Multi-Touch Ring Encoder Software Development Kit User's Guide

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Grayhill

Contents

Introduction

What's in this Guide?

Welcome to the Grayhill Multi-Touch Ring Encoder (MTRE) Software Development Kit User's Guide. We'll first get your encoder up and running with a demo so you can quickly begin to appreciate the MTRE's many features and capabilities. Next we'll dive in deeper into the MTRE operation. Lastly, we'll introduce **Grayhill's Instinct Gesture Recognition Library** that makes product development a snap. **Let's get started!**

What's in the Kit?

The Multi-Touch Ring Encoder Software Development Kit contains a Quick Start Guide, and (1) Grayhill Multi-Touch Ring Encoder (Part number:T101-5C3-111-M0) mounted in a case, with a USB cable ready to plug into your type "A" USB host connector on your hub or PC.

Multi-Touch Ring Encoder Features

The Grayhill Multi-Touch Ring Encoder has the following features:

- **A 50mm round projected capacitive touchpad, that can track up to 5 touch positions**

- **A rotating knob - detented with three different torque options, and encoded for 32 or 48 positions**

- **Integral pushbutton**

- **Proximity sensor**

- **Overlay, with custom logo capabilities, backlit with 256 level adjustable brightness settings**

- **Highlight ring, backlit with 256 level adjustable brightness settings**

- **Interface connectors – (1) USB signaling , (1) redundant encoder (quadrature) and pushbutton I/O**

Multi-Touch Ring Encoder Medical Demo

Downloading the Medical Demo

The Medical Demo is a Windows XP, Windows 7, or Windows 8 application that will introduce you to some of the basic features of the MTRE. The Demo is a simulation of some of the functions that may be required in a typical imaging application. To load and run the demo, follow these steps:

Plug in the USB cable into any convenient USB port on your PC. Your computer should automatically recognize the device without any special drivers.

Next find the Grayhill Instinct Demo application at
http://www.grayhill.com/instinct

For users of Google's Chrome Browser

Click on the link "Grayhill Instinct Demo (zip)"

When the download is complete, click on the file "Grayhill Instinct Demo.zip" that appears in the download area at the bottom of the screen.

Follow the instructions of your zip file extraction tool to extract and locate the files on your PC where it can be easily found.

For users of Mozilla's Firefox Browser

Click on the link "Grayhill Instinct Demo (zip)"

The browser should open a popup box. Under "What should Firefox do with this file?" select your zip file extraction tool under "Open with."

Follow the instructions of your zip file extraction tool to extract and locate the files on your PC where it can be easily found.

For users of Microsoft Internet Explorer

Click on the link "Grayhill Instinct Demo (zip)"

The browser should open a pop up box. Under "Do you want to open or save this file?" select "Open." Under certain settings this step may be skipped.

Follow the instructions of your zip file extraction tool to extract and locate the files on your PC where it can be easily found.

Installing the Demo

To install the demo, navigate to the directory on your system where the application files were extracted and run "setup.exe." Follow the on screen instructions to install the application. An internet connection is required.

Running the Demo

To run the demo, click on the application icon on your desktop. The connect screen should appear as below:

Make sure the USB connector from the MTRE SDK is plugged into the PC's USB port. After the MTRE is found, the type (MTRE) and serial number will be listed in the connection list next to a check box under the "CONNECT?" heading. Click on the check box to connect the MTRE. If multiple devices are connected to the PC, they will also appear in the list. Click on the check box for all the devices you wish to connect, or alternately click on the "CONNECT?" header to connect to all Grayhill devices currently connected to the PC. When the application connects to any type of device, the picture of the device will be highlighted on the following page:
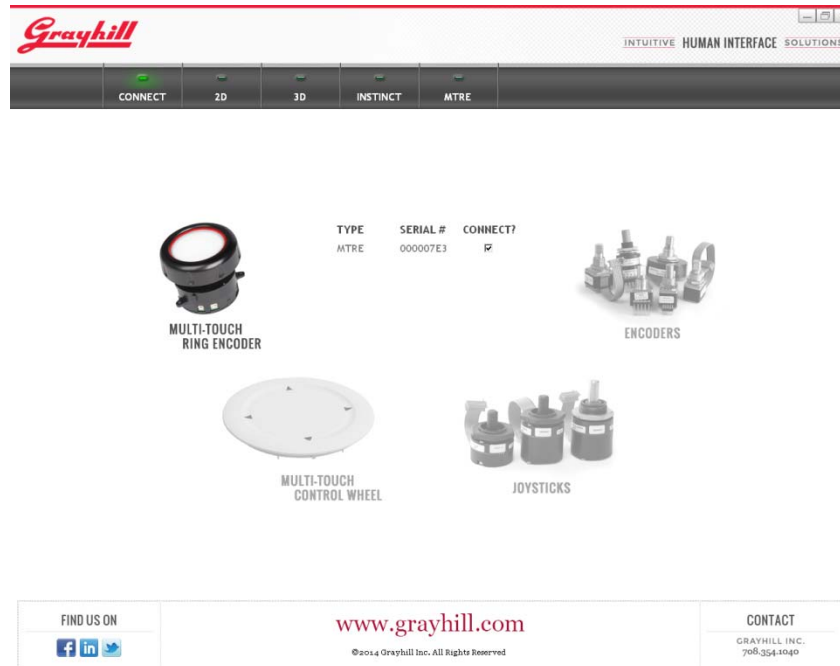
Demo Screens

When only MTRE devices are connected, five buttons will appear across the top of the screen:

- **CONNECT** – Allows editing of the connection list

- **2D** – Demo of 2D picture control application

- **3D** – Demo of 3D object control application

- **INSTINCT** - Demo of the Instinct Gesture Recognition Library

- **MTRE** – Demo of functions specific to the MTRE

To select any of the screens above, use your mouse to click on the button corresponding to the desired function.
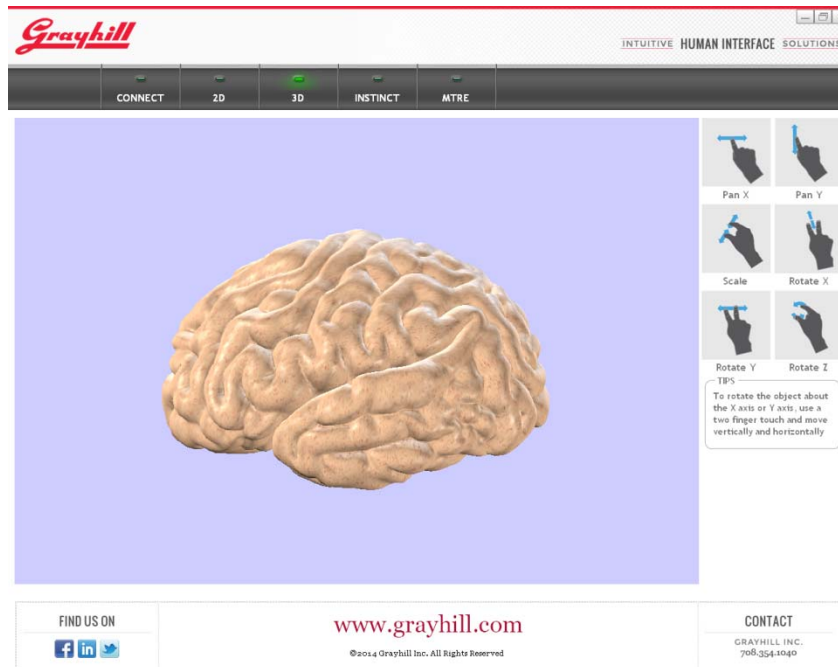
2D Demo

The 2D demo screen is an example application that illustrates how easy it is to position and size an image for viewing using the MTRE. Use a single finger (or two fingers) on the touchpad to pan the image in the X or Y direction. Use two fingers in a pinching or un-pinching motion to control the zoom level. Spin two fingers about each other to rotate the image.

In this example application, any of these gestures can be performed simultaneously to quickly and efficiently position the image. If the fingers are released from the touchscreen during a gesture, the object will continue the gesture's movement with virtual momentum. This is a more efficient method of positioning especially when large images are used.

Also in this example, a different picture can be selected by flipping a single finger to the left or right as if turning a page.

All of the gestures shown on the 2D screen application example can be easily configured and recognized using the Instinct Gesture Recognition Library. The gestures implemented and corresponding actions are only an example of a typical 2D image application. The library is very flexible and allows many different configurations for many different applications. The Instinct Gesture Recognition Library is available license-free for Grayhill customers. For further information about Instinct, please refer to **"Grayhill's Instinct Gesture Recognition Library"** section at the end of this document.

3D Demo

The 3D demo screen is an example application that illustrates how easy it is to position and size an object for viewing using the MTRE. Use a single finger on the touchpad to pan the object in either the X or Y direction. Drop a second finger to rotate the object about the opposite axis. Use two fingers in a pinching or un-pinching motion to move the object in the Z axis (toward or away from the screen.) Spin two fingers about each other to rotate the image in the z plane. In fact, using these simple gestures, all six degrees of freedom of movement can be resolved.

Gestures that use the same number of fingers can be performed simultaneously to quickly and efficiently position the object where it is desired. Again, as in the 2D example, if the fingers are released from the touchscreen during a gesture, the object will continue the gesture's movement with virtual momentum.

All of the gestures shown on the 2D screen application example can be easily configured and recognized using the Instinct Gesture Recognition Library. The gestures implemented and corresponding actions are only an example of a typical 2D image application. The library is very flexible and allows many different configurations for a variety of applications. The Instinct Gesture Recognition Library is available license-free for Grayhill customers. For further information about Instinct, please refer to "**Grayhill's Instinct Gesture Recognition Library**" section at the end of this document.

Instinct Demo

The Instinct Page demonstrates the Instinct Gesture Recognition process by allowing the user to change some of the settings that control how gestures are recognized - and then allowing the user to observe how these changes affect the output. After changing one of the settings, hit the "Apply Changes" button to try out the new settings. Default settings can easily be recovered by hitting the "Reset Defaults" button. The current settings are retained for use with any of the other demo screens.

You can enable or disable any of the Event Gestures in Instinct through a simple bit mask. Setting the check boxes next to the Event Gestures assembles the bit mask and sets up Instinct to recognize only the checked gestures. For more information on Event Gestures see the "Instinct Introduction" section at the end of this document.

The Instinct page lists *some* of the Instinct parameters that can be used to optimize the Gesture recognition process for a particular application. Not all the settings are listed here, but they are a good example of some of the settings available.

- The Down Delay is the time in 20mS intervals before the specific number of current touches are declared down. This delay helps eliminate "false positives" during transitional periods, i.e. when the desired number of fingers is not yet in contact with the touch pad.

- The Max Tap Duration is the maximum number of 20mS intervals that a given number of fingers can be "down" in order for the "TAP" event to be reported.

- The Double Tap Delay is the minimum number of 20mS intervals required in between taps before a "DOUBLE TAP" event is reported.

- The Minimum Touch & Hold Duration is the number of 20mS intervals that a given number of fingers must be "down" in order for the "TOUCH & HOLD" event to be reported.

- The Momentum Decay is the decay factor applied to motion data between subsequent 20mS intervals when momentum is active and no touches are down.

- The Swipe Minimum Move controls the sensitivity of the swipe detection.

- Moving Average Window Size is the number of data samples used for smoothing.

- Rotary Slow Start is the number of rotary counts that are ignored before rotary counts get reported after a direction change or at the beginning of the rotary gesture. This setting is disabled for the MTRE.

- Rotary Resolution is the number of rotary counts reported per full revolution for a single finger sliding around the outside of the touch screen. This setting is disabled for the MTRE.

MTRE Demo

The MTRE page allows interaction with the features exclusive to the MTRE. If a finger or fingers are placed on the touchscreen, while in touch mode, its movements will be tracked in the circular area on the left hand side of the screen.

To demonstrate the push button function, the indicator under the heading "PUSH BUTTON" illuminates when the MTRE push button is activated.

To demonstrate the encoder function, turning the MTRE knob clockwise causes the counter under the heading "ENCODER COUNTS" to increment, while turning it counter-clockwise causes it to decrement.

To demonstrate the brightness control function, the slider bars under the headings "Backlight Intensity" and "Highlight Intensity" can be used to control the brightness of the backlight and highlight rings respectively.

The MTRE can be placed in proximity mode by selecting the "PROXIMITY MODE" option button. To demonstrate the proximity mode function, the circular area where the touch movements are tracked will turn green when proximity is detected. To return to touch tracking, select the "TOUCH MODE" option button.

Multi-Touch Ring Encoder Overview

We've demonstrated some of the functions of the MTRE with a simple demo application - but we've only scratched the surface of its possibilities. While the demo can show some examples of the ways the MTRE can be used, it cannot match your imagination of how it might be used. In this section we'll cover the technical details of the MTRE so that you can appreciate its flexibility.

Mechanical Drawing

The mechanical layout of the MTRE is shown below. The knob is removable but the number of times it can be engaged is limited. For this reason, the knob should not be removed by users in the field but should be installed one time during manufacturing.
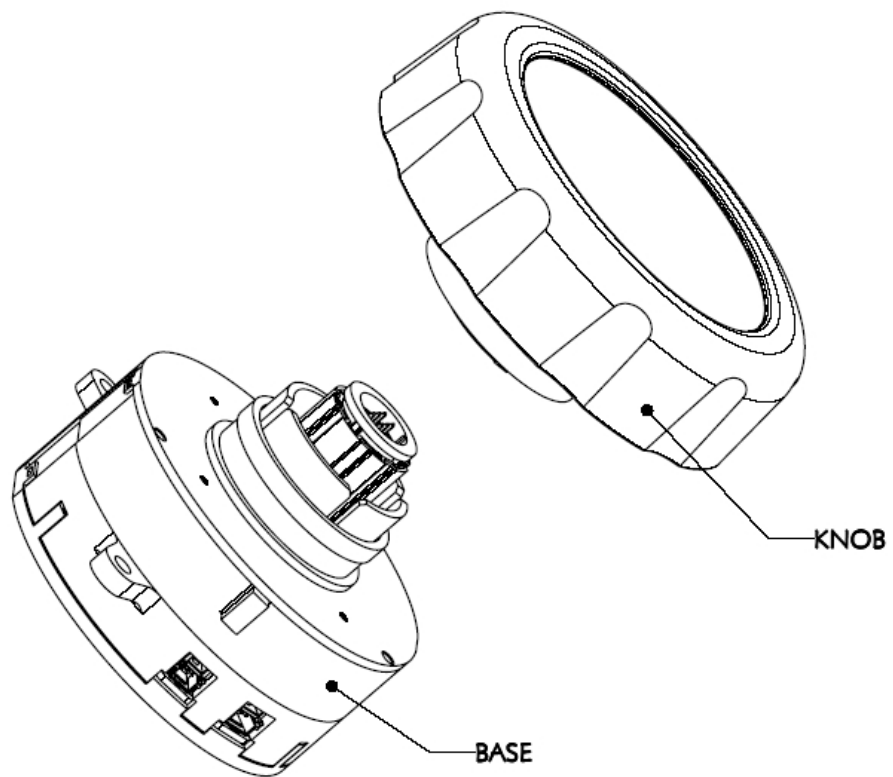
For the discussion of the components of the MTRE see the block diagram of the MTRE shown below:

Knob Section

Touchscreen

Touchscreen Controller

Proximity Sensor

LED Controller

Stem

Encoder Section

Emitter

Detector

Base Section

Power

Switching Power Supply

Push-button

Quadrature Push-button

USB

Microcontroller
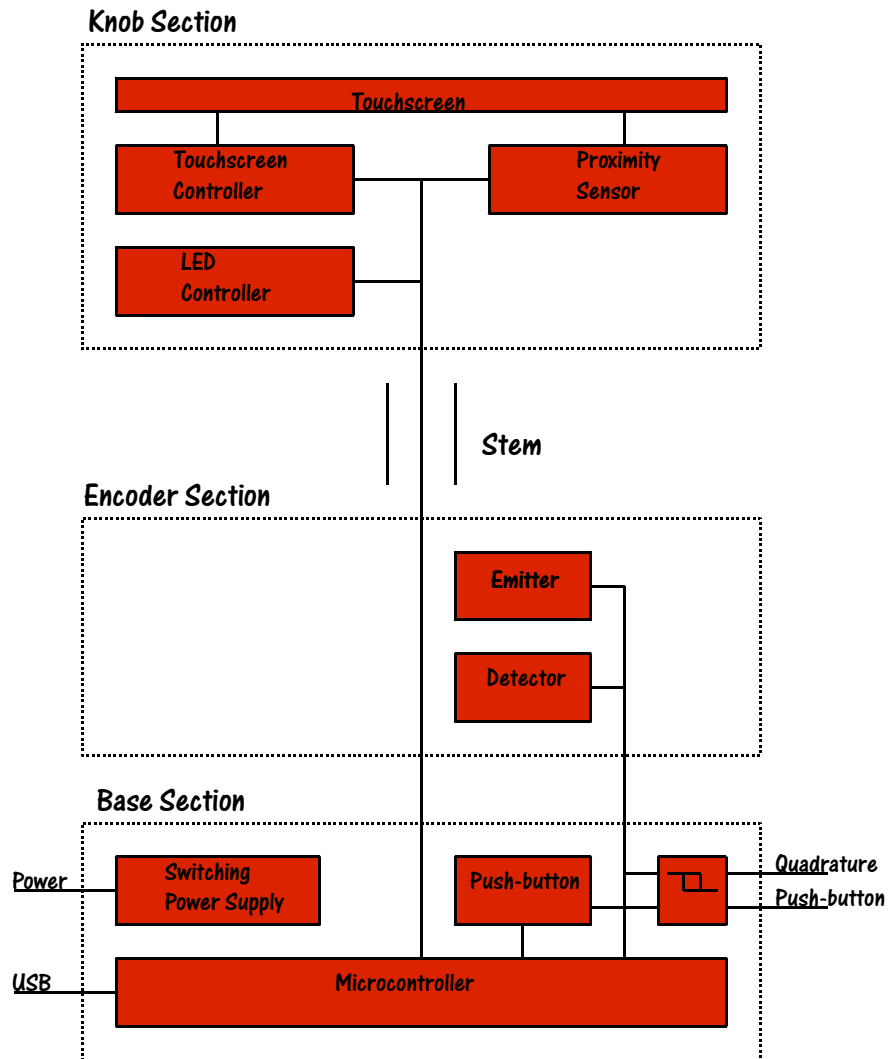
USB – I/O Interface

The MTRE has a full speed USB device interface. Data that is transmitted from the MTRE to the host includes the following: the raw touch positions, proximity status, encoder (outer ring) changes, and pushbutton status. Data can be sent to the MTRE to set the current touchpad/proximity mode, or change the backlight or highlight on - off or control the brightness.

In addition to the USB connector, a redundant output is provided that contains the quadrature output I/O from the encoder and the pushbutton status.

Touchpad

The touchpad built into the MTRE uses the mutual projected capacitive method to track up to 5 touch positions simultaneously with a 20mS sample rate. Some features of the touchpad are listed below:

- As each individual touch is sensed, the touch is assigned the lowest number available from 0 to 4 for reporting.

- The touch is tracked under this number until it has been released.

- The screen has an overall resolution of 1280 x 1280, although because of the round shape, not all of these positions are utilized.

- No gesture recognition is provided in the MTRE, but "Instinct" - Grayhill's gesture recognition library, is available to our customers and will be introduced later in this guide.

- Two-touch differentiation can be sensed down to about 3mm.

- Touch sensing will work with latex gloves.

- The MTRE can be set to either Touch or Proximity mode, but they cannot be used simultaneously.

Ring Encoder

An encoder is connected to the outer ring, which in turn drives the I/O outputs and also is connected to the internal controller for assembly into USB packets. The encoder provides relative (not absolute) position of the outer ring. The USB packet contains the number of counts (up or down) since the last time the MTRE was polled (20ms sample rate.) The I/O connector provides the output directly from the encoder in quadrature format as shown below:
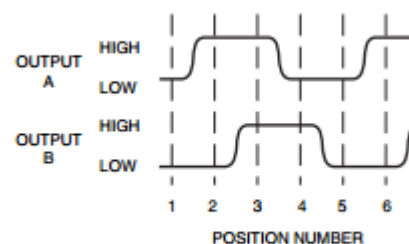
The ring encoder is available in 32 or 48 positions with 3 different torque options. The ring encoder functions in either the touch or proximity mode.

Pushbutton

The pushbutton make and break information is available on the USB and as a redundant I/O. The I/O is "low" whenever the pushbutton is active and

"high" when inactive. The pushbutton functions in either the touch or proximity mode.

Proximity

The device has two modes of operation: touchpad, and proximity. The device is set to proximity mode by command over the USB. In Proximity Mode the device sends make and break codes over the USB corresponding to the current status of the proximity sensor.   Proximity is detected using the mutual projected capacitance method.

Backlight

There are four lighting elements that make up the backlight. Each element can be individually set to on or off. Additionally the four elements together (with a single setting) may be set to one of 256 different brightness levels. In the sample unit provided with the SDK, the backlight has a Grayhill logo, but the standard device has a solid white backlight. Custom logo printing is available for the MTRE.

Highlight Ring

There are 12 lighting elements that make up the highlight ring. Each element can be individually set to on or off. Additionally the twelve elements together (with a single setting) may be set to one of 256 different brightness levels. The highlight ring comes in four different colors: white, blue, red, or green. Custom colors are also available.

Additional Information

Please visit http://www.grayhill.com/instinct for updates to this document, updates and releases of demos, updates to unit firmware and settings files, Errata, and other application notes.

Documentation for the USB data input and output format is available to our customers with a signed Non-Disclosure Agreement. To request a form please email Grayhill at instinct@grayhill.com.

Grayhill's Instinct Gesture Recognition Library

What is Instinct?

Welcome to the Grayhill Instinct Software Developer's Guide. Instinct is Grayhill's Gesture Recognition Software Library for Grayhill Touch Devices that makes developing applications using touch gestures a snap. Instinct uses proven and tested recognition algorithms to accurately track and detect single and multi-touch gestures. The Grayhill Instinct Gesture Recognition

Software Library is a C source code library – which is intended to be included and built into your application. Simple initialization calls allow the flexible setup of parameters to fine-tune the recognition process for your application. During normal operation, data from the Grayhill touch device is passed directly to the library. The data is quickly processed and the results are passed back to your application.

What makes the Grayhill Instinct Gesture Recognition Library unique?

When we looked at Human/Machine interface we found two basic, but powerful types of gestures useful for machine control – we call them **Event Gestures** and **Tracking Gestures**.

Event Gestures

An Event Gesture is defined as any gesture that is performed and recognized as a singular event and that might be used to initiate immediate state changes in the host. The following are examples of event gestures: Tap, Double-Tap, Touch&Hold, Tap,Touch&Hold, Swipe etc. Note that these events don't require any magnitude information - they are simply recognized as the user performs them as single events. These types of events have a long history in user interface. A mouse click or a key press, for example, can both can be thought of as an event.

However, since a touch panel has many more dimensions than a simple pushbutton, these event gestures can be far more complex and powerful. For example, Instinct has the ability to detect event gestures involving from one to five touch points. Instinct can also recognize single-finger gesture events in certain user-configurable circular areas, called "Icons".

If the user taps within the area of Icon1, for example, a Tap event and an Icon1 event is generated. By default, Icon1 through Icon4 are located in the top, bottom, left and right corners of the screen. All other Icons are undefined by default but can be enabled easily by using GestureConfigure.

The Tap,Touch&Hold event gesture is a combination of the Double-Tap and Touch&Hold gestures. During a Tap,Touch&Hold, the second contact with the screen is held longer than during a Double-Tap. One way a Tap,Touch&Hold gesture event might be used is to initiate an object drag across the screen.

The Swipe gesture event is recognized when any given number of touches leaves the touch screen with a specified velocity. The directional gesture events Up, Down, Left, Right are used in combination with Swipe to indicate in which direction the Swipe was performed. One way a Swipe gesture event might be used is to initiate an advance to the next screen (Swipe Left) or a return to the previous screen (Swipe Right).

The following Event Gestures are recognized by Instinct:

- Tap (1-5 fingers)

- Double-Tap (1-5 fingers)

- Touch&Hold (1-5 fingers)

- Tap,Touch&Hold (1-5 fingers)

- Swipe Up (1-5 fingers)

- Swipe Down (1-5 fingers)

- Swipe Left (1-5 fingers)

- Swipe Right (1-5 fingers)

- Icon1 through Icon16* (1 finger only)

*(These events can only be recognized in combination with a single-finger Tap, Double-Tap, Touch&Hold or Tap,Touch&Hold event.)

Tracking Gestures

A Tracking Gesture is not recognized as a single event, but rather, is reported as a continuous stream of control data for as long as the user performs the gesture. Tracking Gestures are very useful for viewing and positioning 2-D and 3-D objects or images, or positioning the view in a field of text. Pan, Zoom, Rotate and Scroll are examples of Tracking Gestures. Note that these gestures need not be exclusive (they can all occur simultaneously) and magnitude and direction information is very important in providing the most intuitive experience.

The Instinct library can be set to provide tracking data optimized for controlling/ positioning either 2-D or 3-D objects. Additionally, the 2-D or 3-D tracking data can be reported either in "*relative*" mode or in "*threshold*" mode. The relative mode reports the changes in normalized tracking data since the last report received from the device. In threshold mode, Instinct keeps an internal cumulative value of the relative data, but then reports the number of times this cumulative value is evenly divisible by the specified threshold value. The internal cumulative value then gets reduced by the reported multiple of the threshold value.

In the 2-D modes (relative and threshold), Instinct provides the following tracking data:

- **X** - *average movement of one to five touch positions along the x-axis*

- **Y** - *average movement of one to five touch positions along the y-axis*

- **Scale** - *average change of scale indicated by the relative expansion (un-pinch) or contraction (pinch) of one to three touch positions*

- **Angle -** *average rotation angle of one to three touch positions about a point determined by the number of touches*

In order to provide the maximum flexibility, Instinct provides full tracking data for up to three touches. For example; using only the X and Y data:

- A mouse cursor could be moved when only one touch is present

- An underlying picture could be panned if two touches are used

- The entire picture album could be re-positioned, or a different one selected, if three touches are used

In this case, the developer simply qualifies the X and Y position data, with the number of touches, and sends the data to the proper function. Although some gesture / number of touch combinations are well known, (such as *two*-finger "pinch" to control zoom) Instinct gives the flexibility to add many more dimensions.

In the 3-D modes (relative and threshold), Instinct provides six parameters corresponding to the six degrees of freedom of movement of any object in space.

- **X** - *average movement of one to five touch positions along the x-axis*

- **Y** - *average movement of one to five touch positions along the y-axis*

- **Z** - *corresponding movement in the z-axis (toward or away from the user) by relative expansion (un-pinch) or contraction (pinch) of from one to three touch positions*

- **X Angle -** *rotation angle around the x-axis that would correspond to an average movement of one to five touch positions along the y-axis*

- **Y Angle -** *rotation angle around the y-axis that would correspond to an average movement of one to five touch positions along the x-axis*

- **Z Angle -** *rotation angle about the z-axis of one to three touch positions, about a point determined by the number of touches*

In 3-D modes, as in 2-D modes, the developer has flexibility to qualify the tracking data with the number of touches desired for a particular gesture. For example; moving fingers along the x-axis produces both **X** data, (panning along the x-axis) and **Y Angle** data (rolling an object about the y-axis.)   The developer may decide that two fingers should be used to perform a pan along the x-axis and three fingers will be used to rotate about the y axis. It is then only a matter of applying the **X** data when two touch positions are indicated and **Y Angle** data when three occur.

Additional Information

The Grayhill Instinct Gesture Recognition Library is available to our customers with a signed Non-Disclosure Agreement. To request a form please contact Grayhill at instinct@grayhill.com.