

[0017] An implementation of a haptic profiling system is schematically illustrated in **FIG. 2**. Haptic profiling system **100** includes a characterization module **120** that is configured to receive data associated with operational characteristics of a mechanical device **130**. The operational characteristics of the mechanical device **130** are associated with a perceptual experience of the mechanical device **130**.

[0018] The perceptual experience of mechanical device **130** is associated with the output (e.g., tactile output, audio output and/or visual output) of the mechanical device **130** as experienced by a user of the device or someone, not necessarily a user, in proximity of the mechanical device **130**. The perceptual experience may be different for each user of the mechanical device **130**. Additionally, the perceptual experience of the mechanical device **130** may vary over time and may vary based on operating conditions and operational modes of the mechanical device **130** as will be described in detail below.

[0019] The characterization module **120** includes characterization application software **122** and characterization hardware **124**. The characterization application software **122** and characterization hardware **124** produce information to characterize the perceptual experience of the mechanical device **130** based on measurements of the mechanical device.

[0020] The characterization hardware **124** includes a sensor **125** and a motor **128**. Sensor **125** outputs a measurement signal associated with the operational characteristics of mechanical device **130**. When used to measure a mechanical device **130** having a rotary feature, such as a rotary switch, the motor **128** rotates the switch at given speeds and the sensor **125** samples, for example, angular positions. The raw data is output to the characterization application software **122**. The characterization application software **122** generates data that substantially matches the operational characteristics of the mechanical device **130**.

[0021] A conversion module **140** is coupled to the characterization module **120**. The conversion module **140** receives the raw data and automatically produces a parametric data set associated with the mechanical device **130**. The conversion module **140** generates the parametric data set based on a parametric analysis of the mechanical device **130**. Parametric analysis is a design-optimization feature that allows the use of variables, rather than static values for specifying design parameters. For example, multiple dynamic measurements of the mechanical device are taken rather than snapshots of static measurements. The parametric data set removes some of the subjective nature from the process of evaluation of a representation of a mechanical device **130**.

[0022] The operational characteristics associated with the perceptual experience of mechanical device **130** and the resulting parametric data set can be used to communicate to a haptic device **160** a signal configured to cause the haptic device **160** to output in a manner that corresponds to the desired perceptual experience. The output of the haptic device **160**, for example, can be experienced by suppliers to evaluate prototype mechanical devices against initial specifications (i.e., as a comparison) to improve consistency of mechanical devices amongst multiple suppliers and to understand performance of switches within a user environment (e.g., a vehicle cockpit).

[0023] The parametric data set contains a set of metrics that quantify the reproduction of the feel or experience of mechanical device **130**. The conversion module **140** can automatically produce the parametric data set without user intervention. In other words, measurements of the mechanical device **130** are taken and a signal associated with the operational characteristics is output in the form of a parametric data set substantially without human intervention. In other embodiments, the parametric data set can be created based on minimal user intervention. For example, user intervention may be required to initiate the generation of the parametric data set or complete the creation of the parametric data set.

[0024] The data associated with the plurality of operational characteristics of the mechanical device **130** can be analog data and/or digital data such as, for example, data indicative of a force profile, a peak force, a dead band parameter, a friction parameter, a symmetry parameter, a click location, a velocity dependence, a torque profile, a detent, a spring return, an audio parameter and other similar profiles. The data associated with the plurality of operational characteristics of the mechanical device **130** can also include, for example, audio data indicative of audio quality. The mechanical device **130** can be, for example, a knob or a switch, a trackball, a pushbutton, etc.

[0025] A controller **170** is in communication with the conversion module **140** and is configured to send a signal to haptic device **160** based on the parametric data set associated with the mechanical device **130**. The signal is operative to output a haptic effect and/or an audio effect from the haptic device **160**.

[0026] In some embodiments, a memory component **180** is in communication with the conversion module **140**. The memory component **180** is configured to store the parametric data set associated with the mechanical device **130** in a library **185** having multiple parametric data sets. Each one of the parametric data sets are uniquely associated with a separate mechanical device. In addition, other parametric data sets not associated with a specific mechanical device can also be stored in the library **185**. Such parametric data sets can be, for example, parametric data sets customized through user interaction described below in connection with design module **150**.

[0027] The parametric data sets stored in the library **185** can be retrieved after they have been stored. To simplify the retrieval process, each parametric data set can be assigned various identifiers such as a unique name for the particular data set, the company for which the data set was produced, the date the data set was created, comments related to the operational characteristics, etc.

[0028] A digital parametric format allows for the creation of the library **185**. The library **185** can be used to experience a number of different previously characterized mechanical devices **130** on one or more haptic devices **160**. The design module **150** can be used to create new designs and store them in the library **185**. In this manner, a complete suite of mechanical device designs can be made available online (e.g., via the Internet) or in some other manner.

[0029] Using the parametric data set(s) stored in the library **185**, it is possible to automatically create or synthesize a matching force profile that will feel similar to the