with a random signal with high maximum variance. In some embodiments, this signal is output only while the user's finger is moving across the surface the touch-sensitive interface. In some embodiments, the processor may adjust the variance of the signal to change the level of roughness.

[0076] FIG. **5***d* is an illustration of one of the textures that a texture engine may generate according to one embodiment of the present invention. In the embodiment shown in FIG. **5***c*, the texture comprises the texture of grass. Grass is characterized by a periodic light sensation that almost tickles the user's finger. In order to create the sensation of grass, the processor may drive an actuator, such as an FPA, with a signal configured to create patches of low friction overlaid with patches of grass. In some embodiments, the processor may render individual grass blades by having a non-visual edge map of the displayed image and outputting a low magnitude signal to an actuator, such as an LPA or ERM, when the user interface detects the user interaction.

[0077] FIG. **5***e* is an illustration of one of the textures that a texture engine may generate according to one embodiment of the present invention. In the embodiment shown in FIG. **5***e*, the texture comprises the texture of fabric. Fabric is characterized by a light smooth sensation. In order to create the sensation of the texture of fabric, the processor may drive an actuator, such as an LPA or an LRA with low magnitude high frequency signals, as the user's finger moves across the surface of the touch-sensitive interface.

[0078] FIG. **5***f* is an illustration of one of the textures that a texture engine may generate according to one embodiment of the present invention. In the embodiment shown in FIG. **5***f*, the texture comprises the texture of water or molasses. Water is characterized by having almost no sensation. However, water that is disturbed may splash around and hit against the user's finger. To emulate the texture of water, the processor may drive an actuator such as an FPA to reduce the friction on the surface of the touch-sensitive interface. To emulate the water sloshing, the processor may output the haptic signal only when the user is touching the screen. To emulate the texture of a more viscous fluid, such as molasses, or oil, the processor may drive the actuator with a signal configured to increase the friction on the user's finger as it moves across the surface of the touch-sensitive interface.

[0079] FIG. **5***g* is an illustration of one of the textures that a texture engine may generate according to one embodiment of the present invention. In the embodiment shown in FIG. **5***g*, the texture comprises the texture of leather. Leather is characterized by an overall smooth feeling that comprises the bumps and valleys of the surface of the leather. In order to create the sensations of the texture of leather, the processor may drive an actuator, such as an FPA, with a signal configured to output a haptic effect that reduces friction as the user's finger moves across the surface of the touch-sensitive interface. The processor can output the cracks and bumps by driving the actuator with a very short low magnitude haptic signal at times when the touch-sensitive interface detects that the user's finger is moving.

[0080] FIG. **5***g* is an illustration of one of the textures that a texture engine may generate according to one embodiment of the present invention. In the embodiment shown in FIG. **5***e*, the texture comprises the texture of wood. Wood may be characterized by an irregular bumpy texture punctuated by a sharp transition as the user moves from board to board. In order to create the irregular bumpy texture, the processor may drive an actuator such as an LRA, LPA, or FPA with a non-visual edge map of the displayed image and drive the actuator with a very short low magnitude signal at various times when the user's finger is moving. To output the transition from plank to plank, the processor may output a haptic signal configured to cause the actuator to generate a high magnitude, short duration, pop.

[0081] In other embodiments, haptic effects associated with different textures may be output. For example, in one embodiment, the processor may transmit a haptic signal configured to cause the actuator to output a haptic effect configured to cause the user to feel a texture associated with the texture of ice. Ice is characterized by low friction, in some embodiments; ice has a completely smooth texture. In other embodiments, ice comprises a fine low magnitude gritty texture. In order to create the texture of ice, the processor may determine a haptic signal configured to cause the actuator to reduce the friction as much as possible while the user moves their finger across the surface of the touch-sensitive interface. In another embodiment, the processor may drive an actuator, such as an LPA or LRA, with a haptic signal configured to output low magnitude effects while the user moves their finger. These low magnitude effects may be associated with imperfections or grit on the surface of the ice.

[0082] In another embodiment, the processor may drive the actuator with a signal configured to cause the actuator to output a haptic effect approximating the texture of lizard skin. Lizard skin is characterized by an overall smooth sensation punctuated by transitions from bump to bump on the skin. In order to implement a haptic effect comprising the texture of lizard skin, the processor may drive an actuator with a haptic signal configured to cause the actuator to create patches of low friction on the touch-sensitive interface. The processor may render cracks on the surface of the skin by outputting high magnitude haptic signals periodically, when the touch-sensitive interface detects that the user's finger is moving across its surface. These high magnitude signals may approximate the cracks in the surface of the skin.

[0083] In yet another embodiment, the processor may drive the actuator with a signal configured to cause the actuator to output a haptic effect approximating the texture of fur. Fur is characterized by a periodic light sensation that is very soft to the touch. In order to implement a haptic effect comprising the texture of fur, the processor may drive the actuator with a haptic signal configured to cause the actuator to output a haptic effect configured to reduce the friction the user feels on the surface of the touch-sensitive interface. The processor may further render individual hairs outputting a low magnitude pulsing haptic signals as the touch-sensitive interface detects the user's movement.

[0084] In yet another embodiment, the processor may drive the actuator with a signal configured to cause the actuator to output a haptic effect approximating the texture of metal. Metal is characterized by a smooth low friction surface that, in some embodiments, includes light grit. In order to implement a haptic effect comprising the texture of metal, the processor may drive the actuator with a signal configured to lower the friction the user feels on the surface of the touch-sensitive interface. In some embodiments, the processor may render individual bumps by outputting brief high magnitude haptic signals when the touch-sensitive interface detects that the user is moving over its surface. These brief high magnitude signals may approximate grit on the surface of the metal.

[0085] In yet another embodiments, the processor may drive the actuator with a signal configured to cause the actua-