Game development on Android

Using the NDK

Overview

- Background
- Porting to JNI
  - Differences to iPhone
  - Basic JNI
  - C++ Threads under JNI
- Debugging
  - (OMG This is B***shit!)
- Some OpenGL tips and tricks

Who am I?

- Matthew Clark matt@thevoxelagents.com
- Programmer/Founder of The Voxel Agents
  - We make games - Original IP
  - iPhone games
    - Train Conductor
    - Train Conductor 2
- Currently in the process of porting to Android

Voxel Engine

- Not a 'Voxel' Engine
- OpenGL engine originally for iPhone
  - C++ as much as possible
  - ObjectiveC for:
    - File access
    - Saving / Loading users data
    - Sounds
    - Texture loading
  - Guess what we need to rewrite? :)

There is more!

- No STL (need to compile and link STLPort)
- No Exceptions
  - Various libraries need tweaking/changing
    - TinyXML
    - JSON
- Minor compiler differences
- Our pipeline is heavily integrated with xcode

And more...

- Many devices means different resolutions and aspect ratios
- Even worse... different video cards!!
  - With different subsets of OpenGL ES extensions
  - No standard texture compression!
    - iPhone uses PVR (4bpp)
    - Smallest standard compression on android is RGB565 (16bpp) – no alpha!
    - For a 1024x1024 texture 512K vs 2Mb !

JNI
-
The Basics

Calling C from Java

- Really Easy
  - In .java:

```
class VoxelGLSurfaceView extends GLSurfaceView
{
    public boolean onTouchEvent(final MotionEvent event)
    {
        touchEvent(event.getAction(), event.getEventTime(), event.getX(), event.getY());
        return true;
    }

    private static native void touchEvent(int action, float time, float x, float y);
```

  - In .cpp :

```
void Java_com_tva_Voxel_VoxelGLSurfaceView_touchEvent( JNIEnv*  env, jobject  thiz,
                                                       jint touchEventType, jfloat time, jfloat x, jfloat y )
{
    Core::Vec2 touchPos(x - backingWidth/2, y - backingHeight/2);
    touchPos = touchPos * Core::Vec2(480.f / backingWidth,320.f / backingHeight);

    Input::TouchInput input(touchPos, touchPos, time, 0, (Input::TouchInputPhase)touchEventType, 0);
    inputStack.push_back(input);
}
```

Calling Java from C

- Bit trickier

```
{
    // Get the environment
    JNIEnv* env = GetJEnv();

    // find the class
    cls = env->FindClass("com/tva/Voxel/FileReader");

    // register the methods
    ctor = env->GetMethodID(cls, "<init>", "(Ljava/lang/String;)V");
    readMethod = env->GetMethodID(cls, "GetBytes", "([B)I");

    // make a string to pass to java
    jstring mystr = env->NewStringUTF(fullPath);

    // Create the object invoking the constructor
    jobject reader = env->NewObject(cls,ctor,mystr);

    // Call GetBytes
    jbyteArray bytes = env->NewByteArray(numBytes);
    jint bytesRead = env->CallIntMethod((jobject)reader, readMethod, bytes);
    jbyte *bPtr = env->GetByteArrayElements(bytes, JNI_FALSE);

    // do something with bPtr
    |
}
```

GLSurfaceView

```
class DemoRenderer implements GLSurfaceView.Renderer
{
    public void onSurfaceCreated(GL10 gl, EGLConfig config)
    {
        nativeInit();
    }

    public void onSurfaceChanged(GL10 gl, int w, int h)
    {
        nativeResize(w, h);
    }

    public void onDrawFrame(GL10 gl)
    {
        nativeRender();
    }

    private static native void nativeInit();
    private static native void nativeResize(int w, int h);
    private static native void nativeRender();
}
```

Loading textures

- Phil Hassey's blog about porting Galcon to android is awesome!
  - Files in /assets/* are directly accessable by filename

```
InputStream stream = app.getAssets().open(filename);
Bitmap bitmap = BitmapFactory.decodeStream(stream);
gl.glBindTexture(GL10.GL_TEXTURE_2D, textureID);
GLUtils.texImage2D(GL10.GL_TEXTURE_2D, 0, bitmap, 0);
```

  - Thats it!
- http://www.philhassey.com/blog/2010/08/03/porting-galcon-using-the-android-ndk/

Sounds

- SoundPool (SoundFX)
  - Specify how many sounds you want to play at once
  - When you play too many sounds, it will stop playing the earliest one
    - This is okay behaviour, but sometimes you want the opposite (requires manual tracking)
- AudioManager (Music)
    - `create()`
    - `setLooping()`
    - `start()`

pthreads

```
JNIEnv* GetThreadJNIEnv()
{
    int status;
    JNIEnv *env;

    const U32 threadId = pthread_self();

    if (g_JNIEnvMap.find(threadId) == g_JNIEnvMap.end())
    {
        // is this even in a special thread?
        status = gJavaVM->GetEnv((void **) &env, JNI_VERSION_1_4);
        if (status < 0)
        {
            DLog("callback_handler: failed to get JNI environment, "
                 "assuming native thread");

            status = gJavaVM->AttachCurrentThread(&env, NULL);
            ASSERT(status == 0);
        }
    }

    return g_JNIEnvMap[threadId];
}
```

C++ threads can't access the JVM directly

They need to have a Java Native Environment created for them

AttachCurrentThread()

http://android.wooyd.org/JNIExample/

the VOXEL AGENTS

pthreads continued...

- Make sure you Detach the thread

```
void EndThread()
{
    JNIEnvMap::iterator iter =
            g_JNIEnvMap.find(pthread_self())

    if (iter != g_JNIEnvMap.end())
    {
        gJavaVM->DetachCurrentThread();
        g_JNIEnvMap.erase(iter);
    }

    pthread_exit(NULL);
}
```

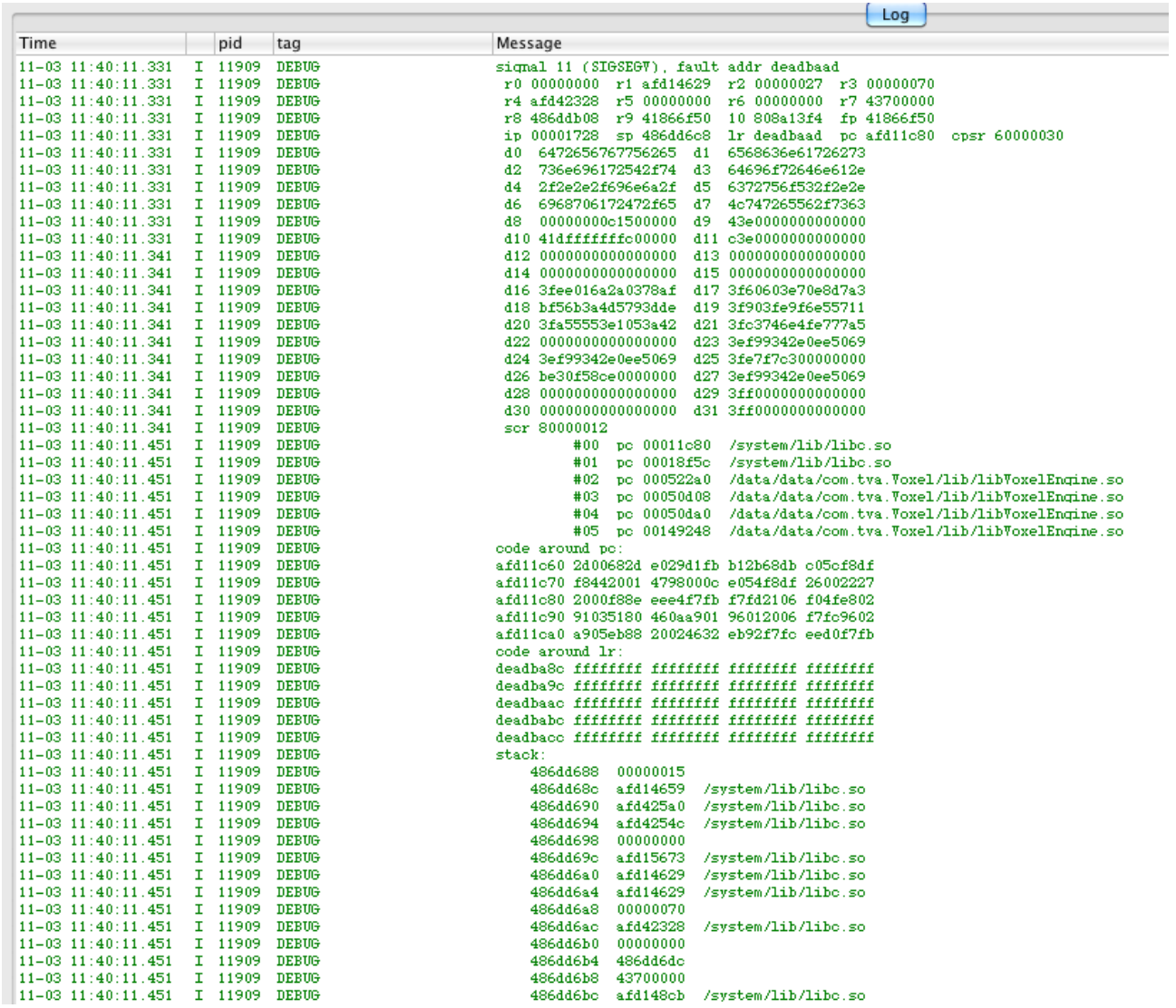
Gotcha

- Because the thread is running outside of the GLContext – we can't do any GL operations
  - Say good bye to threaded texture loading!

Debugging JNI

- No breakpoints in native code
- Poor stack tracing
  - Even worse inside Java!!!!
- Emulator is terrible (1-3 fps)
- Super headache!!!

USELESS INFORMATION*



*from the perspective of a human

arm-eabi-addr2line

- In the NDK tools
- Converts useless information into *slightly* more useful information
  - Doesn't always have line numbers
  - No object inspection
  - Ouch Ouch Ouch

```
libVoxelEngine.so 00057328 _ZNK8Graphics6Sprite12DrawContentsEv ??:0
libVoxelEngine.so 000297b8 _ZNK8Graphics13DisplayObject4DrawEv ??:0
libVoxelEngine.so 000295e8 _ZNK8Graphics13DisplayObject12DrawChildrenEv ??:0
libVoxelEngine.so 000297c0 _ZNK8Graphics13DisplayObject4DrawEv ??:0
libVoxelEngine.so 000295e8 _ZNK8Graphics13DisplayObject12DrawChildrenEv ??:0
libVoxelEngine.so 000297c0 _ZNK8Graphics13DisplayObject4DrawEv ??:0
libVoxelEngine.so 000295e8 _ZNK8Graphics13DisplayObject12DrawChildrenEv ??:0
libVoxelEngine.so 000297c0 _ZNK8Graphics13DisplayObject4DrawEv ??:0
libVoxelEngine.so 000dbec8 _ZN7Project4Game10InlineDrawEv ??:0
libVoxelEngine.so 000dc144 _ZN7Project4Game4DrawEv ??:0
libVoxelEngine.so 001d8108 Java_com_tva_Voxel_VoxelRenderer_nativeRender ??:0
```

Solution?

- Lots of logging
- Use logcat where possible to filter information
  - `__android_log_print(ANDROID_LOG_INFO, "VoxelEngine", "blah”)`
  - `__android_log_print(ANDROID_LOG_DEBUG, "VoxelTextures", "blah”)`
  - `__android_log_print(ANDROID_LOG_WARNING, "VoxelFonts", "blah”)`
    - Filter using debug levels and tags
  - Filter: `VoxelEngine:W VoxelTextures:I *:S`
- Lots of Panadol / Asprin / Valium
- Don't create bugs?

the VOXEL AGENTS

NDK-GDB

- Finally! Available on android 2.2 phones!
- Line numbers! OMG!!!
  - I haven't used it successfully yet

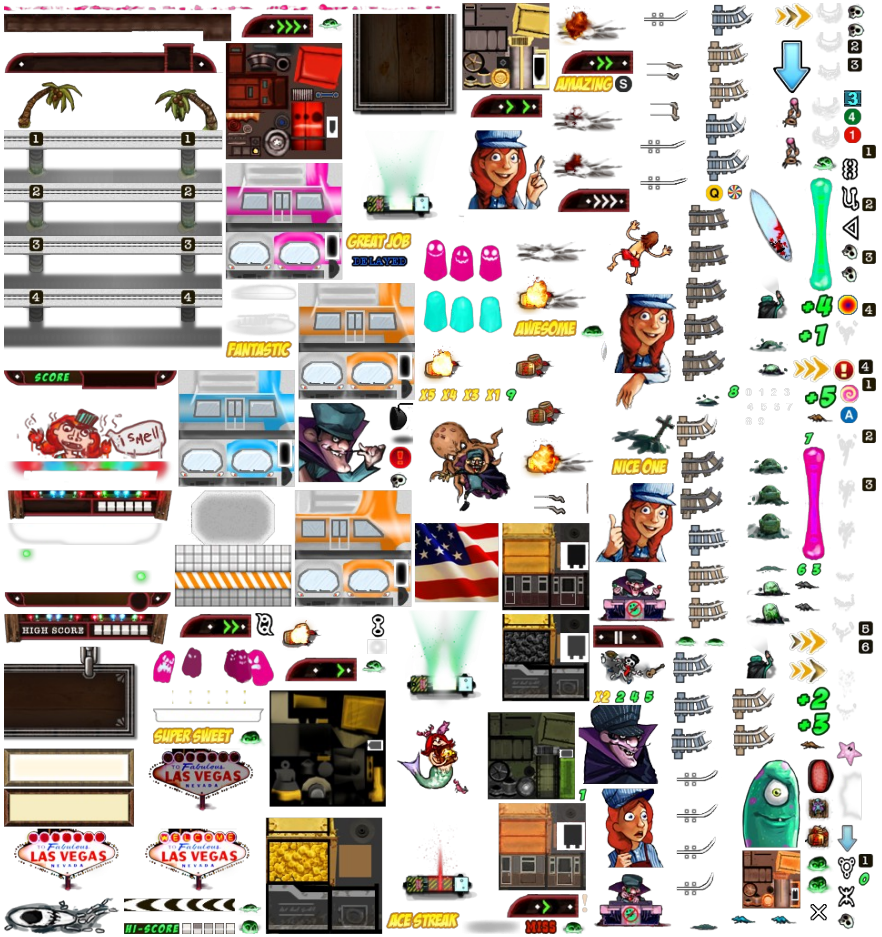
```
Program received signal SIGSEGV, Segmentation fault.
0x80300bae in Java_com_example_hellogdbserver_HelloGdbServer_invokeCrash
(env=0xaa50, clazz=0x4625f0b8)
 at /home/vilimpoc/android-ndk-r4b/samples/hello-gdbserver/jni/hello-
gdbserver.c:29
29              *crasher = 0xdeaddead;

(gdb)
```

http://vilimpoc.org/blog/2010/09/23/hello-gdbserver-a-debuggable-jni-example-for-android/

OpenGL

- The first rule of OpenGL development is...
  - Avoid State Changes
- The second rule is...
  - AVOID STATE CHANGES! :)

Open GL



- Use texture sheets
- Don't rebind a texture that is already bound
  - Cache the last bound textureID
  - Fewer texture swaps
- Textures are rarely square anyway...
  - save texture space!

Open GL

- In our game, we have 5 different types of vert lists
  - x,y,u,v,colour (Sprites with vert colours)
  - x,y,z,nx,ny,nz,u,v (3D model)
  - x,y,u,v (Regular Sprites)
  - x,y (super simple shapes – mostly debug only)
  - x,y,size,col (Point sprites (particles))
- Each different type needs a different setup

```
enum DrawState
{
    S_VertexXYUVCol,
    S_Vertex3D,
    S_VertexXYUV,
    S_VertexXYUVShort,
    S_VertexXY,
    S_VertexXYSizeCol,
};

DrawState prevState = S_VertexXYUV;
inline void KillPrevDrawState(DrawState newState)
{
    switch (prevState)
    {
        case S_VertexXYUVCol: glDisableClientState(GL_COLOR_ARRAY); break;
        case S_Vertex3D: glDisableClientState(GL_NORMAL_ARRAY); break;
        case S_VertexXYUVShort:
        case S_VertexXYUV: /*default*/ break;
        case S_VertexXY: glEnable(GL_TEXTURE_2D);
            glEnableClientState(GL_TEXTURE_COORD_ARRAY); break;
        case S_VertexXYSizeCol: glDisable(GL_POINT_SPRITE_OES);
            glDisableClientState(GL_POINT_SIZE_ARRAY_OES);
            glDisableClientState(GL_COLOR_ARRAY); break;
    }
    prevState = newState;
}

VertexXYUVCol::Draw()
{
    glBindBuffer(GL_ARRAY_BUFFER, buff);
    if (prevState != S_VertexXYUVCol)
    {
        KillPrevDrawState(S_VertexXYUVCol);
        glEnableClientState(GL_COLOR_ARRAY);
    }
    glVertexPointer(2, GL_SHORT, sizeof(VertexXYUVCol),    VERT_OFFSET(VertexXYUVCol,x));
    glTexCoordPointer(2, GL_FLOAT, sizeof(VertexXYUVCol),    VERT_OFFSET(VertexXYUVCol,u));
    glColorPointer(4, GL_UNSIGNED_BYTE, sizeof(VertexXYUVCol),    VERT_OFFSET(VertexXYUVCol,col));
    glDrawArrays(drawMode, 0, numVerts);
}
```

- Remember the previous state
- Only change what you need to change

OpenGL

- Use vertex buffers
- Use GL_SHORT where possible for vertex data.
  - Shorts are half the size of floats
  - Some androids don't support floating points :(