SmartBody Manual

SmartBody Manual

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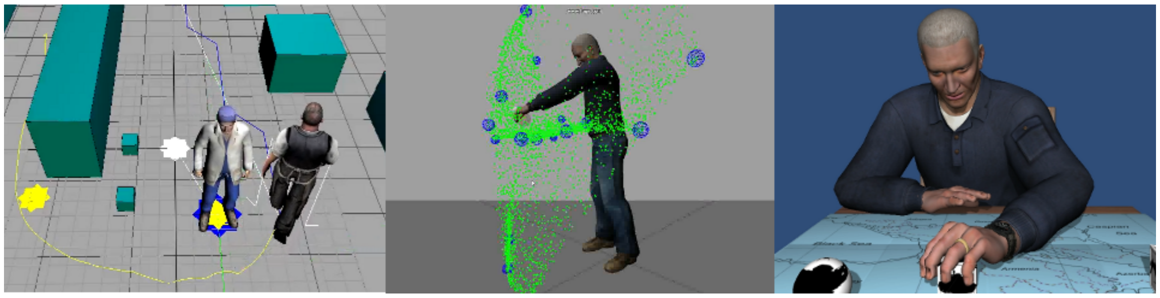
Ari Shapiro

shapiro@ict.usc.edu



Overview

SmartBody is a character animation platform originally developed at the University of Southern California.

SmartBody provides the following capabilities in real time:

- Locomotion (walk, jog, run, turn, strafe, jump, etc.)
- Steering - avoiding obstacles and moving objects
- Object manipulation - reach, grasp, touch, pick up objects
- Lip Synchronization and speech - characters can speak with lip-syncing using text-to-speech or prerecorded audio
- Gazing - robust gazing behavior that incorporates various parts of the body
- Nonverbal behavior - gesturing, head nodding and shaking, eye saccades

SmartBody is written in C++ and can be run as a standalone system, or incorporated into many game and simulation engines. We currently have interfaces for the following engines:

- Unity
- Ogre
- Panda3D
- GameBryo
- Unreal

It is straightforward to adopt SmartBody to other game engines as well using the API.

SmartBody is a Behavioral Markup Language (BML) realization engine that transforms BML behavior descriptions into realtime animations.

SmartBody runs on Windows, Linux, OSX as well as the iOS and Android devices.

The SmartBody website is located at:

http://smartbody.ict.usc.edu

The SmartBody email group is located here:

smartbody-developer@lists.sourceforge.net

You can subscribe to it here:

https://lists.sourceforge.net/lists/listinfo/smartbody-developer

If you have any other questions about SmartBody, please contact:

Ari Shapiro, Ph.D.

shapiro@ict.usc.edu

Contributors

SmartBody Team Lead	**Ari Shapiro, Ph.D.**
SmartBody Team	Andrew W. Feng, Ph.D. Yuyu Xu
Inspiration & Guru	Stacy Marsella, Ph.D.
Past SmartBody Team Members	Marcus Thiebaux Jingqiao Fu Andrew Marshall Marcelo Kallmann, Ph.D.
SmartBody Contributors	Ed Fast Arno Hartholt Shridhar Ravikumar Apar Suri Adam Reilly Matt Liewer

Downloading SmartBody

The SmartBody source code can be downloaded using subversion (SVN) on SourceForge. You will need to have a Subversion client installed on your computer.

Use the SVN command:

```
svn co https://smartbody.svn.sourceforge.net/svnroot/smartbody/trunk smartbody
```

The entire repository is fairly large, several gigabytes in size. Note that only the trunk/ needs to be downloaded. Other branches represent older projects that have been since been incorporated in the trunk.

Windows

We recommend using Tortoise (http://tortoisesvn.net/). Once installed, right click on the folder where you want SmartBody installed then choose 'SVN Checkout', then put `https://smartbody.svn.sourceforge.net/svnroot/smartbody/trunk` into the 'URL of Repository' field, then click 'Ok' - this will start the download process.

Updates to SmartBody can then be retrieved by right-clicking in the smartbody folder and choosing the 'SVN Update' option.

Linux

If you don't have SVN installed on your system, Ubuntu variants can run the following command as superuser:

```
apt-get install subversion
```

Then, run the following in the location where you wish to place SmartBody:

```
svn co https://smartbody.svn.sourceforge.net/svnroot/smartbody/trunk smartbody
```

Updates to SmartBody can then be retrieved by going into the smartbody directory and running:

```
svn update
```

Mac/OsX

Subversion is already installed on OsX platforms. Run the following in the location where you wish to place SmartBody:

```
svn co https://smartbody.svn.sourceforge.net/svnroot/smartbody/trunk smartbody
```

Updates to SmartBody can then be retrieved by going into the smartbody directory and running:

```
svn update
```

Building SmartBody

There are several SmartBody applications that can be built:

Application	Comment
sbm-fltk	a standalone SmartBody application and scene renderer
smartbody-dll	a dynamic library that can be incorporated into a game engine or other application
sbm-batch	a standalone SmartBody application that connects to smartbody-dll without a renderer
SbmDebuggerGui	(*Windows only*) a debugger/visualizer for running SmartBody processes
TtsRelayGui	(*Windows only*) incorporates any text-to-speech engine that uses the TtsRelay interface
FestivalRelay	Text-to-speech engine that uses Festival
MsSpeechRelay	(*Windows only*) Text-to-speech engine that uses Microsoft's built-in speech engine
OgreViewer	The Ogre rendering engine connected to SmartBody

In addition, there are several mobile applications that can be built:

Mobile Application	Comment
sbmjni	(*Android only*) Simple OpenGL ES front end for SmartBody for Android devices
sbm-ogre	(*Android only*) Ogre3D engine connected with SmartBody for Android devices
vh-wrapper	(*Android only*) SmartBody interface to Unity3D.
smartbody-openglES	(*iOS only*) Simple OpenGL ES front end for SmartBody for iOS devices
smartbody-ogre	(*iOS only*) Ogre3D engine connected with SmartBody for iOS devices
smartbody-unity	(*iOS only*) Unity3D project for SmartBody

Building SmartBody for Windows

You will need Visual Studio 2008 or higher to build SmartBody. In the top level SmartBody directory, Open the solution file 'vs2008.sln' and choose Build -> Build Solution. All libraries needed for the build have been included in the SmartBody repository.

You will need to install an ActiveMQ server if you wish to use the message system, although you can run SmartBody without it. The message system is used to send commands remotely to SmartBody. Download and install it from: http://activemq.apache.org/activemq-543-release.html

Building SmartBody for Linux

The Linux build requires a number of packages to be installed. For Ubuntu installations, the command apt-get can be used to retrieve and install those packages, for example:

```
sudo apt-get install cmake
```

Other Linux flavors can use rpm or similar installer.

You need to have the following packages installed:

Linux Packages Needed for SmartBody build
cmake
g++
liblog4cxx10-dev
libxerces-c3-dev
libgl1-mesa-dev
libglu1-mesa-dev
libglut-mesa-dev
xutils-dev
libxi-dev
freeglut3-dev
libglut3
libglew-dev
libxft-dev
libapr1-dev
libaprutil1-dev
libcppunit-dev
liblapack-dev
libblas-dev
build-essential
mono-devel
mono-xbuild
python-dev
libopenal-dev
libsndfile-dev
libalut-dev

Linux packages needed for text-to-speech engine
festival-dev

Linux packages needed for Ogre3D viewer
libzzip-dev
libxaw7-dev
libxxf86vm-dev
libxrandr-dev
libfreeimage-dev

nvidia-cg-toolkit
libois-dev

Linux packages needed for test suite
imagemagick

The Ogre-based renderer is not built by default. To build it, you will need to download the 1.6.5 source (www.ogre3d.org/download/source), build and install it into /usr/local. Next, uncomment the core/ogre-viewer directory from the core/CMakeLists.txt file. This will add the OgreViewer application to the build - the binary will be located in core/ogre-viewer/bin.

To build the Linux version:

1	Install the packages indicated above	

2	Download and install boost:
	
	Download Boost from: http://sourceforge.net/projects/boost/files/boost/1.44.0/boost_1_44_0.tar.gz/download
	
	Place in lib/ and unpack, build and install into /usr/local using:
	
	`./boostrap.sh`
	`./bjam --with-pythonsudo`
	`./bjam install`	

3	Download and install the Boost numeric bindings:
	
	Download from:
	http://mathema.tician.de/news.tiker.net/download/software/boost-numeric-bindings/boost-numeric-bindings-20081116.tar.gz
	
	Place in lib/ and unpack using:
	
	`tar -xvzf boost-numeric-bindings-20081116.tar.gz`
	`cd boost-numeric-bindingssudo`
	`sudo cp -R boost/numeric/bindings /usr/local/include/boost/numeric`	

4	Download and install FLTK 1.3.
	
	Download from: http://ftp.easysw.com/pub/fltk/1.3.0/fltk-1.3.0-source.tar.gz
	
	Place in lib/, unpack and configure:
	
	`./configure --enable-gl --disable-xinerama`
	`make`
	`sudo make install`	

5	Download and install ActiveMQ.
	
	Download from: http://www.apache.org/dyn/closer.cgi/activemq/activemq-cpp/source/activemq-cpp-library-3.4.0-src.tar.gz
	
	unpack to temp folder
	
	`./configure --disable-ssl`
	`make`
	`sudo make install`
	`sudo ldconfig`	

6 Get Open Dynamics Engine (ODE).

Download ode-0.11.1 from:http://sourceforge.net/projects/opende/files/
Place in lib/, unpack and configure:

32 bits:

```
./configure --with-drawstuff=none
```

64 bits:

```
./configure --with-drawstuff=none --with-pic

make

sudo make install
```

7 (Optional) Build the elsender:

```
cd lib/elsender
xbuild elsender.csproj   (ignore post-build error)
```

8 (Optional) Build the Ogre engine:

Download the 1.6.5 version fromfrom: www.ogre3d.org/download/source

```
./configure
sudo make install
```

9 Build speech tools and Festival that are located in the local SmartBody directory:

```
cd lib/festival/speech_tools
./configure
make install
cd ../festival
./configure
make install
```

10 Make and install SmartBody:

First, generate the Makefiles with cmake:

```
mkdir build
cmake ..
```

Go to the build directory, make and install the applications

```
cd build
make install
```

Building SmartBody for OSX

To build the OSX version:

1 Download and install boost:

Download Boost from: http://sourceforge.net/projects/boost/files/boost/1.44.0/boost_1_44_0.tar.gz/download

Place in lib/ and unpack, build and install into /usr/local using:

```
./boostrap.sh
./bjam --with-pythonsudo
sudo ./bjam install
```

2	Download and install the Boost numeric bindings:
	
	Download from:
	http://mathema.tician.de/news.tiker.net/download/software/boost-numeric-bindings/boost-numeric-bindings-20081116.tar.gz
	
	Place in lib/ and unpack using:
	
	`tar -xvzf boost-numeric-bindings-20081116.tar.gz`
	`cd boost-numeric-bindingssudo`
	`sudo cp -R boost/numeric/bindings /usr/local/include/boost/numeric`	

3	Download and install FLTK 1.3.
	
	Download from: http://ftp.easysw.com/pub/fltk/1.3.0/fltk-1.3.0-source.tar.gz
	
	Place in lib/, unpack and configure:
	
	`./configure --enable-gl --enable-shared --disable-xinerama`
	`make`
	`sudo make install`	

4 Download and install the ActiveMQ libraries.

Download from: http://www.apache.org/dyn/closer.cgi/activemq/activemq-cpp/source/activemq-cpp-library-3.4.0-src.tar.gz

Activemq-cpp will need to be changed slightly to work with OsX, as seen in this bug fix:

https://issues.apache.org/jira/browse/AMQCPP-369

Change the following in the activemq-cpp source code:

```
--- activemq/activemq-cpp/trunk/activemq-cpp/src/main/decaf/util/logging/Handler.h    2011/05/02 14:52:26    1098605

+++ activemq/activemq-cpp/trunk/activemq-cpp/src/main/decaf/util/logging/Handler.h    2011/05/02 14:52:30    1098606

@@ -49,9 +49,6 @@

     class DECAF_API Handler : public io::Closeable {

     private:


-        // Default Logging Level for Handler

-        static const Level DEFAULT_LEVEL;

-

         // Formats this Handlers output

         Formatter* formatter;


--- activemq/activemq-cpp/trunk/activemq-cpp/src/main/decaf/util/logging/Handler.cpp    2011/05/02 14:52:26    1098605

+++ activemq/activemq-cpp/trunk/activemq-cpp/src/main/decaf/util/logging/Handler.cpp    2011/05/02 14:52:30    1098606

@@ -28,11 +28,8 @@

using namespace decaf::util::logging;


////////////////////////////////////////////////////////////////////////////////

-const Level Handler::DEFAULT_LEVEL = Level::ALL;

-

-////////////////////////////////////////////////////////////////////////////////

Handler::Handler() : formatter(NULL), filter(NULL), errorManager(new ErrorManager()),

-                     level(DEFAULT_LEVEL), prefix("Handler") {

+                     level(Level::ALL), prefix("Handler") {

}
```

Then rebuild activemq-cpp using:

```
./configure --disable-ssl
make
sudo make install
sudo ldconfig
```

5	Get Open Dynamics Engine (ODE).
	
	Download ode-0.11.1 from:http://sourceforge.net/projects/opende/files/
	Place in lib/, unpack and configure:
	
	32 bits:
	
	`./configure --with-drawstuff=none`
	
	64 bits:
	
	`./configure --with-drawstuff=none --with-pic`
	
	`make`
	
	`sudo make install`	

6	Build and install xerces http://www.takeyellow.com/apachemirror//xerces/c/3/sources/xerces-c-3.1.1.tar.gz	
7	Build and install GLEW https://sourceforge.net/projects/glew/files/glew/1.6.0/glew-1.6.0.tgz/download	
8	Build and install log4cxx http://www.apache.org/dyn/closer.cgi/logging/log4cxx/0.10.0/apache-log4cxx-0.10.0.tar.gz	
9	Build and install OpenAL http://connect.creativelabs.com/openal/Downloads/openal-soft-1.13.tbz2	
10	Build and install FreeALUT http://connect.creativelabs.com/openal/Downloads/ALUT/freealut-1.1.0-src.zip	
11	Build and install libsndfile http://www.mega-nerd.com/libsndfile/files/libsndfile-1.0.25.tar.gz	

12	(Optional) Build the elsender:
	
	`cd lib/elsender`
	`xbuild elsender.csproj   (ignore post-build error)`	

13	(Optional) Build the Ogre engine:
	
	Download the 1.6.5 version fromfrom: www.ogre3d.org/download/source
	
	`./configure`
	`sudo make install`	

14	Build speech tools and Festival that are located in the local SmartBody directory:
	
	`cd lib/festival/speech_tools`
	`./configure`
	`make install`
	`cd ../festival`
	`./configure`
	`make install`	

15	Make and install SmartBody:
	
	First, generate the Makefiles with cmake:
	
	`mkdir build`
	`cmake ..`
	
	Go to the build directory, make and install the applications
	
	`cd build`
	`make install`	

Building SmartBody for Android

The SmartBody code is cross-compiled for the Android platform using the native development kit (NDK), which allows you to use gcc-like tools to build Android applications. This means that SmartBody is nearly fully-functional as a mobile application, since it uses the same code base as the desktop version of SmartBody. Many of the supporting libraries (such as ActiveMQ, boost, Xerces, Python, Festival, etc.) have already been built as static libraries and exist in the smartbody/android/lib directory.

Note that there are three different examples of Android applications using SmartBody that can be built:sbmjni, sbm-ogre, and vh-wrapper.

If your target hardware is the ARM architecture, some dependency libraries are already prebuilt at SmartBodyDir)/android/lib. Therefore you can build the SmartBody projects directly as below:

	Build Instructions for Android
1	Download and install android-sdk from : http://developer.android.com/sdk/index.html
2	Download and install the android-ndk from: http://developer.android.com/sdk/ndk/index.html (Note that when building on the windows platform, you will also need to install cygwin 1.7 or higher from http://www.cygwin.com/) Follow the installation instruction for both the SDK and the NDK. Be sure to set the correct path to android-sdk/bin, android-ndk/bin so the toolchain can be access correctly. For NDK, you also need to export the environment variable NDK_ROOT to the NDK installation directory (for example, export NDK_ROOT= "/path/to/ndk/directory")
3	Install Eclipse (http://www.eclipse.org/) and its Android ADT plug-in (http://developer.android.com/sdk/eclipse-adt.html) The supporting libraries have been built using Android version 2.3.3 or higher.
4	(Optional) Build sbm-jni sbmjni is a hello world project for SmartBody. It has very basic rendering and minimal functionality, but it helps demonstarte the SmartBody port on android. i) Go to (SmartBodyDir)/android/sbm-jni/ ii) ndk-build (Similar to gcc, you can set the option -j $number_threads to accelerate the build process with multi-threading). iii) Use Eclipse to open the project (SmartBodyDir)/android/sbm/. iv) Select Project->Build Project. Connect the device and then run the program as "Android Application".
5	(Optional) Build sbm-ogre sbm-ogre combines SmartBody and ogre for high quality rendering. Currently, it is very slow when rendering in deformable model mode. a. Go to (SmartBodyDir)/android/sbm-ogre/ b. ndk-build (Similar to gcc, you can set the option -j $number_threads to accelerate the build process with multi-threading). c. Use Eclipse to open the project (SmartBodyDir)/android/sbm-ogre/. d. Select Project->Build Project. ThConnect the device and then run the program as "Android Application".

6	(Optional) Build vh-wrapper vh-wrapper is a SmartBody interface to Unity3D. Note that SmartBody connects to Unity via Unity's native code plugin interface, which presently requires a Unity Pro license. In addition, the Unity project needs to be compiled for Android, so a Unity Android license is needed as well. a. Go to SmartBody/android/vh_wrapper/ b. ndk-build c. rename libvhwrapper.so to libvhwrapper-dll.so (for some reason, Android does not accept a build target name with "-") d. copy libvhwrapper-dll.so to the plug-in directory of Unity project. Build the Unity project for Android.

If you are targeting other hardware achitecture (x86, etc) or you prefer to rebuild all libraries from their sources, you will need to perform the following steps:

	Building Supporting Libraries

1	Building Boost for Android:
	
	Download BOOST library, extract it into SmartBody/lib
	
	modify libs\filesystem\v2\src\v2_operations.cpp, change:
	
	`#   if !defined(__APPLE__) && !defined(__OpenBSD__)`
	`#     include <sys/statvfs.h>`
	`#     define BOOST_STATVFS statvfs`
	`#     define BOOST_STATVFS_F_FRSIZE vfs.f_frsize`
	`#   else`
	`#ifdef __OpenBSD__`
	`#     include <sys/param.h>`
	`#endif`
	
	to:
	
	`#   if !defined(__APPLE__) && !defined(__OpenBSD__) && !defined(__ANDROID__)`
	`#     include <sys/statvfs.h>`
	`#     define BOOST_STATVFS statvfs`
	`#     define BOOST_STATVFS_F_FRSIZE vfs.f_frsize`
	`#   else`
	`#ifdef __OpenBSD__`
	`#     include <sys/param.h>`
	`#elif defined(__ANDROID__)`
	`#     include <sys/vfs.h>`
	`#endif`
	
	modifiy the file SmartBody/android/boost/userconfig.jam, look for :
	
	ANDROID_NDK = ../android-ndk ; and change the directory "../android-ndk" so it points to the android NDK directory
	
	You may also need to change all arm-linux-androideabi-xxx to the corresponding toolchain name based on your target architecture and platform.
	
	(use Cygwin in Windows platform)
	`./bootstrap.sh`
	`./bjam --without-python --without-math --without-mpi --without-`
	`iostreams toolset=gcc-android4.4.3 link=static runtime-link=static`
	`target-os=linux --stagedir=android stage`

2	Building iconv TODO
3	Building xerces TODO

4	Building clapack TODO

Building SmartBody for iOS

The iOS build requires two steps: building libraries via the command console, then building applications and libraries via XCode.

	Compiling using console
1	Cross compiling apr • Download apr-1.3.* from http://archive.apache.org/dist/apr/ • Copy setup-iphoneos.sh and setup-iphonesimulator.sh from trunk/ios/activemq/apr to the folder where you extracted the above downloaded contents. • Change the SBROOT inside setup-iphoneos.sh and setup-iphonesimulator.sh to your trunk directory. • Make sure you have gcc-4.2 installed on the system. If not, please download the version of xcode 4.02 iOS4.3 which contains gcc-4.2 and install it (make sure you change the installation folder to something other than /Developer, make it something like /Developer-4.0, uncheck update system environment options). You can download previous xcode4.02 from https://developer.apple.com/downloads/index.action , search for xcode 4.02 iOS4.3. P.S. Latest xcode 4.2 and iOS5.0 is using LLVM GCC compiler which has trouble building apr, apr-util and activemq, not sure if it can compile the other third party library, for now just stick on gcc4.2. • If, in the previous step, you had to download a different version of xcode, make sure in both the scripts, you change the following variable from - • export DEVROOT=/Developer/Platforms/iPhoneOS.platform/Developer to • export DEVROOT=/Developer-4.0/Platforms/iPhoneOS.platform/Developer (if you installed the xcode in /Developer-4.0) • Run setup-iphoneos.sh or/and setup-iphonesimulator.sh • Go to trunk/ios/activemq/apr/iphone*/include/apr-l • edit line 79 of apr_general.h to be: - • #if defined(CRAY) || (defined(__arm) && !(defined(LINUX) || defined(__APPLE__)))
2	Cross compiling apr-util • Download apr-util-1.3.* from http://archive.apache.org/dist/apr/ • Copy setup-iphoneos.sh and setup-iphonesimulator.sh from trunk/ios/activemq/apr-util to the folder where you extracted the above downloaded contents. • Change the SBROOT inside setup-iphoneos.sh and setup-iphonesimulator.sh to your trunk directory • If in the step 1, you had to download the gcc-4.2 (from xcode), change the DEVROOT variable in the scripts as in the previous step from - • export DEVROOT=/Developer/Platforms/iPhoneOS.platform/Developer to • export DEVROOT=/Developer-4.0/Platforms/iPhoneOS.platform/Developer (if you installed the xcode in /Developer-4.0) • Run both of the scripts

3	Cross compiling activemq-cpp-library
	• Download activemq-cpp-library-3.4.0 from http://apache.osuosl.org/activemq/activemq-cpp/source/
	• Copy setup-iphoneos.sh and setup-iphonesimulator.sh from trunk/ios/activemq/apr-util to the folder where you extracted the above downloaded contents.
	• Change src/main/decaf/lang/system.cpp line 471 inside activemq folder (above mentioned folder) from "#if defined (__APPLE__)" to "#if 0"
	• Change the SBROOT inside setup-iphoneos.sh and setup-iphonesimulator.sh to your trunk directory
	• If in the step 1, you had to download the gcc-4.2 (from xcode), change the DEVROOT variable in the scripts as in the previous step from -
	• export DEVROOT=/Developer/Platforms/iPhoneOS.platform/Developer to
	• export DEVROOT=/Developer-4.0/Platforms/iPhoneOS.platform/Developer (if you installed the xcode in /Developer-4.0)
	• Run both of the scripts
	Note: for smartbody iphone running on unity, we need to rename variables inside activemq-cpp-library decaf/internal/util/zip/*.c to avoid conflict symbols. If you don't want to do that, you can directly use the one under trunk/ios/activemq/activemq-cpp/libs/activemq-unity
4	Cross compiling xerces-c
	• Download xerces-c-3.1.1.tar.gz from http://xerces.apache.org/xerces-c/download.cgi
	• Copy setup-iphoneos.sh and setup-iphonesimulator.sh from trunk/ios/activemq/activemq-cpp to the folder where you extracted the above downloaded contents.
	• Change the SBROOT inside setup-iphoneos.sh and setup-iphonesimulator.sh to your trunk directory
	• If in the step 1, you had to download the gcc-4.2 (from xcode), change the DEVROOT variable in the scripts as in the previous step from -
	• export DEVROOT=/Developer/Platforms/iPhoneOS.platform/Developer to
	• export DEVROOT=/Developer-4.0/Platforms/iPhoneOS.platform/Developer (if you installed the xcode in /Developer-4.0)
	• Run both of the scripts
5	Cross compiling ODE
	• Download ode-0.11.1.zip from http://sourceforge.net/projects/opende/files/
	• Copy setup-iphoneos.sh and setup-iphonesimulator.sh from trunk/ios/activemq/activemq-cpp to the folder where you extracted the above downloaded contents
	• Change the SBROOT inside setup-iphoneos.sh and setup-iphonesimulator.sh to your trunk directory
	• If in the step 1, you had to download the gcc-4.2 (from xcode), change the DEVROOT variable in the scripts as in the previous step from -
	• export DEVROOT=/Developer/Platforms/iPhoneOS.platform/Developer to
	• export DEVROOT=/Developer-4.0/Platforms/iPhoneOS.platform/Developer (if you installed the xcode in /Developer-4.0)
	• Run both of the scripts

6 Cross compiling clapack (Not required. If you chose not to cross compile, make sure you add Acceleration framework from xcode project)

- Download clapack-3.2.1-CMAKE.tgz from http://www.netlib.org/clapack/

- Copy toolchain-iphone*.cmake and setup-iphone*.sh from trunk/ios/activemq/activemq-cpp to the folder where you extracted the above downloaded contents
- If in the step 1, you had to download the gcc-4.2 (from xcode), change the IPHONE_ROOT variable in the toolchain-iphone*.cmake from -
  - /Developer/Platforms/iPhoneOS.platform/Developer to
  - /Developer-4.0/Platforms/iPhoneOS.platform/Developer (if you installed the xcode in /Developer-4.0)

- To make a Unity compatible build, you need to modify the cmake file. If not used for Unity Iphone, you can skip the following step:

```
-Go to clapack/CMakeLists.txt, comment out include(CTest) and add_subdirectory(TESTING)
-Go to clapack/BLAS/CMakeLists.txt, comment out add_subdirectory(TESTING)
-Go to clapack/F2CLIBS/libf2c/CMakeLists.txt, take out main.c from first SET so it became
        set(MISC
        f77vers.c i77vers.c s_rnge.c abort_.c exit_.c getarg_.c iargc_.c
          getenv_.c signal_.c s_stop.c s_paus.c system_.c cabs.c ctype.c
         derf_.c derfc_.c erf_.c erfc_.c sig_die.c uninit.c)
 -Go to clapack/SRC/CMakeLists.txt, take out ../INSTALL/lsame.c from first SET so it became
        set(ALLAUX  maxloc.c ilaenv.c ieeeck.c lsamen.c  iparmq.c
            ilaprec.c ilatrans.c ilauplo.c iladiag.c chla_transtype.c
        ../INSTALL/ilaver.c) # xerbla.c xerbla_array.c
```

- Change the SBROOT inside setup-iphoneos.sh and setup-iphonesimulator.sh and run the scripts.

7 Cross compiling python

- Go to trunk/ios/python, modify the SBROOT inside setup-iphoneos.sh

- If in the step 1, you had to download the gcc-4.2 (from xcode), change the DEVROOT variable in the scripts as in the previous step from -
  - export DEVROOT=/Developer/Platforms/iPhoneOS.platform/Developer to
  - export DEVROOT=/Developer-4.0/Platforms/iPhoneOS.platform/Developer (if you installed the xcode in /Developer-4.0)

- Run the script, you may need to add sudo before the script in case the copying step fails (last step is to copy libpython2.6.a out)

8 Cross compiling pocket sphinx (Not required)

Download from http://www.rajeevan.co.uk/pocketsphinx_in_iphone/. The steps are on the website.

P.S.

- Since the results are not that good on Unity and I don't have time fully test out, the code is not intergrated into smartbody yet.
- When integrating pocketsphinx with Unity, it would have duplicated symbol problem(this might be the reason of bad recognizing result, it's under sphinx/src/util). I already built a library for Unity that can be used directly.
- Also for Unity you may need get prime31 iphone plugin AudioRecorder

Compiling using Xcode4

1 Build bonebus

- Open smartbody-iphone.xcworkspace, select the scheme to be bonebus, build

2 Build boost

- Download boost_1_44_0.tar.gz from http://www.boost.org/users/history/version_1_44_0.html and unzip to trunk/ios/boost. Make sure the folder name is boost_1_44_0.

- Open smartbody-iphone.xcworkspace, select boost_system, boost_filesystem, boost_regex, build them seperately.

- Download boost_numeric_bindings from http://mathema.tician.de/news.tiker.net/download/software/boost-numeric-bindings/boost-numeric-bindings-20081116.tar.gz and unzip it to trunk/ios/boost, make sure the name is boost_numeric_bindings

3	Build steersuite • Open smartbody-iphone.xcworkspace, select the steerlib, pprAI, build them seperately.
4	Build vhmsg • Open smartbody-iphone.xcworkspace, select scheme vhmsg and build.
5	Build vhcl • Since the vhcl_log.cpp hasn't been changed from VH group, you have to copy trunk/ios/vhcl/vhcl_log.cpp to trunk/lib/vhcl/src/vhcl_log.cpp for now. • Open smartbody-iphone.xcworkspace, select scheme vhcl and build.
6	Build wsp • Open smartbody-iphone.xcworkspace, select scheme wsp and build.
7	Build smartbody-lib • Open smartbody-iphone.xcworkspace, select scheme smartbody-lib and build. P.S. This xcode project needs maintenance by the developer to make sure it incorporates all the file from SmartBody core.
8	Build smartbody-dll (Not required) • Open smartbody-iphone.xcworkspace, select scheme smartbody-dll and build.
9	Build vhwrapper-dll (Not required, for Unity only) • Open smartbody-iphone.xcworkspace, select scheme vhwrapper-dll and build.

Once those steps have been completed, you can build any of three applications:

- smartbody-openglES - a simple example of using SmartBody with OpenGL
- smartbody-ogre - an example of using SmartBody with the Ogre3D rendering engine
- smartbody-unity - The Unity3D game engine connected to SmartBody.

Make sure that your iOS device is connected and follow any of the three applications below:

	Building smartbody-openglES
1	Build smartbody-openglES Go to trunk/ios/applications/minimal, open smartbody-iphone.xcodeproj, build and run. P.S. Under smartbody-openglES project Frameworks, you should see all the libraries existing. If not, go over previous steps to check if anything is wrong

	Building smartbody-ogre

1	Build ogre iphone • Download OgreSDK: http://www.ogre3d.org/download/sdk • Build the Ogre iPhone libraries as indicated here: http://www.ogre3d.org/tikiwiki/tiki-index.php?page=Building%20From%20Source%20-%20iPhone&redirectpage=Building%20From% • Make sure all the libraries exist inside build/lib/Debug
2	Build smartbody ogre application • Go to trunk/ios/applications/ogreIphone, open smartbody-ogre.xcodeproj • go to smartbody-ogre project, set OGRE_SDK_ROOT to your ogreSDK directory, • set OGRE_SRC_ROOT to your ogre source directory. • Select scheme smartbody-ogre, build and run. p.s. • If the program hangs on boost thread function, try rebuild the ogre iphone dependencies boost libs (pthread, date_time), alternative iOS libraries with Boost symbol turned off which may affect the results. • ogre 1.8 seems to have trouble when building for iphone/ipad, use ogre 1.7.3.It is extremely slow running on armv6 ipod(after testin wrong with the texture and shader. So maybe should just run on armv7 iPhone/iPad

	Building smartbody-unity
1	TODO

SmartBody iOS build maintenance

This piece of documentation is written mainly for the developer.

- smartbody-iphone.xcworkspace needs to change if there's cpp file added or code re-arrangement.
- vhcl_log.cpp is modified and copied over to make ios build work. So if the source changed, this file may need to be changed.
- vhwrapper.h and vhwrapper.cpp are copied from VH svn, they are used to build smartbody unity application. So if these two files got changed outside, they have to be copied over again and modifies maybe needed to make it working.

Controlling Characters with BML

SmartBody characters can be controlled by using the Behavioral Markup Language (BML).BML contains instructions for characters to walk, talk, gesture, nod, grab objects, look at objects, and so forth.

About BML

The purpose of BML is to provide a common language for controlling virtual humans and embodied conversational agents, such that behavior designers do not have to focus on the behavioral realization (i.e. what does smiling look like?) but rather can focus on the behaviors generation and coordination with other behaviors.SmartBody supports the Vienna Draft version of BML with enhancements. SmartBody does not yet support the 1.0 specification as detailed at http://www.mindmakers.org/projects/bml-1-0/wiki/Wiki.

How to Specify a BML Command

Using Python, use the implicit *bml* object in the Python dictionary and call the *bmlExec()* function:

```
bml.execBML('utah', '<head type="NOD"/>')
```

where utah is the name of the character, and the second parameter to the bmlExec function is the BML, described below. Note that using Python, commands can be specified using the single quote, instead of the double quote character, which is advisable, since most BML commands will contain many double quote character for use with attributes. Alternatively, you could specify BML using Python like this:

```
bml.execBML("utah", "<head type=\"NOD\"/>")
```

Notice that double quotes are used for the function parameters, while double quotes contained within the BML are escaped using the slash character.

Quick BML Reference for SmartBody

Each BML command specifies a behavior that a character will perform.

Behavior	**Example**	**BML Command**
Gaze	look at the object called 'table'	`<gaze target="table"/>`
Locomotion	move to location (10, 75)	`<locomotion target="10 75"/>`
Head Movement	nod your head	`<head type="NOD"/>`
Idle	assume an idle posture called 'idling_motion1'	`<body posture="idling_motion1'/>`
Animation	play an animation called 'dosomething'	`<animation name="dosomething"/>`
Gesture	point at character1	`<gesture type="POINT" target="character1"/>`
Reach	Grab the object 'cup'	`<sbm:reach target="cup"/>`
Constraint	Constraint your hand to 'ball'	`<sbm:constraint target="ball"/>`
Face	Raise your eyebrows	`<face type="FACS" au="1" side="both" amount="1"/>`
Speech	Say 'hello, how are you?'	`<speech type="text/plain">hello how are you?</speech>`
Eye saccade	Move your eyes around automatically	`<saccade mode="LISTEN"/>`
Event	Send out an event 3 seconds in the future	`<sbm:event stroke="3" message="sbm echo hello"/>`

In general, BML commands that are not part of the original BML Vienna Specification and are specific to SmartBody use the prefix *sbm:*.

Timing BML Commands

Each BML command specifies a behavior, which, by default, start immediately, and end at various times depending on the specific behavior. For example, a nod lasts one second by default, a gesture lasts as long as the animation used to specify it, and so forth. A behavior can be scheduled to play or finish playing at different times using synchronization points. Each behavior generated by a BML command uses a set of synchronization points. Most use the minimal set of points - *start* and *end*. Some behaviors are deemed persistent, and have no finish time, such as gazing or idling, and thus have no *end* synchronization point. A behavior can be designed to to start or stop at a specific time in the future. For example:

```
<head type="NOD" start="2"/>
```

Indicates that you would like your character to start nodding his head two seconds from the time the command is given. Some BML commands, such as <animation> and <gesture> also contain implicit synchronization points that indicate the phases of the action. For example, the *stroke* synchronization point indicates the emphasis phase of a gesture, so:

```
<gesture type="BEAT" stroke="5"/>
```

indicates to make a beat gesture where the *stroke* (emphasis) point is five seconds after the BML command was given. The gesture will be automatically started such that the *stroke* phase of the gesture will occur at the five second mark. For example, if the gesture ordinarily takes 2 seconds to complete, with the stroke phase at the 1 second mark, then the above command will start the gesture four seconds after the command was given, yielding the stroke phase at the 5 seconds, and completion at the 6 seconds.

BML commands can also use relative timings by using the + or - modifiers, such as:

```
<head type="NOD" start="2" end="start+5"/>
```

which indicates to finish the head nod five seconds after it started, in this case, finishing at seven seconds.

The following table shows the synchronization points used for each behavior.

Behavior	Synchronization Points	Comments
Gaze	start	
Locomotion	start ready	start = start time of idle motion ready = time when motion is fully blended with last idle motion

Head Movement	start
	ready
	stroke
	relax
	end
		ready = ramp-in time
		stroke = middle of head movement
		relax = ramp-out time

Idle	start ready	

Animation	start
	ready
	stroke
	relax
	end
		ready = ramp-in time
		stroke = emphasis point of the animation
		relax = ramp-out time

Gesture	start
	ready
	stroke
	relax
	end
		ready = ramp-in time
		stroke = emphasis point of the animation
		relax = ramp-out time

Reach	start	
Constraint	start ready	ready = time needed to achieve constraint

Face	start
	ready
	stroke
	relax
	end
		ready = ramp-in time
		stroke = emphasis point of the face motion
		relax = ramp-out time

Speech	..?	
Eye saccade	..?	

Timewarping Motions

Some behaviors, such as animation can be timewarped (stretched or compressed) by specifying more than one synchronization point. SmartBody handles timewarping of behaviors as follows:

1. If only one synchronization point is specified, align the behavior such that the behavior will occur at normal speed in line with the synchronization point. Example, let's assume that motion1 lasts for 3 seconds, with it's stroke point at second 2:
   `<animation name="motion1" stroke="5"/>`

   will play *motion1* such that the middle (or stroke) of the motion occurs at second 5, with the rest of the motion aligned to that time. In other words, the beginning of the motion will play at second 4, and finish at second 6.

2. If two synchronization points are specified, then timewarp the rest of the motion according to the relative scale of two synchronization points. For example:
   `<animation name="motion1" start="1" stroke="5"/>`

   will play *motion1* by timewarping it (in this case, slowing it down) by 2x, since the original motion took two seconds to go from the start point to the stroke point, and the user is specifying that that phase should now take 4 seconds, yielding a slowdown of 2x. Thus, the remainder of the motion which has not been explicitly specified by the user, will also play at 1/2 speed. Thus the entire motion will now take 6 seconds to play, and finish at second 7.
3. If three or more synchronization points are specifed, then the behavior will be unevenly timewarped such that each phase of the behavior will be stretched or compressed according to the closest explicitly specified behavior segment. For example, let's assume that the synchronization points for motion1 are: start = 0, ready = 1, stroke = 2, relax = 3, end = 4. Then by specifying:<animation name="motion1" start="1" ready="1.5" stroke="4"/> Then the start-ready phase will be double in speed (since the user explicitly requested it), the ready-stroke phase will now be slowed down by 3x times (originally took 1 second, but the user requested that it now take 3 seconds), and the stroke-relax and relax-end phases will also be slowed down by 3x, since their closest explicit request was a 3x slowdown.

Compounding & Synchronizing BML Commands

BML commands can be compounded together in blocks. For example, to have your character both raise his eyebrows while nodding, a BML block could look like this:

```
<face type="FACS" au="1" side="both" amount="1"/><head type="NOD"/>
```

There is no limit to the number of BML commands that can be compounded together. Either BML command could be explicitly started or timed by adding the appropriate synchronization points, such as:

```
<face type="FACS" au="1" side="both" amount="1" start="2"/><head type="NOD" start="4"/>
```

which instructs the character to move his eyebrows at two seconds, and nod his head at four seconds. The synchronization points can also be used by adding an *id* to a BML behavior, then using that id to synchronize other behaviors. For example:

```
<face id="foo" type="FACS" au="1" side="both" amount="1" start="2"/><head type="NOD" start="foo:start+2"/>
```

Thus the eyebrow raise has an *id* of *foo*, and the head nod will occur two seconds after the start of the *foo* behavior.The id is unique to each behavior block, and thus the same name can be reused on a different behavior block.

Synchronizing Multiple Character's Behaviors with BML

BML blocks that contain behaviors can only be specified per character. You are allowed to send multiple commands to different characters, such as the following:

```
bml.execBML('utah', '<head type="NOD"/>')
bml.execBML('harmony', '<head type="NOD"/>')
```

but since each block contains behaviors for only a single character, each character's BML cannot be explicitly synchronized with each other. However, you can use the <sbm:event> BML tag to trigger an event that will synchronize one character to the other, as in:

```
harmonyBML = "<head type=\"NOD\"/>"
harmonyName = "harmony"
bml.execBML('utah', '<head id="a" type="NOD"/><sbm:event stroke="a:start+1" message="sbm python
bml.execBML(harmonyName, harmonyBML)"/>')
```

which will trigger a BML nod behavior once Utah's nod has been in effect for one second. The syntax of the <sbm:event> tag is as follows:

- the *sbm* keyword tells SmartBody to respond to this message.
- the *python* keyword tells SmartBody that the rest of the command will be using Python

Note that all <sbm:event> BML tags are sent over the VH message bus (the ActiveMQ server), thus the need to use the *sbm* keyword. In general, any command can be placed in the message="" attribute, as long as the contents comply with XML syntax.

BML Behaviors

Each BML behavior has a number of parameters that can be used to alter its performance. Also note that many behaviors cannot be used unless they have the proper animations, skeleton topology, and so forth.Behaviors are typically implemented by means of a Controller, which will have different requirements. For example, a head nod controller requires a skeleton that has three neck and spine joints, whereas an animation controller requires a motion asset, but is indifferent about the skeleton topology, as long as the motion data matches the skeleton topology of the character. Certain behaviors have multiple modes; a low-quality mode when the configuration isn't available or set up, and a high-quality mode when the proper data or configuration is made. For example, the locomotion behavior will move any character around in the virtual environment, regardless of topology, but will do so without moving the character's body. Once the proper locomotion files are provided, the character will accurately step and turn in a realistic manner.

Each behavior listed on the following pages will contain:

- a description of the behavior
- a list of parameters that can modify the performance of a behavior
- a description of the setup requirements to use this behavior

Idling

Description

Characters can perform an idle motion, usually a repeatable animation that engages the entire body of the character that represents the subtle movements of the character while it is not performing any other behaviors.An idle behavior will repeatedly play a looped motion. Other behaviors will be layered on top of the idle motion, or replace it entirely. Subsequent calls to the idle behavior will override the old idle behavior and replace it with the new idle behavior.

Usage

```
<body posture="idlemotion1"/>
```

where idlemotion1 is the name of the motion to be played. Note that the idle motion will be played at a location and orientation in the world based on the character's offset.

Parameters

Parameter	Description	Example
start	starts the idle posture at a time in the future	`<body posture="idlemotion1" start="3"/>`
ready	the time when the posture is fully blended. The total ramp-in time is (ready-start)	`<body posture="idlemotion1" start="3" ready="5"/>`

Animation

Locomotion

Gesture

Reach, Grab, Touch

Gaze

Constraint

Head Movements

Face

Speech

Eye Saccade

Event

Character Physics

Physics-based characters can produce realistic reaction to external forces such as gravity, or collision contact. SmartBody now supports physics simulation to drive the character animations.

A physics character is basically a set of connected body links based on his skeleton topology. During setup, user needs to provide appropriate mass, collision geometries, and joint parameters for the character. At run-time, physical simulation will update the new body link position and orientation at each time step to achieve realistic motions. A basic example is the ragdoll, which simulate the character with only gravity and collisions. In addition to ragdolls, SmartBody also supports more advanced feature like pose tracking. It enables the character to follow an input kinematic motions under physical simulation.

In our current implementation, Open Dynamic Engine (ODE) is used as our simulation engine. In the future, we would like to support multiple physics engines such as PhysX or Bullets.

Character Physics Features

The current supported features include :

- **Ragdoll Animations :** The character will naturally die down based on gravity and other collisions. The future extension includes adding mechanisms for the character to naturally get back from a lie down pose.
- **Proportional Derivative (PD) Motion Tracking :** The character will track an input kinematic motion as much as possible. This enables the character to execute a motion under physical simulation, and at the same time respond directly to external push or collisions. The current implementation does not control the character balance. Instead, the root joint is driven directly by the kinematic motion to prevent character from falling down.
- **Kinematic Constraint :** A physics-based character is simulated by a set of connected body links. Instead of using physical simulation, each body link can also be constrained to follow a kinematic motion. This allows the user to "pin" a body link in a fixed position, or have a specific link to follow the original kinematic motion.
- **Collision Events :** A collision event will be sent out from the simulation system when a physics character is collided with other objects. User can provide a python script to handle this collision. For example, the character can gaze at the object that is hitting him, or execute a reaction motion. This helps enhance realism and interactivity of a character with the virtual environment.

How to Setup a Physics Character

Physics-based character can be regarded as a set of connected body links. Each body link is simulated as a rigid body and all body links are connected based on character joints. In order to simulate the character correctly, user needs to provide correct mass and geometry information for each body links, as well as some joint properties such as joint limits.

The overall procedural of setting up a physics character :

1. **Initialize a kinematic character with appropriate skeleton.**

2. **Create physics character using Physics Manager.**
    a. phyManager = scene.getPhysicsManager();

    b. phyManager.createPhysicsCharacter("charName");

3. **Although step 2. will procedurally setup collision geometries and masses based on default parameters. Although this will generate the default parameters for you, they are usually not ideal for a specific character or scenario.**

4. **Setup collision geometries manually.**
    a. phyBodyLink = phyManager.getJointObj("charName","jointName"); # get corresponding body link for joint "jointName" from character "charName".
    b. phyBodyLink.setStringAttribute("geomType",geomShape); # This command set the collision geometry to a different shape. Here 'geomShape' is a string value. It can be either "box", "capsule" , or "sphere".
    c. phyBodyLink.setVec3Attribute("geomSize",size); # This command set the size for collision geometry.

5. **Setup mass.**
    a. phyBodyLink = phyManager.getJointObj("charName","jointName"); # get corresponding body link for joint "jointName" from character "charName".
    b. phyBodyLink.setDoubleAttribute("mass",massValue); # set the mass for this body link.

6. **Setup joint limit**
    a. phyJoint = phyManager.getPhysicsJoint("charName","jointName"); # get corresponding physics joint with "jointName" from character "charName".
    b. phyJoint.setVec3Attribute("axis0", dirVec); # set rotation axis0 according to dirVec. We can set axis1, axis2 similarly.
    c. phyJoint.setDoubleAttribute("axis0LimitHigh", highLimit); # set the maximum rotation angle for axis0 in positive direction. highLimit must be larger than zero. "axis1" and "axis2" can also be done similarly.
    d. phyJoint.setDoubleAttribute("axis0LimitLow", lowLimit); # set the rotation angle limit for axis0 in negative direction. lowLimit must be negative.

The above process setup a physics character with appropriate joint limits and body link geometry and mass. A proper joint limit setting should allows the character to perform all required kinematic motions within its joint limit while preventing unnatural joint angles. A proper geometry and mass should be set to approximate the actual body link shape and mass distribution. This allows more accurate collision detection and realistic response when interacting with the environment.

These settings can also be done using GUI in Resource Viewer–>Service–>Physics. (To-Do : add GUI picture and step by step guide).

Setting Physics Parameters

The results of physics simulation are affected by many parameters. If these parameters are not set correctly, we may not obtain the desired character motions. Some default values have been set to work in a typical settings and environment. However, user may want to fine tune these parameters when using a different skeleton, different scale unit to obtain best results.

1. **gravity :** A typical gravity should be 9.8 m/s^2. In practice, it should be set according to the unit currently used. For example, if your character is created in centimeter (cm), then you should set gravity to 980 instead of 9.8.
   To set the gravity with Python script :
    a. phyEngine = phyManager.getPhysicsEngine(); # get the physics engine currently used
    b. phyEngine.setDoubleAttribute("gravity", valueOfGravity); # set the gravity value.
2. **dt :** The time step taken for each physics update. Physics engine usually requires small time steps for the simulation to be stable. For simple features like rigid body dynamics or ragdoll simulation, the time step can be as large as the screen refresh rate (60 Hz). For more advanced features like pose tracking, the time step needs to be much smaller (~ 1000Hz) to maintain a stable simulation.
   To set the time step :
    a. phyEngine = phyManager.getPhysicsEngine(); # get the physics engine currently used
    b. phyEngine.setDoubleAttribute("dT", value); # set the dt value. It must be positive.
3. **Ks :** This parameter determines how strong is the pose tracking. The higher this parameter is, the more closely the physical simulation will match the kinematic motion. The higher value also gives the character a more "rigid" feeling when there are external forces or collisions. However, setting this parameter too high would cause the physical simulation to become unstable. This will in turn require dt to be decreased to avoid such instability. In general, it should be set to counter the gravity so the character can just stay upright and follow the kinematic motion.
   To set Ks :
    a. phyEngine.setDoubleAttribute("Ks", value); # set the Ks value. It must be positive.

4. **Kd :** The damping parameter. This parameter is set to counter some unnatural oscillation body movements when Ks is high. If Kd is high, the resulting motion would be slower and less responsive. Similar to Ks, setting this parameter too high may also cause instability.
   To set Kd :
    a. phyEngine.setDoubleAttribute("Kd", value); # set the Kd value. It must be positive.

5. **MaxSimTime :** This parameter sets the maximum allowing time used for physics engine update. By default, the physics simulation will keep updating to match the current system time. This keeps the physics engine to sync up with the kinematic animation. However, if the scene is complicated or if the dt is very small, the physics engine may take a significant chunk of time for updating. This makes it more

and more difficult for physics engine to sync up with the system and the performance will be slowed down significantly. By setting this parameter to a proper value (by default it is 0.01 second), it prevents the physics simulation from taking too much time and drag down the system performance. Note that when both dt and MaxSimTime are very small, the physics engine may not be able to iterate enough to follow the motion. This could cause the pose tracking to be inaccurate and slower physics response.
To set MaxSimTime :
    a. phyEngine.setDoubleAttribute("MaxSimTime", value); # set the MaxSimTime value. It must be positive.

6. **KScale :** This parameter scale the Ks, Kd for a specific joint. This allows different Ks, Kd setting for each joint. Since each body link may have different mass and different number of descendent body links, it would not be feasible to use a single Ks, Kd for pose tracking. For example, a shoulder may need a larger Ks to generate more torque so the arm can be lifted to match the desired pose, while the wrist will need smaller values. The general guideline for setting this parameter should be according to the effective mass for the joint – the sum of mass from all descendent body links.
   To set KScale :
    a. phyJoint = phyEngine.getPhysicsJoint("charName","jointName"); # get corresponding physics joint
    b. phyJoint.setDoubleAttribute("KScale", scaleValue); # set the KScale. It must be positive.

Setting Up Constraint

Physics character by default is driven purely by simulation. Although pose tracking can be used to bias the simulation toward desired kinematic motion, it is difficult to keep the character stand upright or fixed some body link exactly. The constraint is introduced to provides this functionality. For example, instead of developing a complicated balance controller to have the character maintain upright pose, we can constrain the character's root to prevent him from falling down. Also, we can constrain a character's hands to a moving objects and have that object drive the character's global movements. This can create effects like a character grabbing a bar or ladder from a helicopter, etc. Note that although some body links are constrained, the other parts are still in effects for physical simulation and pose tracking can still work for the rest of joints.

To setup constraints :

1. Select the body link to be constrained :
    a. bodyLink = phyManager.getJointObj("charName","jointName"); # get corresponding body link from a character
    b. bodyLink.setBoolAttribute("constraint", true); # enable constraint

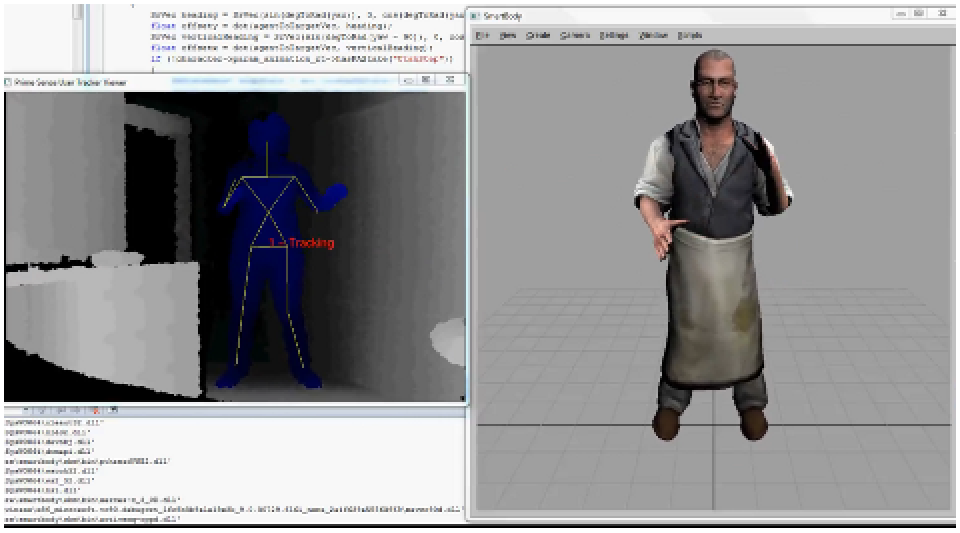
2. If we do not specified a constrain target (the target object which the body link will follow), then the body link will follow its kinematic motion. This is used when user want some body links (for example, the foot) to exactly match the desired kinematic trajectory.
3. If we want to fix the body link to a target object, we need to specify the name for that object.
    a. bodyLink = phyManager.getJointObj("charName","jointName"); # get corresponding body link from a character
    b. bodyLink.setBoolAttribute("constraintTarget",targetPawnName); # set the constraint target to a pawn

Note that although the physical simulation will try to accommodate user specified constraints as much as possible, it can not handle constraints that conflict the character setup. For example, if user sets up constraints that control each hand, the distance between two constraints can not exceed the total length of both arms. Otherwise the character will not be able to perform such a task and simulation would become unstable to satisfy the conflicting goals.

Using SmartBody With Kinect

SmartBody characters can receive data and be controlled by a Kinect camera. This works as follows:

1. A standalone application reads the data from the Kinect
2. The standalone application sends a message over the ActiveMQ network containing joint positions and orientations
3. SmartBody receives the ActiveMQ message, then overrides the joint position and orientations of the joints of one or more characters
4. Any joints not overridden (such as the face and fingers) will retain the existing character positions and orientations.



Note that the skeleton from the Kinect does not match the topology or bone lengths of the SmartBody character. The online retargeting is done by mapping the standard names of the Kinect character to similar names on the SmartBody character. Thus the "RightWrist" of the Kinect character will map to the "r_wrist" of the SmartBody character.

Also note that any motion capture system could use a similar mechanism to control a SmartBody character by sending the appropriate SmartBody commands in order to override the joint information.

Building Kinect Application on Windows

1	Download and install OpenNI 32-bit Development Edition http://www.openni.org/Downloads/OpenNIModules.aspx Select 'OpenNI Binaries' , 'Stable', then choose the Windows x86 32-bit Development Edition
2	Download and install NITE http://www.openni.org/downloadfiles/ Select 'OpenNI Compliant Middleware Binaries' , 'Stable', then choose the PrimeSense NITE Windows x86 Development Edition
3	Download the Kinect drivers https://github.com/avin2/SensorKinect/blob/unstable/Bin/SensorKinect091-Bin-Win32-v5.1.0.25.msi
4	

Building Kinect Application on Linux

The original instructions for installing OpenNI and NITE are found here: http://www.greenfoot.org/doc/kinect/ubuntu.html, but is detailed below:

	Instructions

1	Retrieve and install the OpenNI drivers
	`cd OpenNI`
	`wget http://www.greenfoot.org/doc/kinect/OpenNI-Linux32.tar.bz2`
	`tar -jxf OpenNI-Linux32.tar.bz2`
	`sudo ./install.sh`
	`cd ..`

2	Retrieve and install NITE
	`mkdir NITE`
	`cd NITE`
	`wget http://www.greenfoot.org/doc/kinect/NITE-Linux32.tar.bz2`
	`tar -jxf NITE-Linux32.tar.bz2`
	`echo '0KOIk2JeIBYClPWVnMoRKn5cdY4=' | sudo ./install.sh`
	`cd ..`

3	Install the Kinect driver for Linux
	`mkdir Kinect`
	`cd Kinect`
	`wget http://www.greenfoot.org/doc/kinect/SensorKinect-Linux32.tar.bz2`
	`tar -jxf SensorKinect-Linux32.tar.bz2`
	`sudo ./install.sh`
	`cd ..`

4	Make sure that your ActiveMQ service is running, since messages between the standalone kinect application and SmartBody are managed via ActiveMQ. If it is not running, run: `sudo activemq start`

5	Build the kinecttracker application located in smartbody/lib:
	uncomment the line in smartbody/lib/CMakeLists.txt that says:
	add_directory (kinecttracker)
	by removing the hash mark (#) in front of that line. This will add the kinecttracker application to the standard SmartBody build process.
	Then build SmartBody:
	`cd smartbody/build`
	`make install`
	You should see an application called smartbody/lib/kinecttracker/kinectracker

6	Run sbm-fltk: `./smartbody/core/smartbody/sbm/bin/sbm-fltk`

7	The character that is controlled by kinect depends on the attribute 'receiverName', which is set to 'kinect1' by default, which is the first character the kinect tracks. If you want the SmartBody character to respond to the second or greater skeleton tracked by kinect, set the 'receiverName' to 'kinect2' or 'kinect3':
	
	From Python:
	
	`c = scene.getCharacter("utah")`
	`c.setAttribute("receiverName", "kinect2")`

7	Run the kinecttracker application: `./smartbody/lib/kinecttracker/kinecttracker` Then approach the kinect camera and track your pose. You should be able to control one or more characters with the kinect data.

Building Kinect Application on OSX

We use the OpenNI library (http://www.openni.org)