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Interactivity: Using Expressy to Demonstrate Expressiveness in Touch-based Interactions

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Abstract
We present an interactivity demonstration of Expressy. A system that augments existing touchscreen devices with a variety of continuous expressive interaction capabilities, using movement data from a wrist-worn IMU. Our demonstration comprises a set of applications that show how the expressive touch interaction capabilities, offered by Expressy, can enable intuitive and meaningful interactions, in contexts including productivity, entertainment and lifestyle apps. This demo submission accompanies a full paper, describing a conceptual model of expressive touch interaction and the implementation and evaluation of Expressy.

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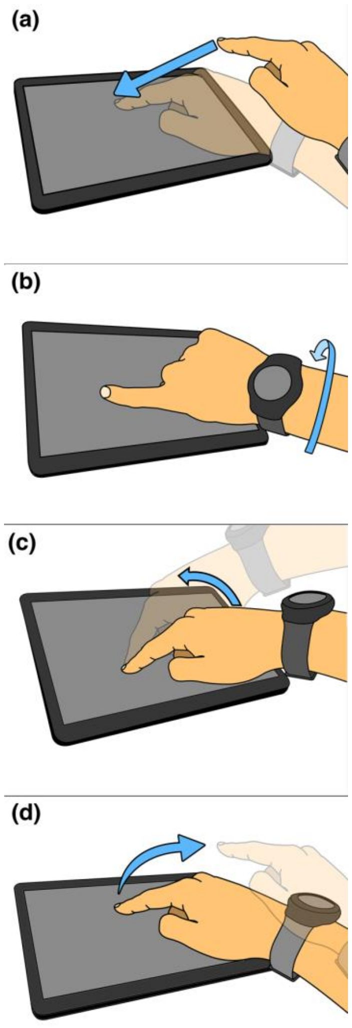
Expressy
Touch devices offer opportunities for natural and intuitive interaction across a wide range of application scenarios. However, most mainstream touch-based devices confine users' interactions to a small number of degrees of freedom (i.e. the location and duration of touches). This basic set of information about touches has been used to support a wide range of interactions that extend upon those offered by a traditional mouse and keyboard. However, it can prove to be insufficient to enable users to express the intent and richness of their actions, especially in skilled contexts.



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Force, (b) Roll, (c) Pitch, (d) Flick Force

Expressy [7] is a system that adds expressiveness to touch-based interactions. Using a wrist-worn IMU we can track previously inaccessible information about the movement of the hand before, during and after touch interactions. Expressy combines this information with data about the location and duration of touches (provided by standard touch hardware) to enable a variety of continuous expressive interaction capabilities.

In this demo, we present a range of applications demonstrating expressiveness applied to touch-based interactions. We focus on enhancing the richness and complexity of touch interaction by tracking features of the hand including instantaneous force, wrist roll and patch. In doing so, we enable a range of expressive interaction capabilities for skilled contexts like musical performance, drawing and gaming; in addition to alternative ways to interact with common user interface controls.

Implementation

Expressy tracks the following information about the movement of the hand during touch interactions: instantaneous force, roll and pitch changes.

Hardware Implementation

In our demonstration applications we primarily use the Open Movement WAX9 IMU platform [5], the sensor is used in a wrist strap and streams accelerometer and gyroscope data via Bluetooth to the client device at 50Hz. These sensors enable the state of a users wrist to be modeled. We have also developed Microsoft Band [4] support to demonstrate how Expressy can be used with other hardware platforms.

Software Implementation

Using the sensor data provided by the wrist-worn IMU we calculate an estimation of the orientation of the hand using Madgwick's sensor fusion algorithm [2]. This provides a quaternion, denoting the current orientation. We use this to determine roll and pitch changes about the wrist as well as estimation of gravity to provide true acceleration of the wrist with gravity removed. The Expressy software implementation was developed for the iOS 9 SDK.

Please refer to Expressy paper for further technical details [7].

Demo Applications

In this interactivity demo submission, we provide a number of sample applications to demonstrate Expressy and how these interactions can be applied to a broad range of usage scenarios. Our focus is on scenarios where Expressy could offer users capabilities that could not be easily or swiftly accomplished using an alternative sequence of discrete touch interactions.

Painting

The qualities afforded to a painter through their manipulation of a brush stroke is an aspect of painting which is difficult to replicate in touch interactions. The complexity and expressiveness behind touch interactions cannot be easily tracked due to the limited degrees of freedom offered by touch devices. Current applications have addressed this issue by offering traditional user interface controls to adjust these qualities manually [6]. This restricts the painter to performing adjustments before the interaction, thus limiting the expressiveness in the resultant interaction.

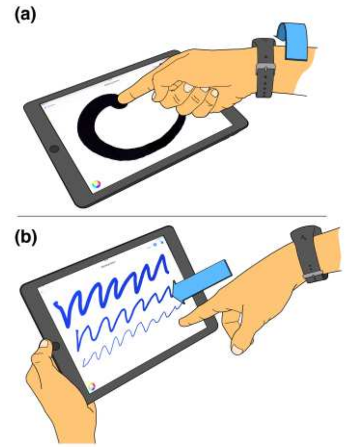

Figure 2. Painting demo: (a) Roll enriches touch interaction through stroke width, (b) Tap Force determines initial stroke width.

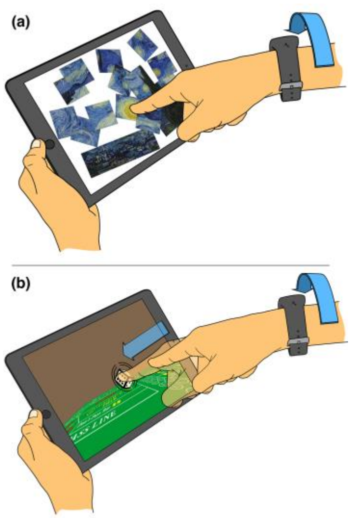

Figure 3. (a) Wrist roll rotates puzzle pieces during touch. (b) Tap force determines dice throw. Wrist roll after interaction manipulates dice roll.

Expressy allows users to continuously control qualities of the stroke during the interaction.

Our painting application demonstrates how Expressy can replicate aspects of the expressive interaction experienced by a traditional painter on a touch device. The user expresses an intention to create a flicked brush stroke on touch by striking the screen softly, and then further enriches the touch interaction by rolling their hand, continuously adjusting stroke width. Finally, as the user ends a stroke we provide a follow-up interaction where flicking off the screen produces a flicked stroke and lifting gently does not.

Image and Jigsaw Puzzle Piece Rotation
The rotation of elements on multi-touch surfaces is often achieved by using a two-finger gesture. This gesture becomes difficult when the size of the selected element is small. Expressy allows elements to be rotated by rolling the wrist. This interaction benefits from placing the center of rotation at the touch position, and that changes in angle of the element match the change in roll of the wrist i.e. turning the wrist through 90 degrees will turn the selected element by a right angle.

Dice Roll Game
The action of rolling a dice in touch interaction games is often suggested rather than simulated. For example, touching the screen once can spin an animated dice before a second touch reveals how it landed. Expressy can simulate a dice throw where the touch force controls how hard the dice was thrown. In addition, spin can be imparted to the dice by using the rotation of the wrist. In this demonstration we illustrate this interaction with rigid body physics. The simulation uses the touch force and angular velocity of the wrist to influence our rigid body dice model.

Maps
Traditional manipulation of a 3D map view often requires awkward and unintuitive multi-touch gestures to pitch and rotate the view. Expressy demonstrates how we can enrich touch interaction and enable the pitching and rotating of a 3D map view, simply by pitching and rolling the wrist. As the user pitches their wrist, the camera angle pitches and as the user rolls their hand the camera heading changes.

Drums and Piano
Development of musical instrument applications for touch-based devices has long been considered a challenge [1]. Simple touch interactions fail to provide the required complexity to interact with a virtual musical instrument. Using Expressy, we can detect the force with which a drum and piano are struck, adjusting the volume of the sound based upon this information.

Video Scrubbing
Control offered by scrubbing through a video is a task that is limited based upon the size of the screen and the length of the video, as highlighted by Matejka et al. [3]. Expressy enables fine control over video position by allowing users to step through a video frame by frame by rolling their wrist. Users can slide to the rough position in the video, then step forwards or backwards by rolling their wrist clockwise or anti-clockwise respectively.

Scrolling
Scrolling through large documents and web pages with kinetic scrolling can be a fatiguing and tedious

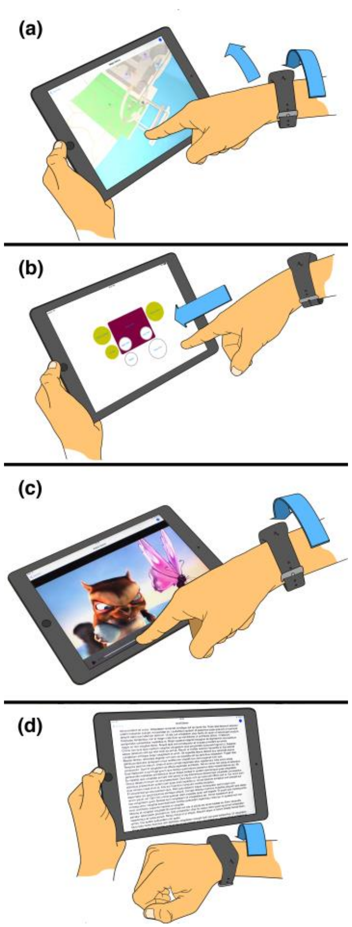

Figure 4. Demo applications: (a) Maps, (b) Drums, (c) Video Scrubbing, (d) Scroll

interaction. Expressy allows users to follow-up their interaction, initiating a scroll direction we can then use changes in the roll of the wrist like a throttle. Rolling the wrist in the direction opposite to travel speeds up the scroll, rolling the other way slows the scroll to an eventual halt. Users can continue until they reach the desired point.

Multi-Use Widgets

Efficient usage of screen real estate is an important consideration when developing interfaces for mobile devices. Reduction in the size of certain controls, such as sliders, often results in loss of fine-grained control. This often results in the use of controls, such as steppers, which provide the required control on small displays at the expense of speed. Using Expressy we present examples of controls that provide fine and wide-ranging control. A radial dial as a contact point which can be adjusted by wrist roll during touch provides quick and accurate control over settings which previously would have required large sliders or slow stepping controls.

Summary

In this interactivity demonstration we will show a range of applications that illustrate the expanded expressive interactions capabilities made possible by Expressy [7].

Acknowledgements

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