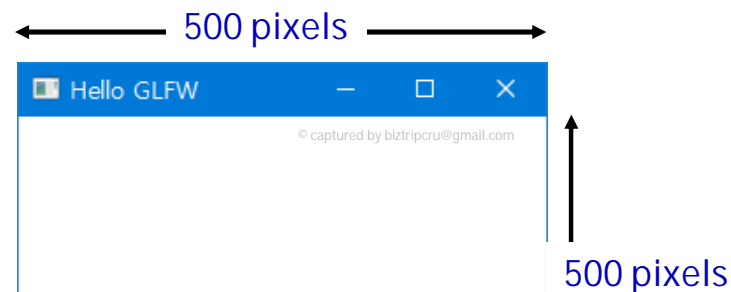
Hello, GLFW

hello-glfw.c – 기본 구조

```
#include <GLFW/glfw3.h>
#pragma comment(lib, "glfw3.lib")

const unsigned int WIN_W = 500; // window size in pixels, (Width, Height)
const unsigned int WIN_H = 500;

int main(void) {
    // start GLFW
    glfwInit();
    GLFWwindow* window = glfwCreateWindow(WIN_W, WIN_H, "Hello GLFW", NULL, NULL);
    glfwMakeContextCurrent(window);
    // main loop
    while (!glfwWindowShouldClose(window)) {
        glfwPollEvents();
    }
    // done
    glfwTerminate();
    return 0;
}
```



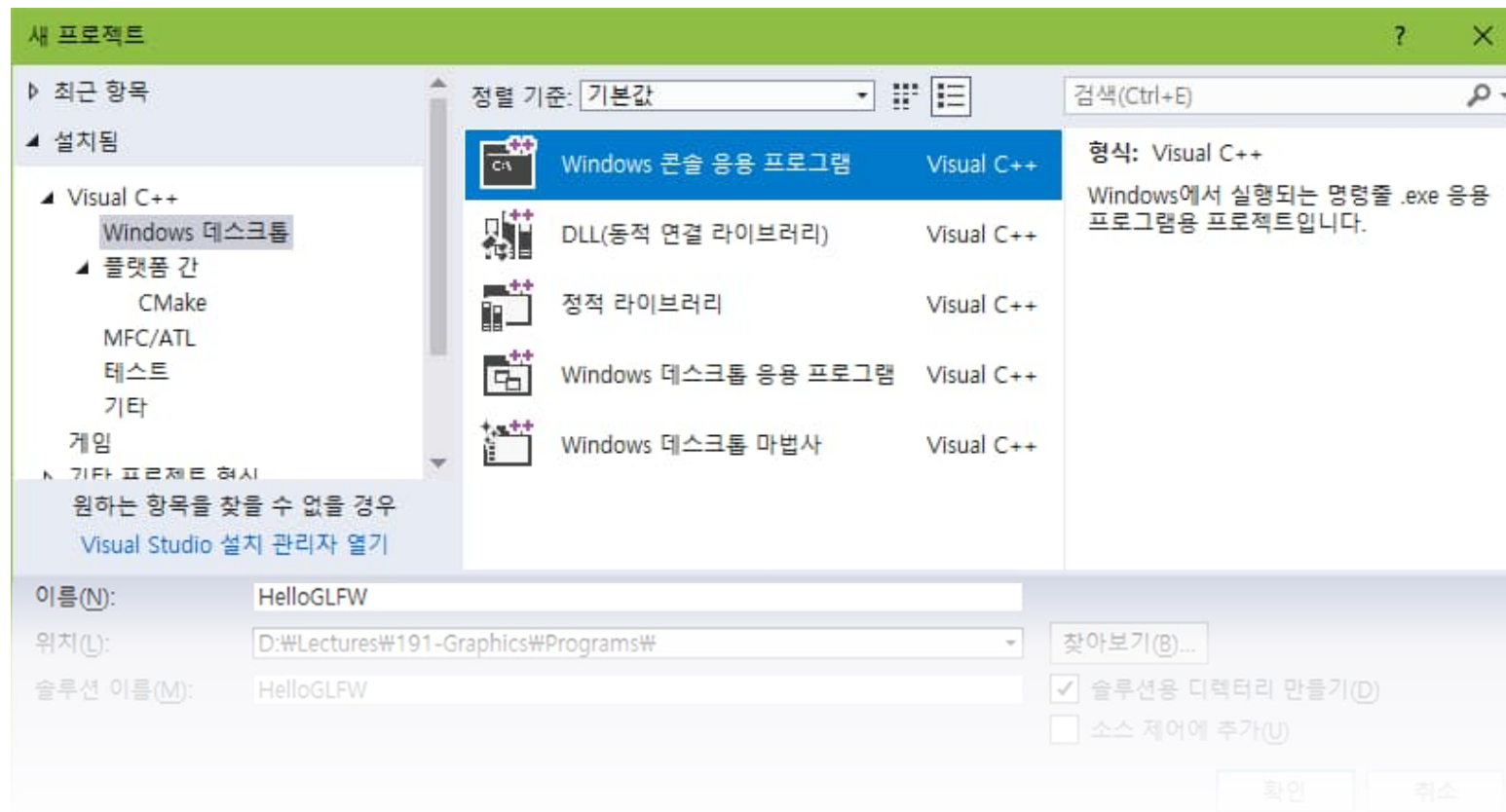
© Illustration by biztripcru@gmail.com

비주얼 스튜디오 설정

● 새 프로젝트

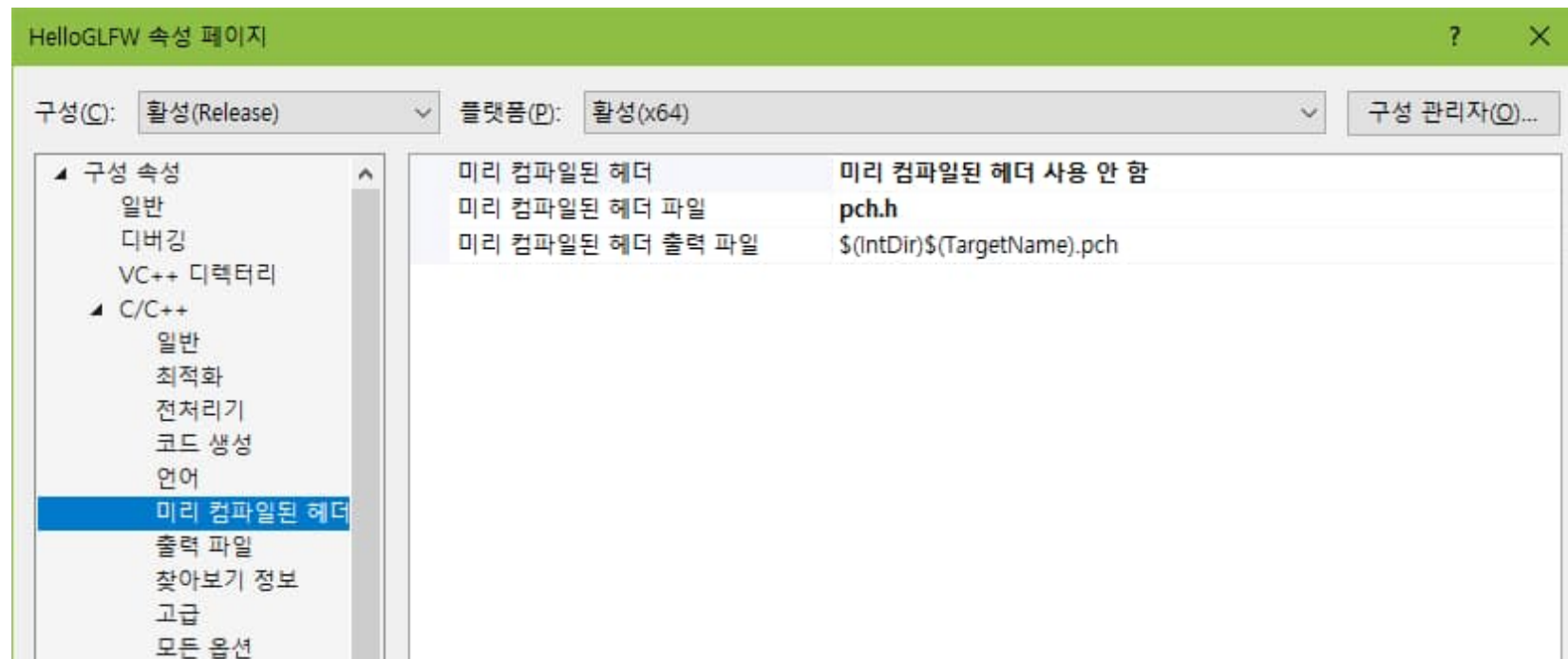
- "Windows 콘솔 응용 프로그램 Console Application" 선택

© captured by biztripcru@gmail.com



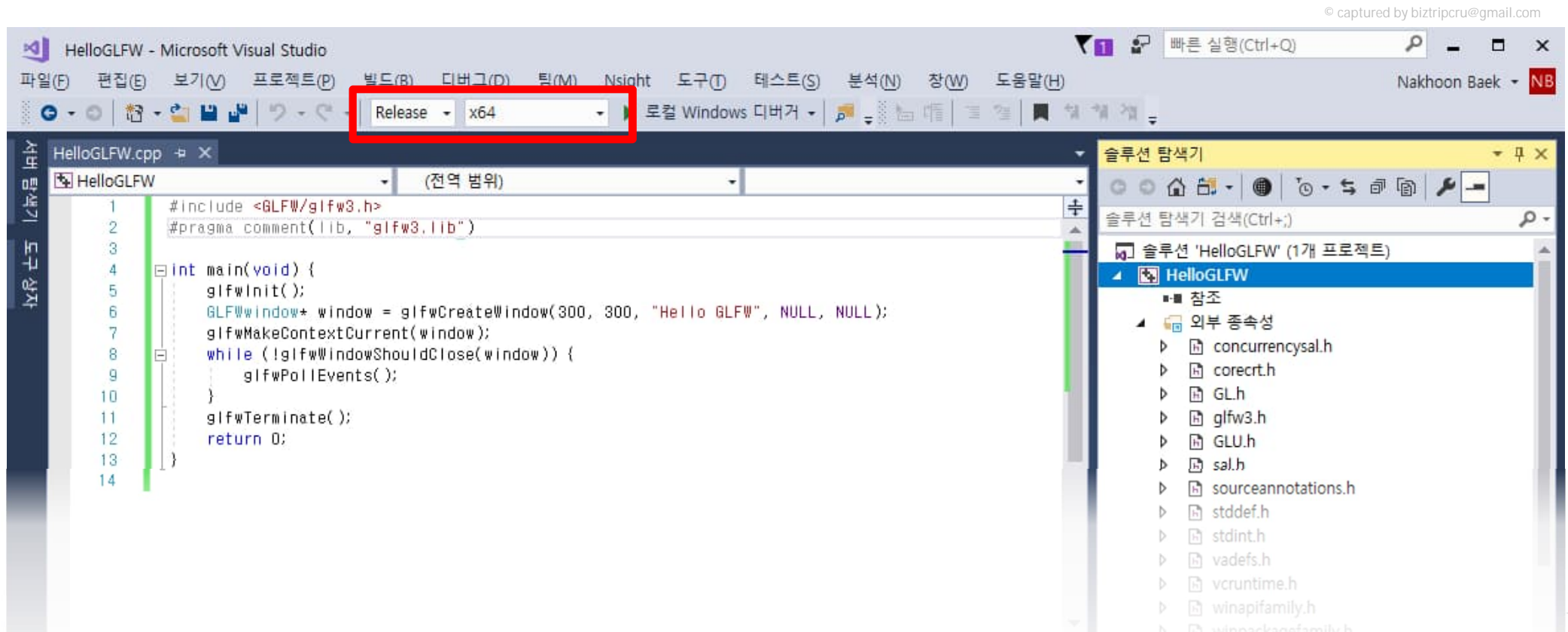
비주얼 스튜디오 설정

- "미리 컴파일된 헤더 pre-compiled headers" 사용 안 함 (선택 사항)
 - "pch.cpp", "pch.h" 삭제



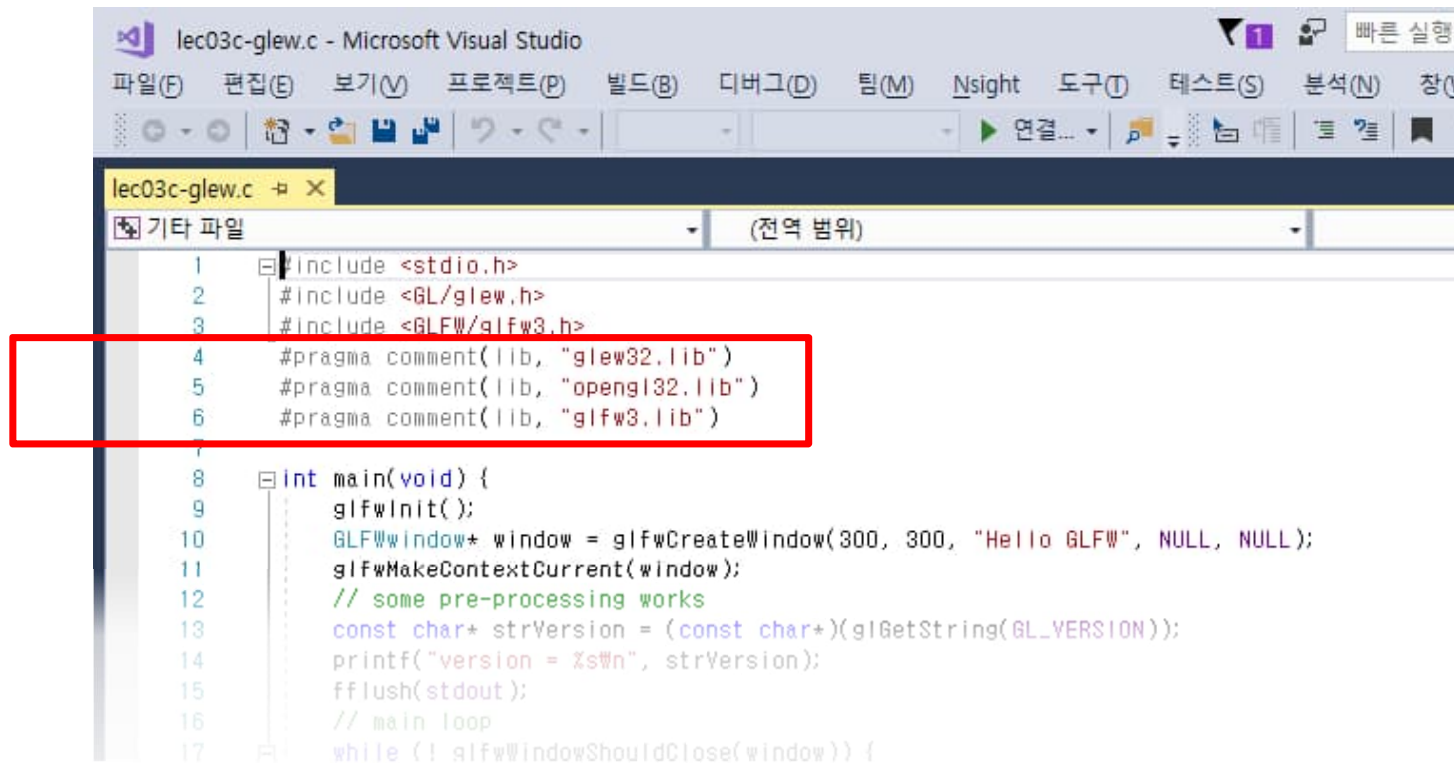
비주얼 스튜디오 설정

- "64bit CPU", "release" mode



비주얼 스튜디오 설정

- "glfw3.lib" 를 "additional dependencies" (추가종속성) 에 추가
- 또는 `#pragma comment(lib, "glfw3.lib")`

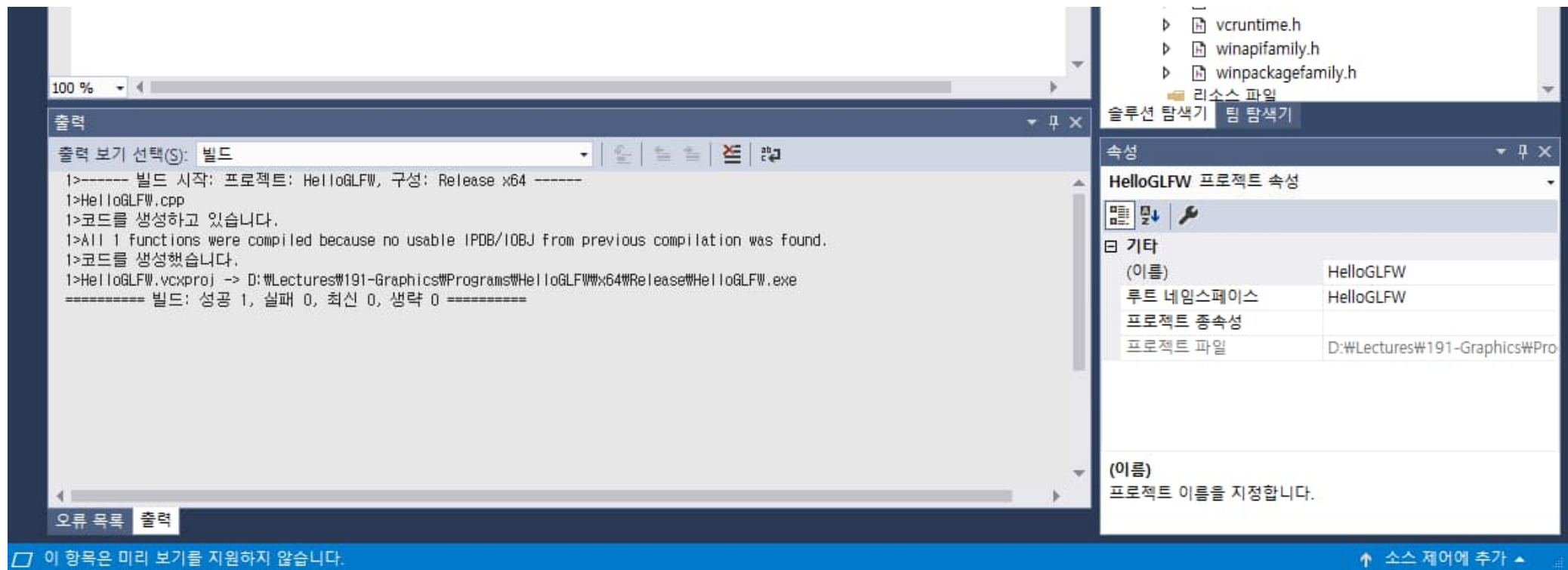


```
1  #include <stdio.h>
2  #include <GL/glew.h>
3  #include <GLFW/glfw3.h>
4  #pragma comment(lib, "glew32.lib")
5  #pragma comment(lib, "opengl32.lib")
6  #pragma comment(lib, "glfw3.lib")
7
8  int main(void) {
9      glfwInit();
10     GLFWwindow* window = glfwCreateWindow(300, 300, "Hello GLFW", NULL, NULL);
11     glfwMakeContextCurrent(window);
12     // some pre-processing works
13     const char* strVersion = (const char*)(glGetString(GL_VERSION));
14     printf("version = %s\n", strVersion);
15     fflush(stdout);
16     // main loop
17     while (!glfwWindowShouldClose(window)) {
```

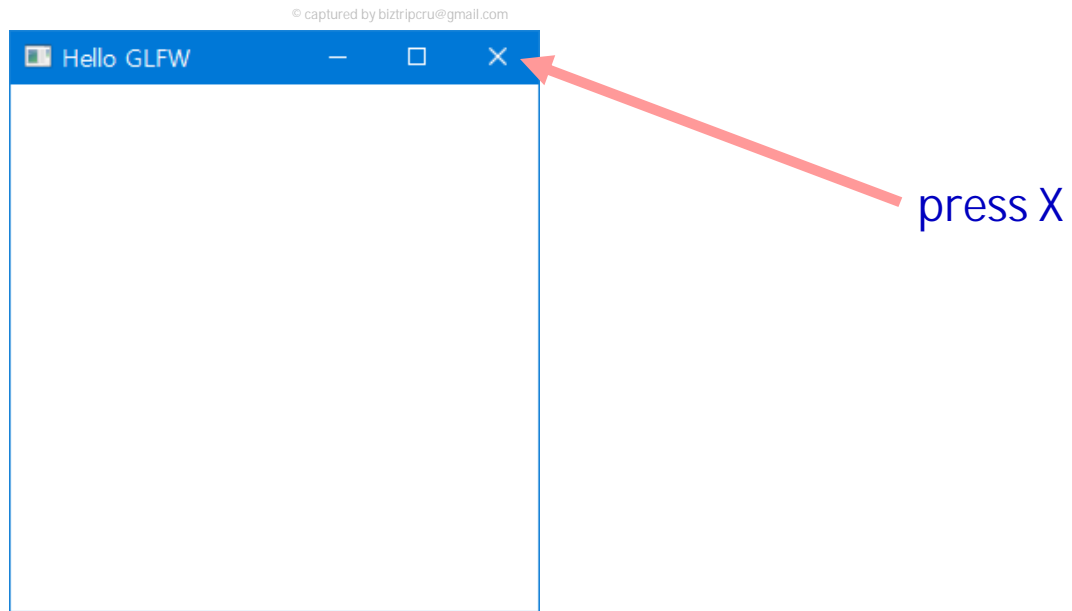
비주얼 스튜디오 설정

● 컴파일 빌드 . . .

© captured by biztripcru@gmail.com



실행 결과



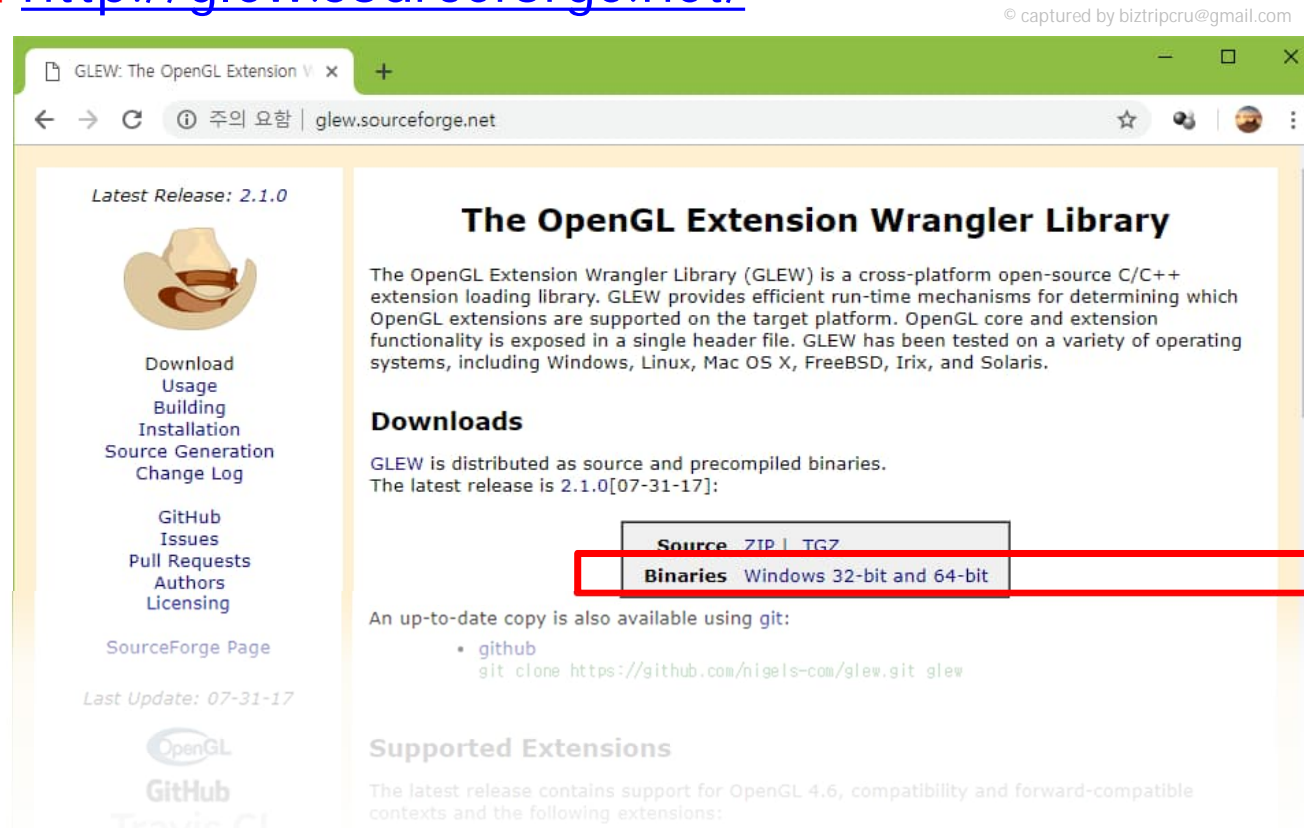
- 종료 처리 : press X button
 - 좀더 우아한 방법은 나중에 ...

GLEW 설치

Installing GLEW

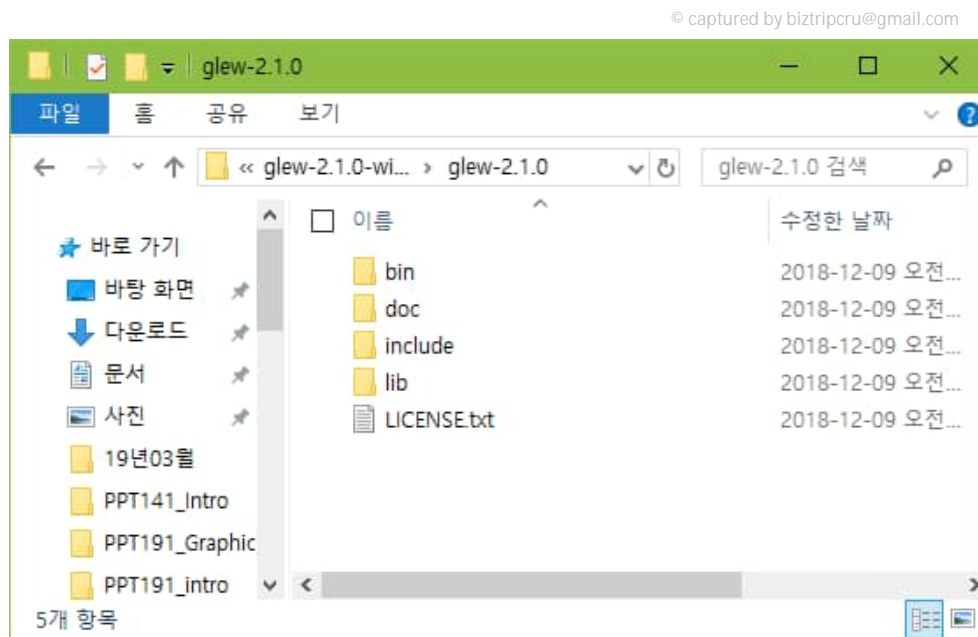
GLEW

- The OpenGL Extension Wrangler Library
 - cross-platform open-source C/C++ extension loading library
 - <http://glew.sourceforge.net/>



GLEW 설치

- "Windows 32-bit and 64-bit" version 다운로드
- unzip "glew-x.y.z-win32.zip"

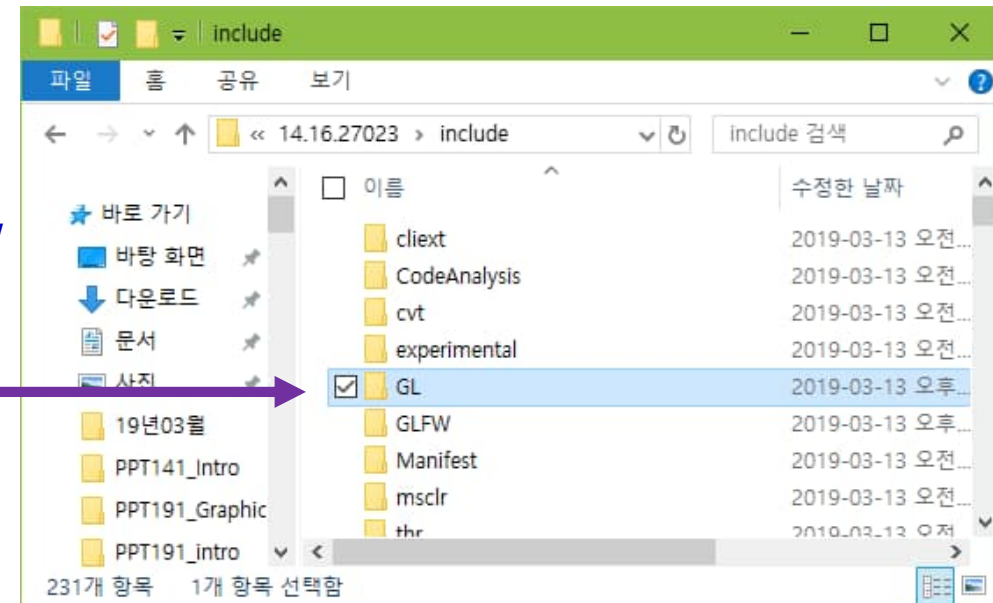
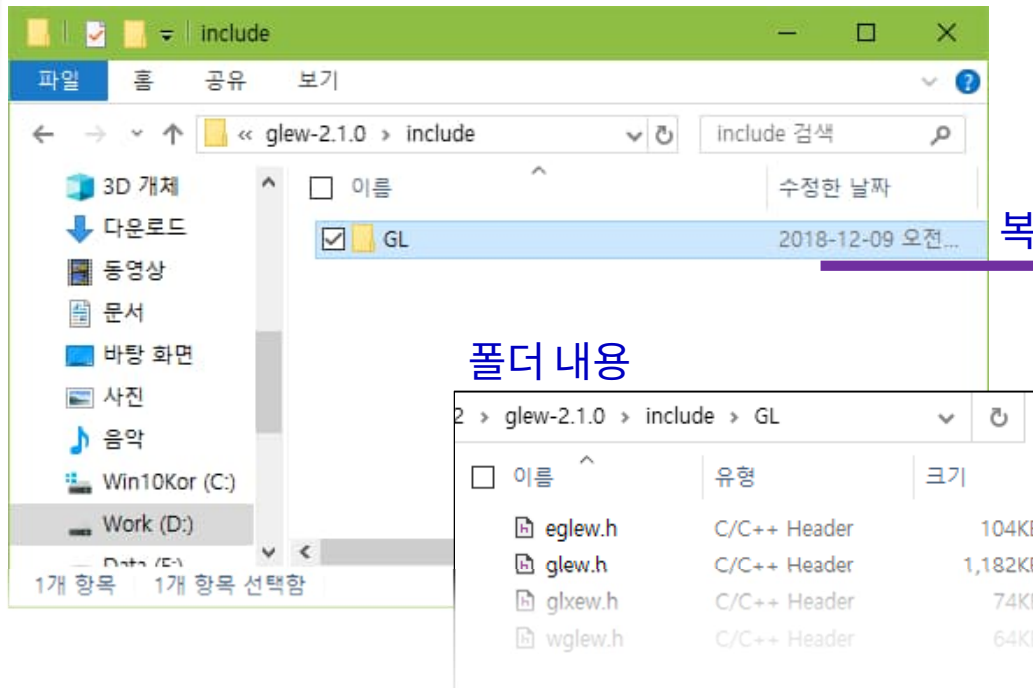


GLEW 설치

- copy "glew-x.y.z/include/GL/" header files to
 - C:/Program Files (x86)/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/include
 - C:/Program Files/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/include
- #include <GL/glew.h> 가능 !

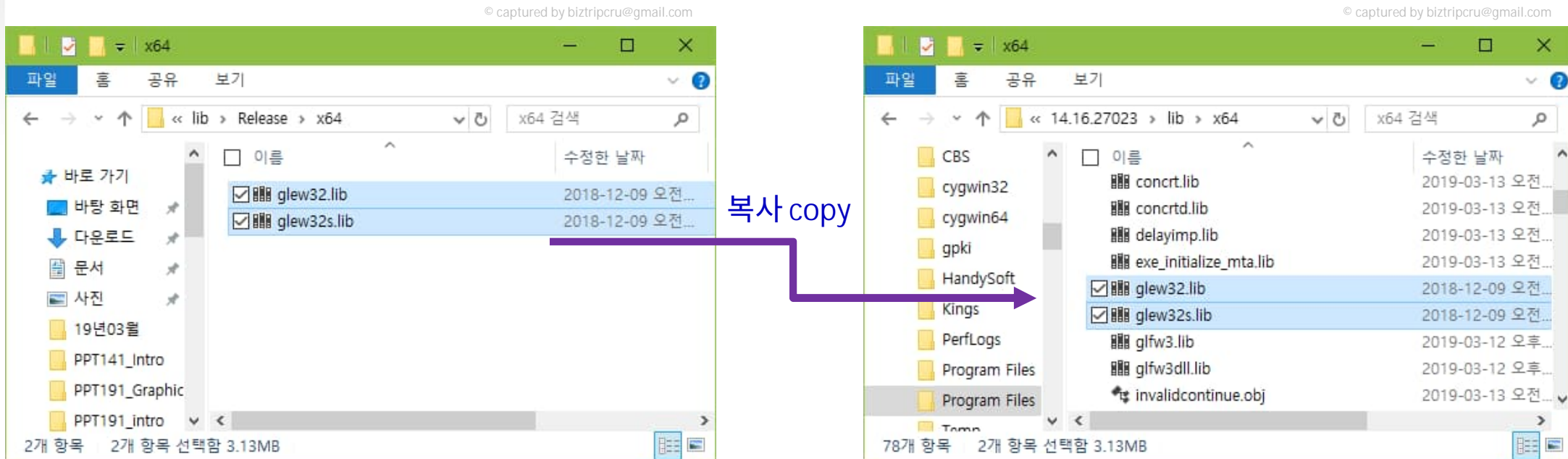
© captured by biztripcru@gmail.com

© captured by biztripcru@gmail.com



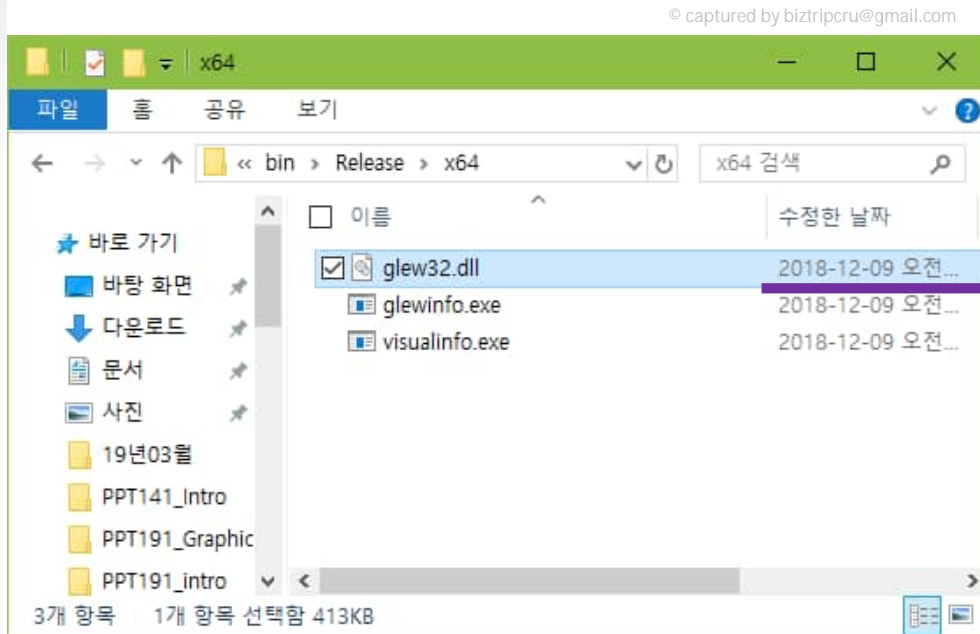
GLEW 설치

- copy "glew-x.y.z/lib/Release/x64/" static lib files to
 - C:/Program Files (x86)/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/lib/x64
 - C:/Program Files/Microsoft Visual Studio/20xx/Community/VC/Tools/MSVC/xx.yy.zzzz/lib/x64

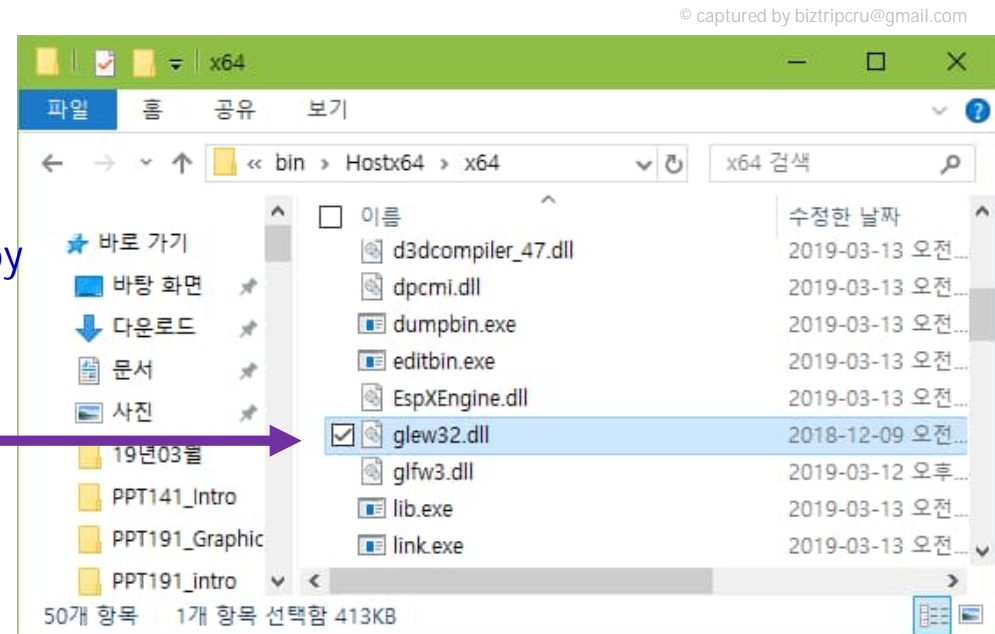


GLEW 설치

- copy "glew-x.y.z/bin/Release/x64/" DLL files to
 - C:/Program Files (x86)/Microsoft Visual Studio/ 20xx /Community/VC/Tools/MSVC/xx.yy.zzzz/bin/Hostx64/x64
 - C:/Program Files/Microsoft Visual Studio/ 20xx /Community/VC/Tools/MSVC/xx.yy.zzzz/bin/Hostx64/x64

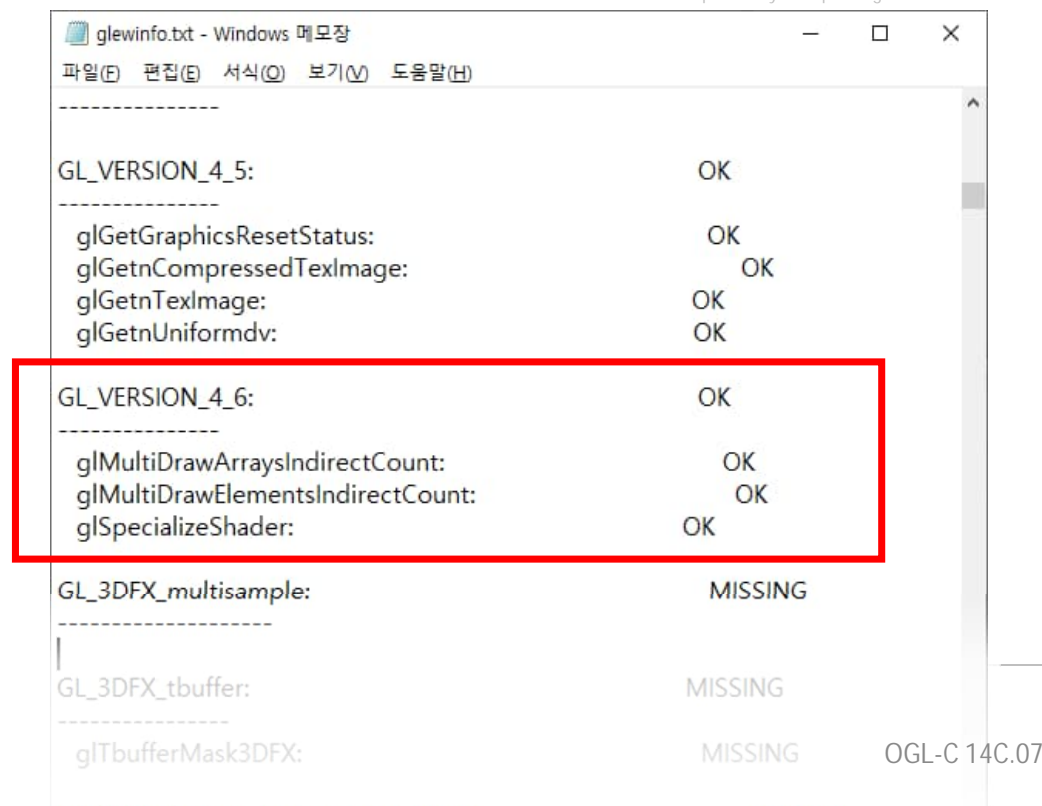
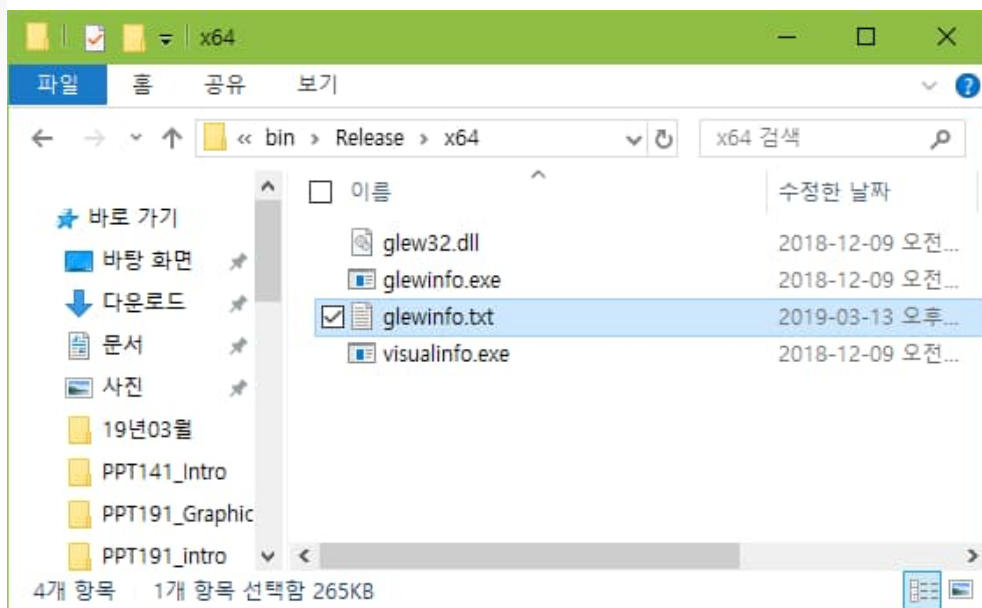


복사 copy



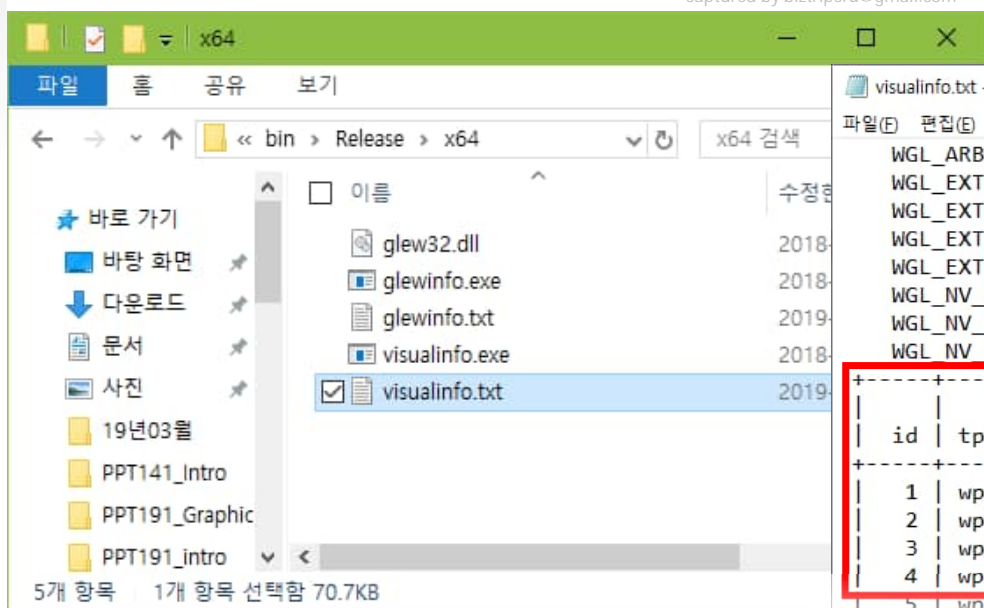
GLEW 테스트

- "glew-x.y.z/bin/Release/x64/glewinfo.exe" 실행
 - 조용히 실행, 종료됨 → "glewinfo.txt" 파일 생성
 - 지원되는 OpenGL 버전 version, 익스텐션 extension, 함수 등이 나옴



GLEW 테스트

- "glew-x.y.z/bin/Release/x64/visualinfo.exe" 실행
 - 조용히 실행, 종료됨 → "visualinfo.txt" 파일 생성
 - OpenGL 익스텐션 extension 리스트 + 가능한 프레임버퍼 설정



visualinfo.txt - Windows 메모장

파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)

WGL_ARB_render_texture, WGL_ATI_pixel_format_float, WGL_EXT_colorspace,
WGL_EXT_create_context_es_profile, WGL_EXT_create_context_es2_profile,
WGL_EXT_extensions_string, WGL_EXT_framebuffer_sRGB,
WGL_EXT_pixel_format_packed_float, WGL_EXT_swap_control,
WGL_EXT_swap_control_tear, WGL_NVX_DX_interop, WGL_NV_DX_interop,
WGL_NV_DX_interop2, WGL_NV_copy_image, WGL_NV_delay_before_swap,
WGL_NV_float_buffer, WGL_NV_multisample_coverage, WGL_NV_multigpu_context,
WGL_NV_render_depth_texture, WGL_NV_render_texture_rectangle.

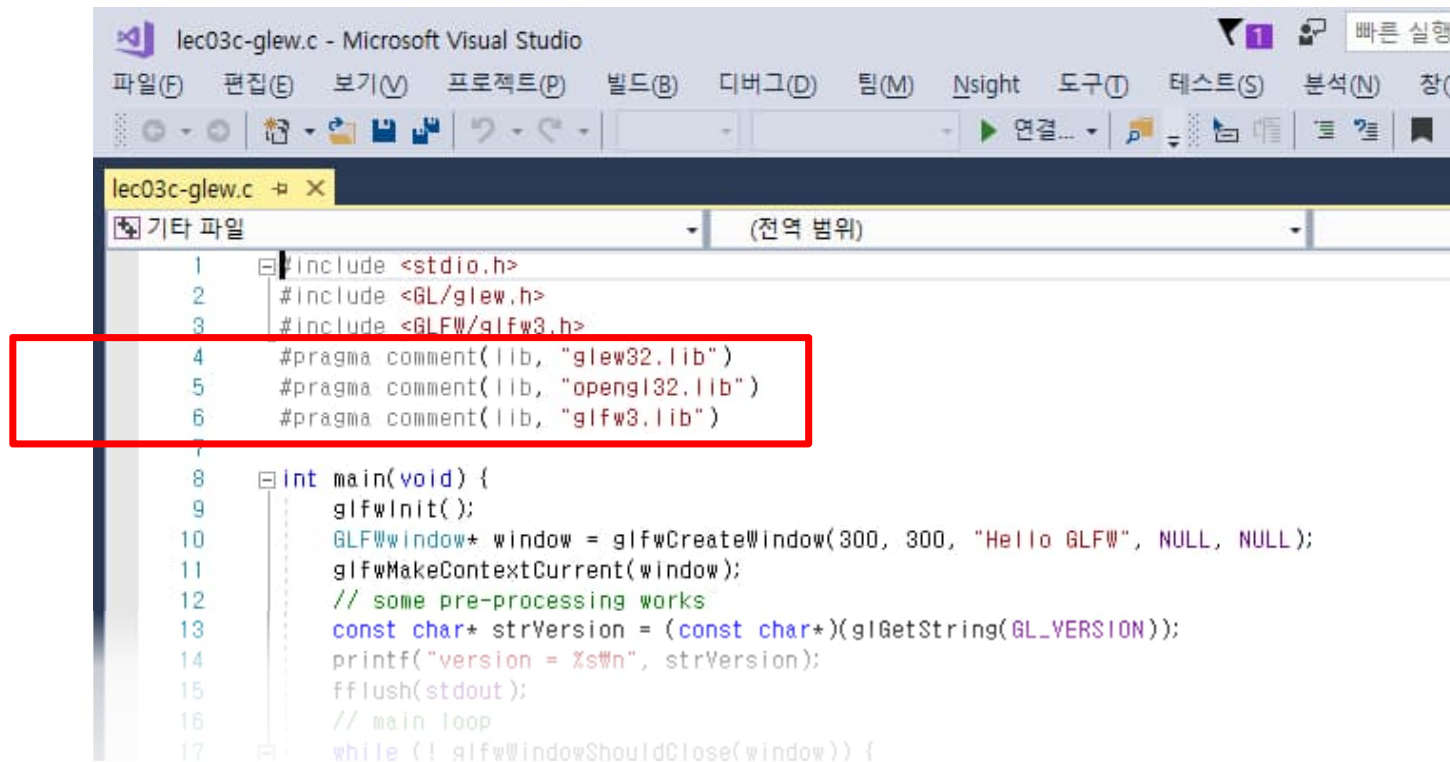
id	visual								color					ax dp st				accum					layer		
	tp	ac	gd	fm	db	sw	st	ms	sz	r	g	b	a	bf	th	cl	sz	r	g	b	a	ov	un	sw	
1	wp	fu	.	i	.	.	.	.	32	8	8	8	.	4	24	.	64	16	16	16	16	.	.	.
2	wp	fu	.	i	.	.	.	.	32	8	8	8	8	4	24	.	64	16	16	16	16	.	.	.
3	wp	fu	.	i	.	.	.	.	32	8	8	8	.	4	24	8	64	16	16	16	16	.	.	.
4	wp	fu	.	i	.	.	.	.	32	8	8	8	8	4	24	8	64	16	16	16	16	.	.	.
5	wp	fu	.	i	.	.	.	.	32	8	8	8	.	4	.	.	64	16	16	16	16	.	.	.
6	wp	fu	.	i	.	.	.	.	32	8	8	8	8	4	.	.	64	16	16	16	16	.	.	.
7	wp	fu	.	i	.	.	.	.	32	8	8	8	.	4	.	8	64	16	16	16	16	.	.	.
8	wp	fu	.	i	.	.	.	.	32	8	8	8	8	4	.	8	64	16	16	16	16	.	.	.
9	wp	fu	.	i	y	x	.	.	32	8	8	8	.	4	24	.	64	16	16	16	16	.	.	.	
10	wp	fu	.	i	y	x	.	.	32	8	8	8	8	4	24	.	64	16	16	16	16	.	.	.	
11	wp	fu	.	i	y	x	.	.	32	8	8	8	.	4	24	8	64	16	16	16	16	.	.	.	

OGL-C 14C.0

비주얼 스튜디오 관련 설정

- "glew32.lib" 를 "additional dependencies" (추가종속성) 에 추가
- 또는 `#pragma comment(lib, "glew32.lib")`

© captured by biztripcru@gmail.com



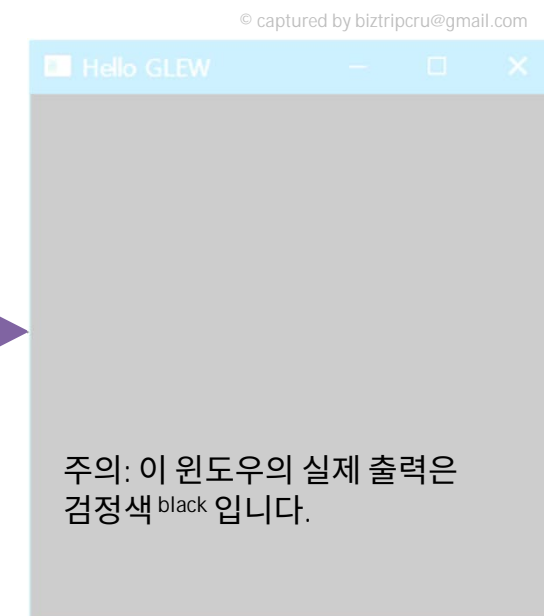
```
1  #include <stdio.h>
2  #include <GL/glew.h>
3  #include <GLFW/glfw3.h>
4  #pragma comment(lib, "glew32.lib")
5  #pragma comment(lib, "opengl32.lib")
6  #pragma comment(lib, "glfw3.lib")
7
8  int main(void) {
9      glfwInit();
10     GLFWwindow* window = glfwCreateWindow(300, 300, "Hello GLFW", NULL, NULL);
11     glfwMakeContextCurrent(window);
12     // some pre-processing works
13     const char* strVersion = (const char*)(glGetString(GL_VERSION));
14     printf("version = %s\n", strVersion);
15     fflush(stdout);
16     // main loop
17     while (!glfwWindowShouldClose(window)) {
```


hello-glew.c

```
#include <GL/glew.h>
#include <GLFW/glfw3.h>
#pragma comment(lib, "glew32.lib")
#pragma comment(lib, "opengl32.lib")
#pragma comment(lib, "glfw3.lib")
#include <stdio.h>

int main(void) {
    glfwInit();
    GLFWwindow* window = glfwCreateWindow(300, 300, "Hello GLEW", NULL, NULL);
    glfwMakeContextCurrent(window);
    // start GLEW
    glewInit();
    // main loop
    while (!glfwWindowShouldClose(window)) {
        // draw
        glClear(GL_COLOR_BUFFER_BIT);
        // end of loop
        glfwSwapBuffers(window);
        glfwPollEvents();
    }
    // done
    glfwTerminate();
    return 0;
}
```

검정 바탕!



GLFW / GLEW 설정 추가 사항

- header file 순서를 지켜야 함

```
#include <GL/glew.h>
```

```
#include <GLFW/glfw3.h>
```

```
#pragma comment(lib, "opengl32.lib")
```

```
#pragma comment(lib, "glew32.lib")
```

```
#pragma comment(lib, "glfw3.lib")
```

```
#include <stdio.h>
```

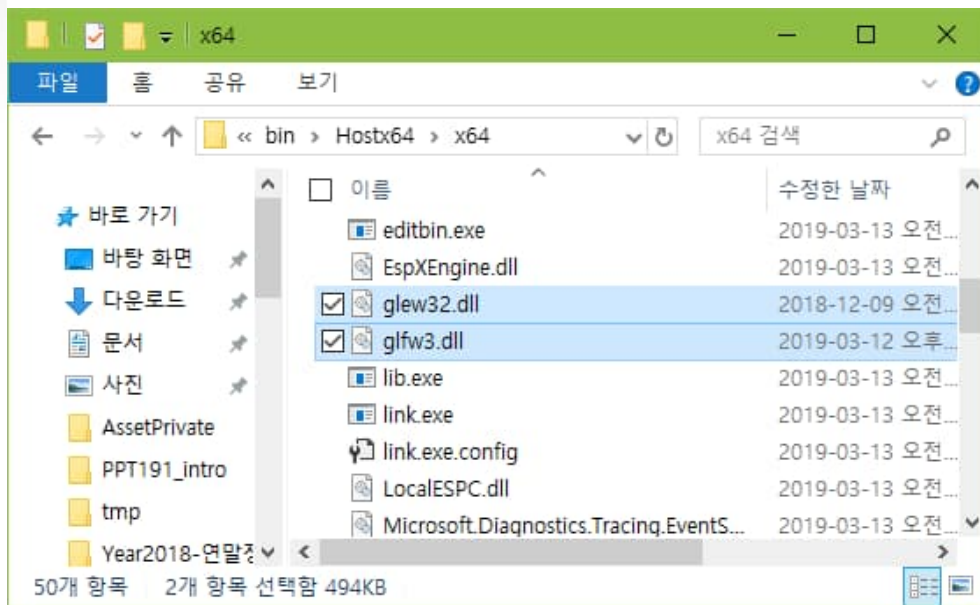
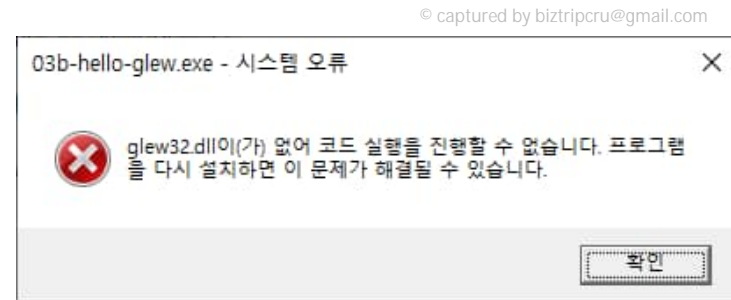
- 순서가 바뀌었을 때, 컴파일러 에러 메시지

- C:\Program Files (x86)\Microsoft Visual Studio\2019\Community\VC\Tools\MSVC\14.29.30133\include\GL\glew.h(85,1): fatal error C1189: #error: gl.h included before glew.h

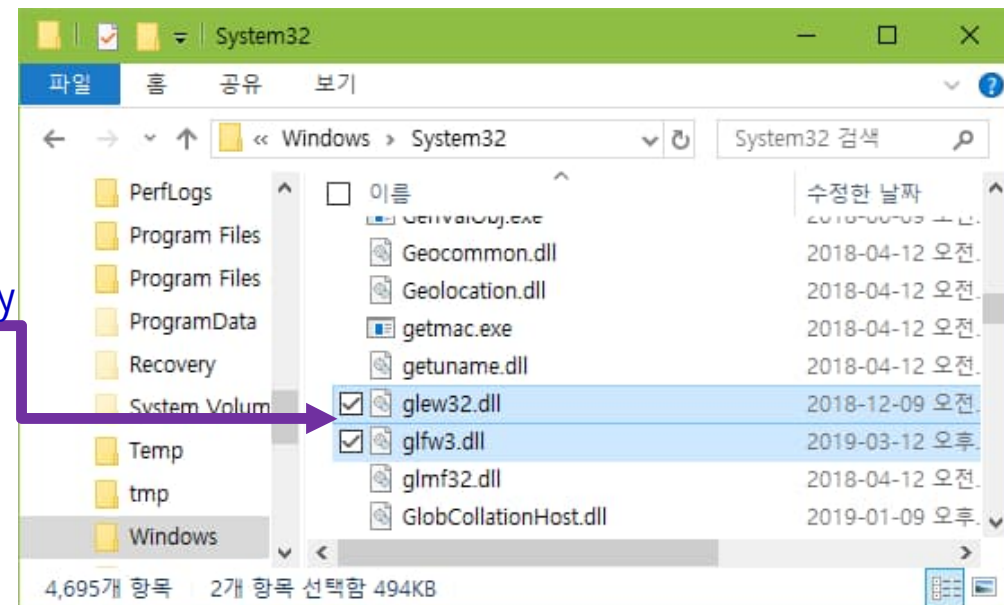
- #error gl.h included before glew.h

GLFW / GLEW 설정 추가 사항

- 실행 시에, DLL 관련 문제가 발생하면 . . .
- copy GLFW/GLEW DLL files to
 - C:\Windows\System32



복사 copy



Linux 에서 OpenGL 컴파일

Compiling OpenGL programs on Linux systems

Linux 에서 OpenGL 컴파일 하기

- **패키지 설치: super-user 권한 필요**

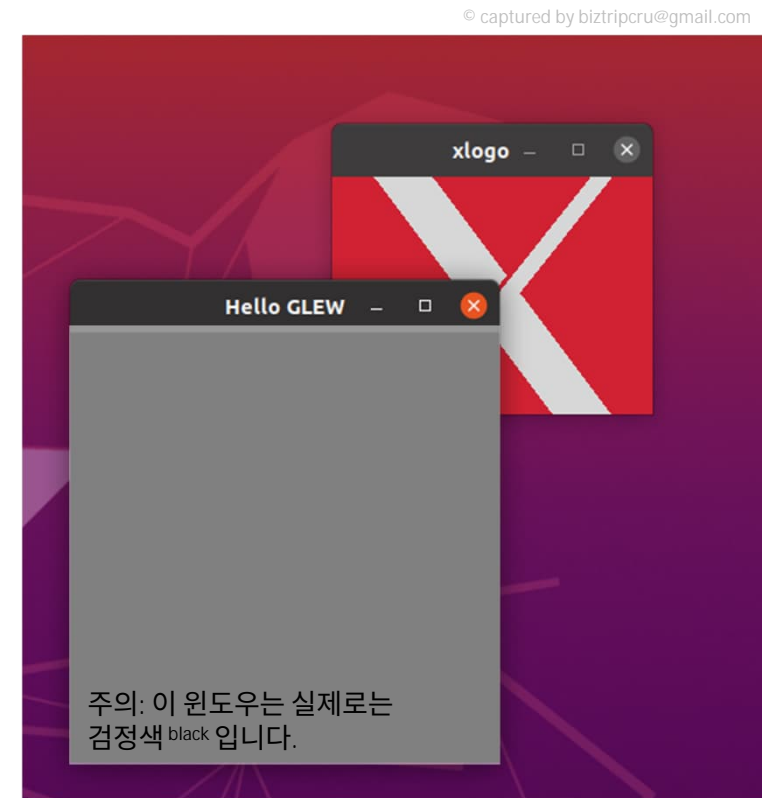
- `$ apt install libglfw3-dev`
 - ▶ 내부적으로, `libgl-dev`, `libx11-dev` 등을 install
- `$ apt install libglew-dev`
 - ▶ 확인: `/usr/include/GL`, `/usr/include/GLFW` 디렉토리가 생겼는가?

- **프로그램 컴파일: 일반 사용자로 가능**

- 라이브러리를 명시해야 함 : `-IGLEW -lglfw -lGL`
- `$ cc -o hello-glew.exe hello-glew.c -IGLEW -lglfw -lGL`
- `$./hello-glew.exe`

실행 결과

- X window 시스템에서 OpenGL 윈도우 생성됨



Contents **내용**

- OpenGL, GLFW **설치**
- Hello, GLFW
- GLEW **설치**
- Linux **에서** OpenGL **컴파일**

OpenGL 인스톨

OpenGL installation

본고딕 Noto Sans KR

Source Sans Pro

Source Serif Pro

정참판 양반댁 규수 큰 교자 타고 혼례 치른 날

The quick brown fox jumps over the lazy dog

Mathematical Notations $O(n \log n)$