OpenHaptics®

Developer Edition

3DSYSTEMS

Add 3D Touch™ Navigation and Haptics to Your Applications

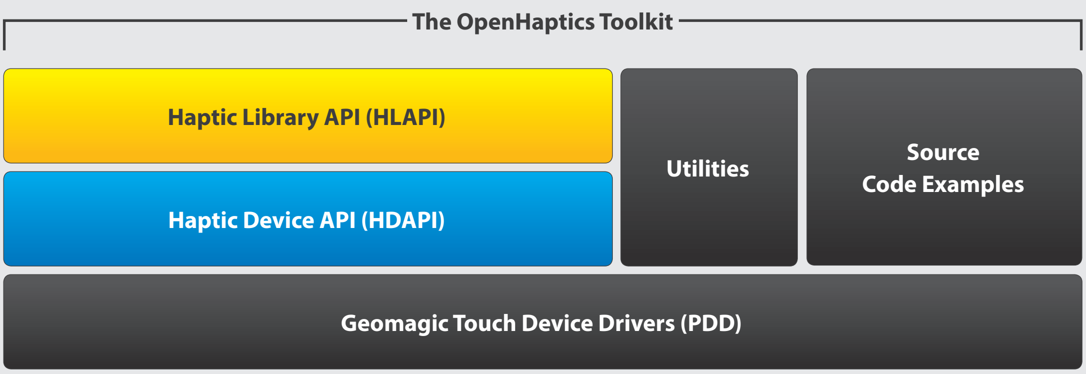
Create a compelling user experience for your customers: Enable users to go beyond working with a 2D mouse in your applications, to interacting with and manipulating objects in a realistic intuitive way. Allow users to feel objects in a virtual 3D scene, making skills easier to learn. Give your customers true 3D navigation and direct interaction in a way that makes them more productive and adds a "wow" factor to your application.

OpenHaptics® Developer Edition enables software developers to add haptics and true 3D navigation to a broad range of applications including 3D design and modeling, medical, games, entertainment, visualization, and simulation. This haptics toolkit is patterned after the OpenGL® API making it familiar to graphics programmers and facilitating integration with OpenGL applications. Using the OpenHaptics toolkit, developers can leverage existing OpenGL code for specifying geometry and supplement it with OpenHaptics commands to simulate haptic material properties such as friction and stiffness. The extensible architecture enables developers to add functionality to support new types of shapes. It is also designed to integrate third-party libraries such as physics/dynamics and collision detection engines. The OpenHaptics toolkit supports the range of 3D Systems PHANTOM® devices, from the low-cost Touch 3D Stylus device to the larger PHANTOM Premium devices. The OpenHaptics toolkit supports Microsoft® Windows® 7 and 8, and Linux®.

```
// display method for "HelloHaptics" program
void display(void)
{
     hlBeginFrame();
     glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
     glColor3f(1.0,0.0,0.0);
     hlBeginShape(HL_SHAPE_DEPTH_BUFFER, myShapeId);
     glBegin(GL_POLYGON);
        glVertex3f(0.25, 0.25, 0.0);
        glVertex3f(0.75, 0.25, 0.0);
        glVertex3f(0.75, 0.75, 0.0);
        glVertex3f(0.25, 0.75, 0.0);
     glEnd();
     hlEndShape();
     glFlush();
     hlEndFrame();
 }
```

The OpenHaptics toolkit is easy for graphics programmers to learn and allows significant reuse of existing OpenGL code.

This toolkit includes the Haptic Device API (HDAPI), the Haptic Library API (HLAPI), utilities, PHANTOM Device Drivers (PDD), and source code examples. The HDAPI provides low-level access to the haptic device, enables haptics programmers to render forces directly, offers control over configuring the runtime behavior of the drivers, and provides convenient utility features and debugging aids. The HLAPI provides high level haptic rendering and is designed to be familiar to OpenGL API programmers. It allows significant reuse of existing OpenGL code and greatly simplifies synchronization of the haptics and graphics threads. The Device Drivers support all 3D Systems' Touch and Phantom haptic devices.



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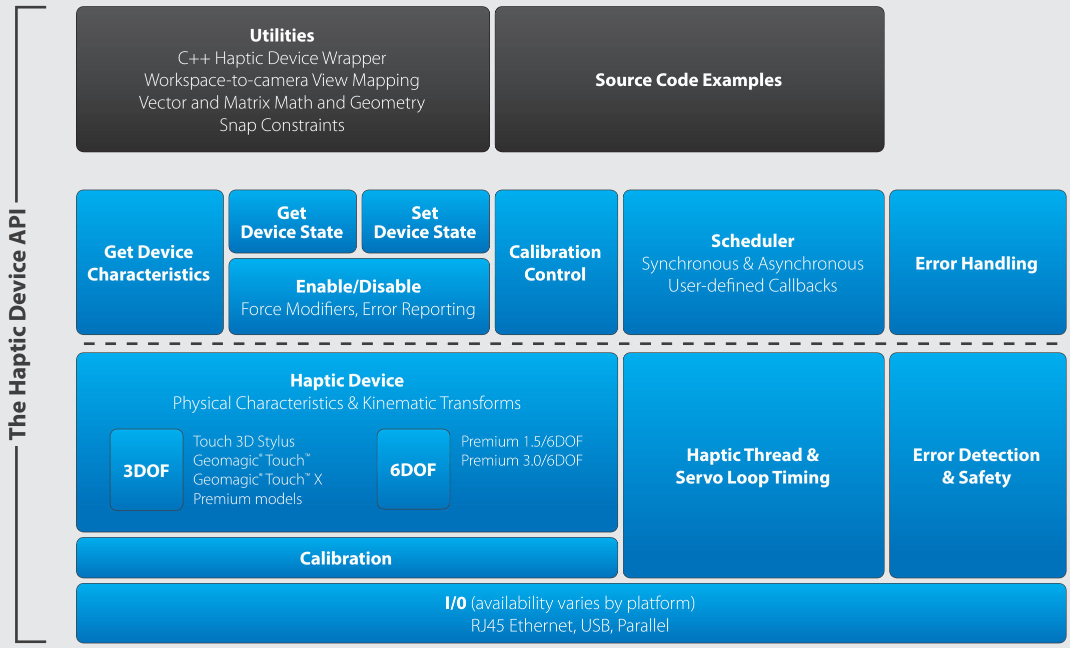


Key Features & Benefits

- Optimized interface to the 3D Systems haptic devices, including the low-cost Touch devices
- Architected to be extensible
- Software control over:
  - User-definable haptic servo loop for ideal performance
  - Error handling and safety limits for an optimal user experience
  - Scheduling user-defined callbacks within the haptic thread for maximum control over synchronization
  - Direct access to encoder values and control over motor DAC values for advanced programming
- Includes API, utilities, and source code examples

Haptic Device API Functionality

Get Device State
- Position, orientation, velocity
- 3 coordinate spaces: Cartesian, joint, raw data I/O (encoder/DAC)
- Buttons

Get Device Characteristics
- Model, version, serial number
- Workspace dimensions, I/O DOF
- Max stiffness, max force, max velocity, max torque, max torque stiffness
- Motor temperature
- Calibration capabilities

Set Device State
- Force/torque in Cartesian space
- Motor DAC
- LED status

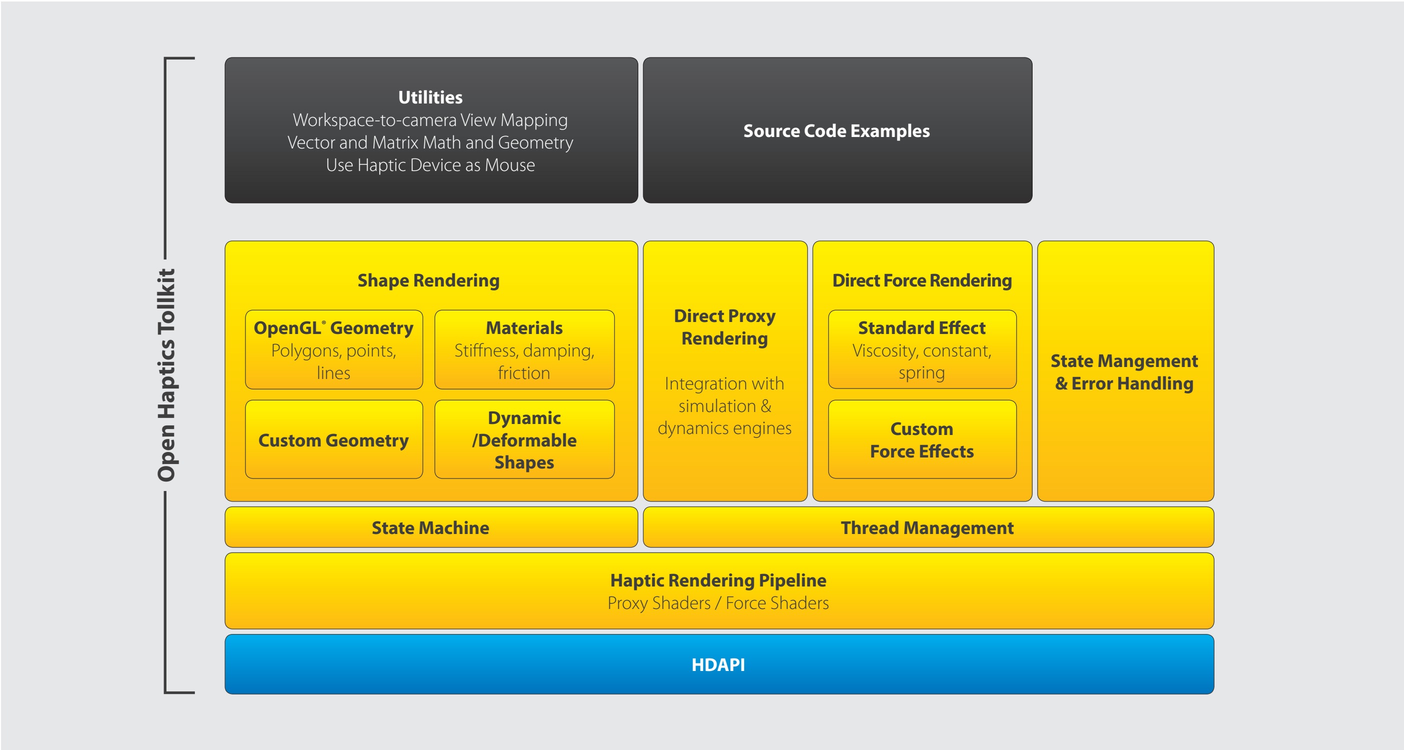
Scheduler
- Synchronous and asynchronous user-defined callbacks
- Customizable scheduling of callbacks
- Facilitates synchronization of the haptics and graphics threads
- User-definable haptic servo loop rate

Enable/Disable
- Force: output, clamping, ramping
- Error reporting
- Software checks: max force, max velocity
- Error Reporting and Handling
- Error categories, including:
  - Function
  - Force
  - Device
  - Haptic rendering
  - Scheduler
- Error stack

Device Calibration Interface
- Auto calibration
- Manual calibration

Utilities
- C++ haptic device wrapper
- Workspace-to-camera view mapping
- Vector and matrix math and geometry
- Snap constraints

The HLAPI provides high-level haptic rendering and is designed to be familiar to OpenGL API programmers. It allows significant reuse of existing OpenGL code and greatly simplifies synchronization of the haptics and graphics threads.



Key Features & Benefits

- Designed for programmers familiar with graphics and with no prior knowledge of haptics
- Enables reuse of existing OpenGL code for fast integration
- Designed to integrate third-party libraries such as physics/dynamics and collision detection engines
- Extensible and flexible architecture will enable future support of other graphics libraries such as Microsoft® DirectX®
- Support for polygonal meshes, tessellatedNURBS, and subdivision surfaces
- Includes API, utilities, and source code examples
- The QuickHaptics micro API enables rapid program design deployment. With QuickHaptics you can write a simple graphic/haptics application using 8 lines of programming code instead of 300.

Haptic Library API Functionality

Shapes
- OpenGL primitives (polygons, points, and lines)
- Custom/extension

Force Effects
- Constant (e.g. gravity)
- Viscosity, 3D friction
- Spring
- Custom/extension

Touch Model
- Single point
- Future support for multipoint
- Contact/constraint

Surface Material Properties
- Friction
- Stiffness and damping
- Front/back faces

Dynamics
- Capabilities for integration with third-party physics/dynamics and collision detection engines

Deformable Objects
- Capabilities for third-party integration

Events
- Windows
  - 2D Mouse
- Haptic device
  - Touch/untouch
  - Motion
  - Calibration

Programmer Productivity
- Dynamic changes for effects
- Push/pop attributes

The Broadest Range of 3D Systems® Haptic Devices & Toolkits for Haptic Application Development

Touch 3D Stylus

Geomagic® Touch™

Geomagic® Touch™ X

Pantom Premium 1.5/6DOF & 1.5 High Force/6DOF

Phantom Premium 3.0/6DOF

Haptic Devices

The 3D Systems product line of haptic devices enables users to touch and manipulate virtual objects. Different models in this industry-leading product line meet the varying needs of commercial software developers, academic and commercial researchers, and product designers. The PHANTOM Premium models are high-precision instruments and, within the PHANTOM product line, provide the largest workspaces and highest forces, and some offer 6 degrees of freedom (6DOF) output capabilities. The Geomagic Touch and TouchX devices offer affordable desktop solutions.

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About 3D Systems

3D Systems is a leading provider of 3D content-to-print solutions including 3D printers, print materials and on-demand custom parts services for professionals and consumers alike. The company also provides CAD, reverse engineering and inspection software tools and consumer 3D printers, apps and services. Its expertly integrated solutions replace and complement traditional methods and reduce the time and cost of designing new products by printing real parts directly from digital input. These solutions are used to rapidly design, create, communicate, prototype or produce real parts, empowering customers to create and make with confidence.