LiveVideoStackCon

聚音视 研修不止于形

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北京.丽亭华苑酒店

LiveVideoStackCon

全平台硬件解码的渲染优化

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PPTV/移动端播放器技术经理

目录

- 常规方法渲染硬解数据的问题
- 硬解纹理转换一般思路
- D3D11 转 OpenGLES纹理
- macOS、iOS 纹理转换及统一
- Android 硬解渲染及常见难题解决

- 主要介绍纹理加载

常规的OpenGL渲染

- 软解OpenGL渲染流程

准备纹理

↓

glGenTextures()

↓

glTexParamteri()
glTexImage2D(...)

渲染前更新纹理

↓

glBindTexture()

↓

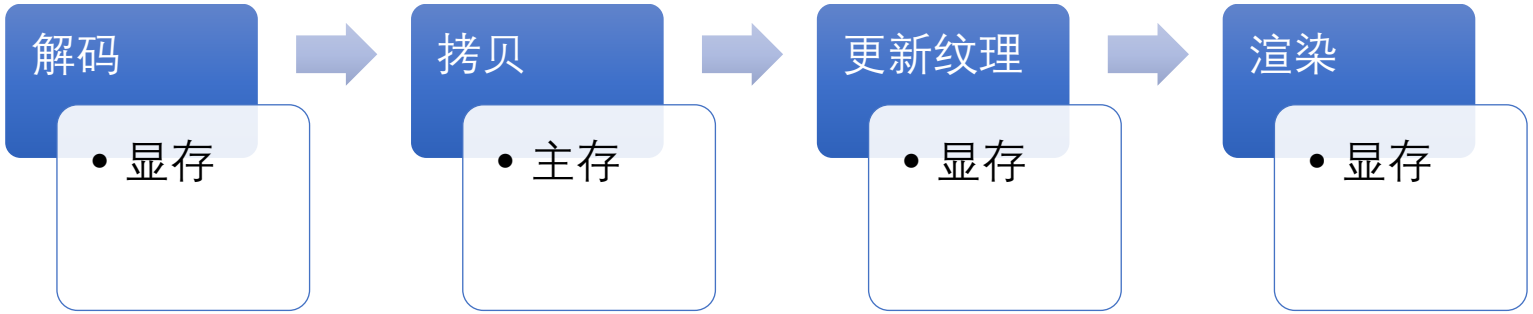
glTexSubImage2D(..., dataptr)

常规的OpenGL渲染

- 软解数据流

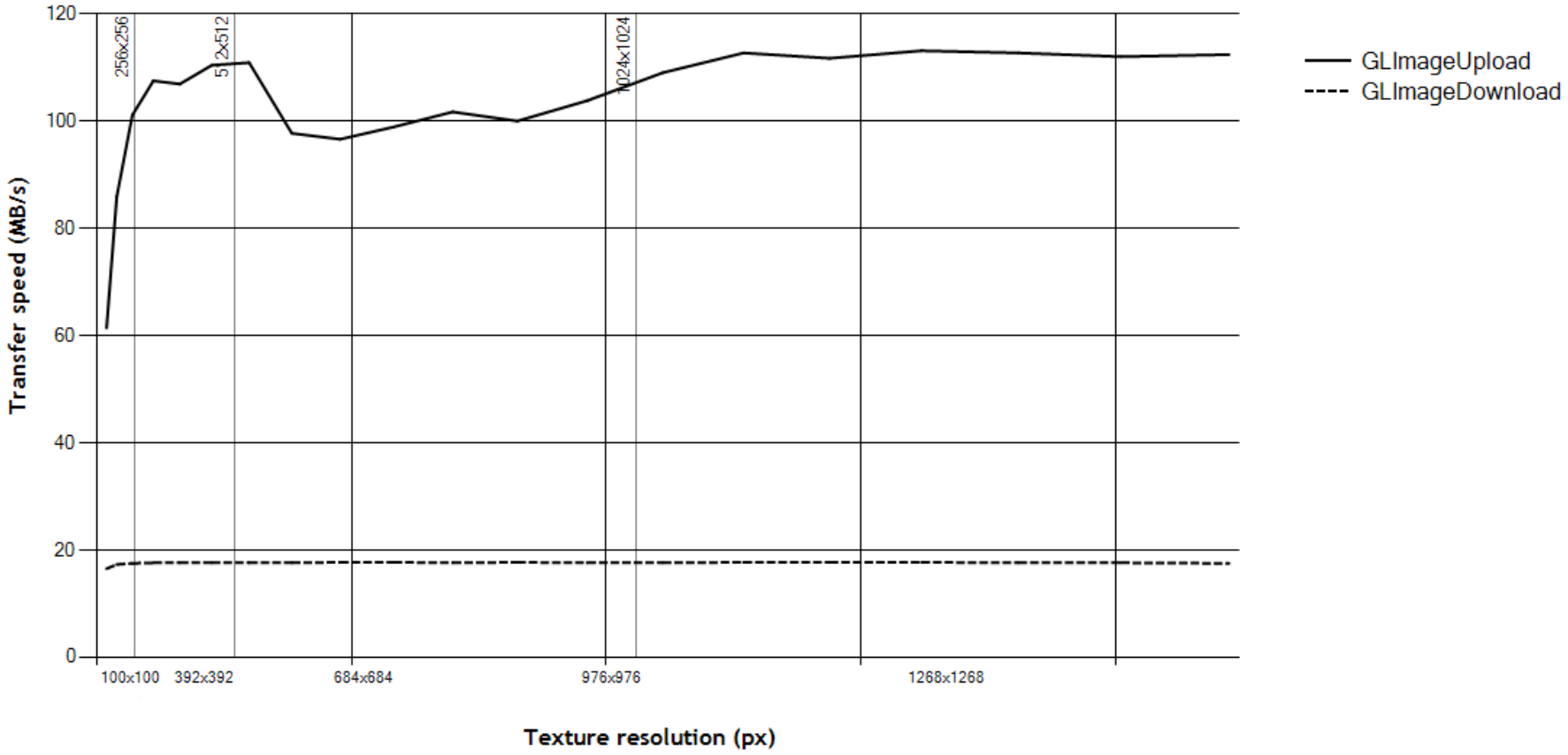
硬解的OpenGL渲染

- 常规方法渲染的数据流



- glTexSubImage2D：CPU、GPU之间内存不共享
- 从显存拷贝非常慢，甚至不如软解，如DXVA2

硬解的OpenGL渲染



http://uu.diva-portal.org/smash/get/diva2:641061/FULLTEXT01.pdf

硬解的OpenGL渲染

- 理想的硬解数据流

目标：从解码开始到渲染结束，全程GPU处理数据，CPU只发送指令

方式：API间数据共享，让GPU拷贝、转换

硬解纹理转换一般思路

- 输出的是什么：对象、格式(RGB, YUV)，尽量使用YUV

- **平台提供的共享、转换接口**: apple, android
- 硬解库提供的共享、转换接口: CUDA, libva-glx
- **EGL 扩展**:
  - EGLImage (OMX IL, MMAL, VA-API): ClientBuffer, Pixmap(RGB)
  - EGLStream (OMX AL, D3D11): producer/consumer
- OpenGL扩展:
  - Windows: WGL_NV_DX_interop (DXVA2,D3D11)
  - Linux: GLX_EXT_texture_from_pixmap(VA-API), GL_NV_vdpau_interop

D3D11+EGLStream

- **EGL扩展提供的D3D资源共享功能**

- ANGLE： 开源的EGL+OpenGL ES实现， OpenGL ES指令转成D3D9/D3D11， 兼容性好。支持Windows Store， Windows Desktop (XP+)
- 应用：
  - Chromium, Firefox, Qt…
  - iOS & android 应用移植

D3D11+EGLStream

- 解码输出：ID3D11VideoDecoderOutputView->GetResource()->ID3D11Texture2D
- 格式：NV12、P010
- 方法一：PBuffer扩展+D3D11 VideoProcessor转RGB
- 方法二：EGLStream扩展 (2016)，直接共享，无需转换
- EGL_ANGLE_**stream_producer**_d3d_texture_nv12
- GL_NV_EGL_**stream_consumer_**external

D3D11+EGLStream

准备纹理

- eglCreateStreamKHR
- glGenTextures
- eglStreamConsumerGLTextureExternalAttribsNV
- eglCreateStreamProducerD3DTextureNV12ANGLE

更新、渲染纹理

- eglStreamPostD3DTextureNV12ANGLE (共享)
- eglStreamConsumerAcquireKHR
- **渲染纹理**
- eglStreamConsumerAcquireKHR

iOS, macOS

- **平台提供的纹理共享接口**

- 解码器：VideoToolbox
- 解码输出：CVPixelBufferRef
- 输出格式：UYVY422(文档、官方例子使用), RGB, YUV420P, NV12
- 性能对比: NV12>UYVY422>RGB>YUV420P

macOS

- IOSurface/CVOpenGLTextureCache(RGB)

准备纹理

glGenTextures()

glTexParamteri()
glTexImage2D(...)

更新纹理

glBindTexture()

CVPixelBufferGetIOSurface(buf)

CGLTexImageIOSurface2D(..., surface, p)

iOS

- CVOpenGLESTextureCache

准备纹理缓存

↓

CVOpenGLESTextureCache Create()

获取纹理

↓

CVOpenGLESTextureCacheCreateTextureFromImage(… cache, cvpixbuf, …)

↓

CVOpenGLESTextureGetName

iOS11 最新方法

- iOS11公开了IOSurface框架
- IOSurface: buffer sharing across processes
- CVPixelBufferGetIOSurface: 存在于macOS10.6+/iOS4.0+ CoreVideo.framework, iOS11才加入头文件
- EAGLContext.texImageIOSurface: 只存在于iOS11
- 与macOS的CGLTexImageIOSurface2D 参数相似

```
@interface EAGLContext(IOSurface)
- (BOOL)texImageIOSurface:(IOSurfaceRef)ioSurface target:(NSUInteger)target internalFormat:
    (NSUInteger)internalFormat width:(uint32_t)width height:(uint32_t)height format:
    (NSUInteger)format type:(NSUInteger)type plane:(uint32_t)plane NS_AVAILABLE_IOS(11_0);
@end
extern CGLError CGLTexImageIOSurface2D(CGLContextObj ctx, GLenum target, GLenum internal_format,
                        GLsizei width, GLsizei height, GLenum format, GLenum type, IOSurfaceRef
                            ioSurface, GLuint plane) OPENGL_AVAILABLE(10_6);
```

iOS11, macOS 统一流程

glGenTextures() glTexParameteri()

生成、设置纹理（一次）

↓

绑定第p平面纹理

glBindTexture(..., tex)

↓

IOSurfaceRef surface = CVPixelBufferGetIOSurface(buf);

↓

iOS: [[EAGLContext currentContext] texImageIOSurface:surface ...];

macOS: CGLTexImageIOSurface2D(CGLGetCurrentContext(), ..., surface, p)

↓

glBindTexture(..., 0)

iOS 再探


```
- thread #18: tid = 0x5264, 0x009280e6 libglInterpose.dylib`EAGLContext_texImageIOSurface_t
arget_internalFormat_width_height_format_type_plane_invert(EAGLContext*, objc_selector*, __
IOSurface*, unsigned int, unsigned int, unsigned int, unsigned int, unsigned int, unsigned
int, unsigned int, signed char) + 442, stop reason = EXC_BAD_ACCESS (code=1, address=0xcb4)
  frame #0: 0x009280e6 libglInterpose.dylib`EAGLContext_texImageIOSurface_target_internalFo
rmat_width_height_format_type_plane_invert(EAGLContext_, objc_selector_, __IOSurface_, unsi
gned int, unsigned int, unsigned int, unsigned int, unsigned int, unsigned int, unsigned in
t, signed char) + 442
  frame #1: 0x2240ef66 CoreVideo`CVOpenGLESCont[illegible]t::texImageIOSurface(unsigned int, unsigne
d int, int, int, unsigned int, unsigned int, [illegible]rface_, unsigned int) + 58
  frame #2: 0x224201c8 CoreVideo`CVPixelBu[illegible]STextureBacking::createStandardTexture
(CVImageBuffer*) + 508
  frame #3: 0x224204aa CoreVideo`CVPixelBuf[illegible]ESTextureBacking::initWithPixelBackingC
ontext(CVPixelBufferBacking_, CVOpenGLESCont[illegible]CFDictionary const_, CVImageBuffer_, in
t_) + 182
  frame #4: 0x2241deac CoreVideo`CVPixelBuf[illegible]g::createTextureBackingForContext(__CFA
llocator const_, CVOpenGLESContext_, __CFDi[illegible] const_, CVImageBuffer_, int_) + 68
  frame #5: 0x2241be72 CoreVideo`CVOpenGLES[illegible]che::createTextureBackingFromImageBacki
ng(__CFAllocator const*, CVImageBacking*, C[illegible]fer*, __CFDictionary const*, int*) + 36
2
  frame #6: 0x2241bc7c CoreVideo`CVOpenGLESTextureCache::createTextureFromImageWithParams(_
_CFAllocator const_, CVImageBuffer_, unsigned int, int, int, int, unsigned int, unsigned in
t, unsigned long, int*) + 232
  frame #7: 0x2241a220 CoreVideo`CVOpenGLESTextureCacheCreateTextureFromImage + 132
```

iOS 再探

- 未公开接口

```
WangBindeMacBook-Air:mkspecs wangbin$ nm -a ~/Library/Developer/Xcode/iOS\ DeviceSupport/5.1.1\ \(9B206\)/Symbol
s/System/Library/Frameworks/OpenGLES.framework/OpenGLES |grep texImageIOSurface
301021b0 t -[EAGLContext texImageIOSurface:target:internalFormat:width:height:format:type:plane:invert:]
WangBindeMacBook-Air:mkspecs wangbin$ nm -a ~/Library/Developer/Xcode/iOS\ DeviceSupport/11.0.1\ \(15A402\)/Symb
ols/System/Library/Frameworks/OpenGLES.framework/OpenGLES |grep texImageIOSurface
0000000183a35de8 t -[EAGLContext texImageIOSurface:target:internalFormat:width:height:format:type:plane:]
0000000183a35e20 t -[EAGLContext texImageIOSurface:target:internalFormat:width:height:format:type:plane:invert:]
```

- 所有iOS版本

```
if (@available(iOS 11, *))
    [[EAGLContext currentContext] texImageIOSurface:s target:tgt internalFormat:ifmt
        width:w height:h format:fmt type:t plane:p];
else
    [[EAGLContext currentContext] texImageIOSurface:s target:tgt internalFormat:ifmt
        width:w height:h format:fmt type:t plane:p invert:NO];
```

Android 硬解

- MediaCodec：java， NDK (android 5.0+)
- OMX AL

- ~~OMX IL~~: EGLImage所需扩展非公开(GraphicBuffer作为ClientBuffer)
- ~~OMX IL~~: 7.0不支持非NDK系统库调用

Android MediaCodec

- **平台提供的纹理转换接口**
- 解码输出: ~~ByteBuffer~~, Surface(**RGB**)
- 如何构造Surface: ~~SurfaceView~~, SurfaceTexture

解码线程输出准备

↓

SurfaceTexture(**texName**)

↓

Surface(surfaceTexture)

↓

MediaCodec.configure(..., surface,...)

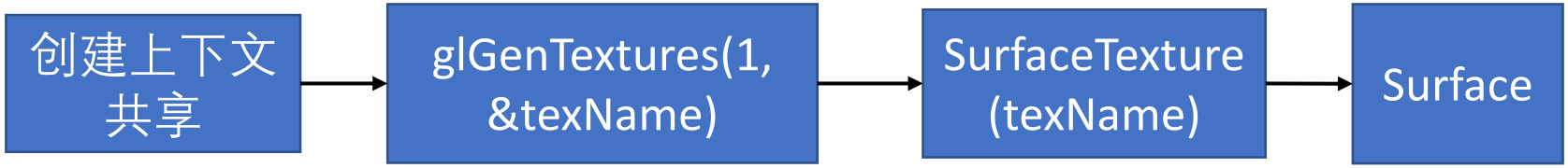
渲染线程更新纹理

↓

surfaceTexture.updateTexImage()

Android MediaCodec

- SurfaceTexture构造问题：texName？
- KODI(XBMC)等播放器的处理方法：等待渲染线程生成texName
- 新方法：
- 1. 共享上下文



Android MediaCodec

- 2. 无效的texName, 渲染线程attachToGLContext()

解码线程输出准备

SurfaceTexture(0)

Surface(surfaceTexture)

MediaCodec.configure(…, surface,…)

渲染线程更新纹理

glGenTextures(1, &tex)

surfaceTexture.attachToGLContext(tex)

调用一次

SurfaceTexture.updateTexImage()

Android MediaCodec常见问题

- 后台切回前台的updateTexImage()错误

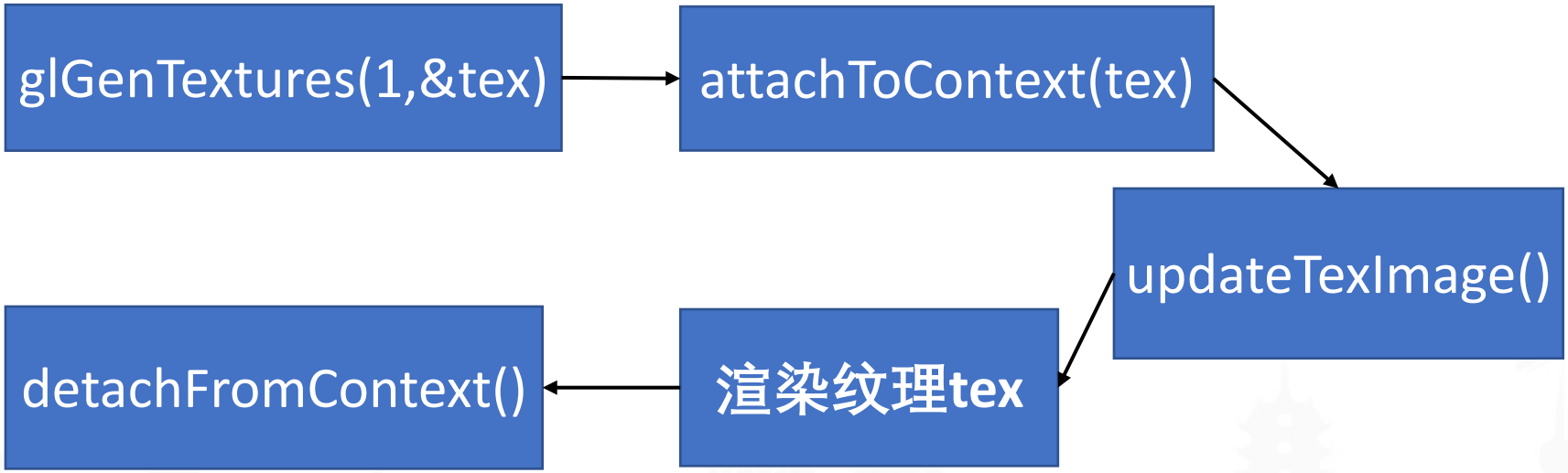
  E/GLConsumer: [SurfaceTexture-0-8349-0] checkAndUpdateEglState: invalid current EGLContext

- 常见解决方法：
  - View销毁后重新初始化解码器
  - 使用TextureView

- 如何支持SurfaceView?
- SurfaceTexture.attachToGLContext(): 检测并保存上下文
- SurfaceTexture上下文：需要共享，适用SurfaceView，不适用外部提供的上下文如GLSurfaceView，上下文切换的消耗

Android MediaCodec常见问题

- 如何支持任意View？
- 每次渲染：
  - SurfaceTexture.attachToGLContext()
  - 必须detachFromContext()，但会删除纹理



Android OMX AL

- EGLStream: 不支持 KHR_stream_producer_aldatalocator

```
typedef struct XADataSink_ {
    void * pLocator;
    void * pFormat;
} XADataSink;

typedef struct XADataLocator_NativeDisplay_{
    XAuint32 locatorType;
    XANativeHandle hWindow;
    XANativeHandle hDisplay;
} XADataLocator_NativeDisplay;
```

- hWindow: ANativeWindow, 从Surface获取
- hDisplay: NULL
- 渲染流程和MediaCodec一样

Thank You

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