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Virtual Ambient Lighting for User-Interface Elements

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Abstract:

This publication describes systems and techniques to adaptively apply virtual ambient lighting to user-interface (UI) elements on a portable electronic device. Portable electronic devices, such as smartphones, include a UI with passive elements and interactive elements. The UI generally presents elements, including interactive elements, as flat, two-dimensional objects. Because the UI does not intuitively differentiate interactive elements from passive elements, a user must rely on prior experience or trial-and-error to identify the interactive elements. This publication discloses a portable electronic device that captures and analyzes the lighting environment around the user of the device and displays onscreen elements as part of a virtual UI environment. For example, the portable electronic device can provide depth, lighting, and shadowing to interactive elements based on the positioning of light sources in the user's environment. The virtual ambient lighting improves the discoverability of interactive elements, provides depth to the UI, and may reduce eye fatigue.

Keywords:

Front-facing camera, selfie camera, wide-angle camera, mobile device, smartphone, portable electronic device, ambient light, environment, depth, three-dimensional, 3D, shadow, virtual lighting, graphical user interface, GUI, screen, display, interactive element, accelerometer, compass, position.

Background:

Portable electronic devices, such as smartphones, tablets, laptops, handheld video game consoles, and electronic readers, include a UI that enables users and the electronic device to interact and allows users to carry out various tasks. The UI is generally a two-dimensional area displayed on a screen, which includes passive elements and interactive elements. A passive element presents media, data, and other information to a user, but the user cannot interact with the passive element to provide input. In contrast, interactive elements allow a user to input information, controls, or other data. A UI contains a mixture of passive elements and interactive elements, as illustrated in Figure 1.

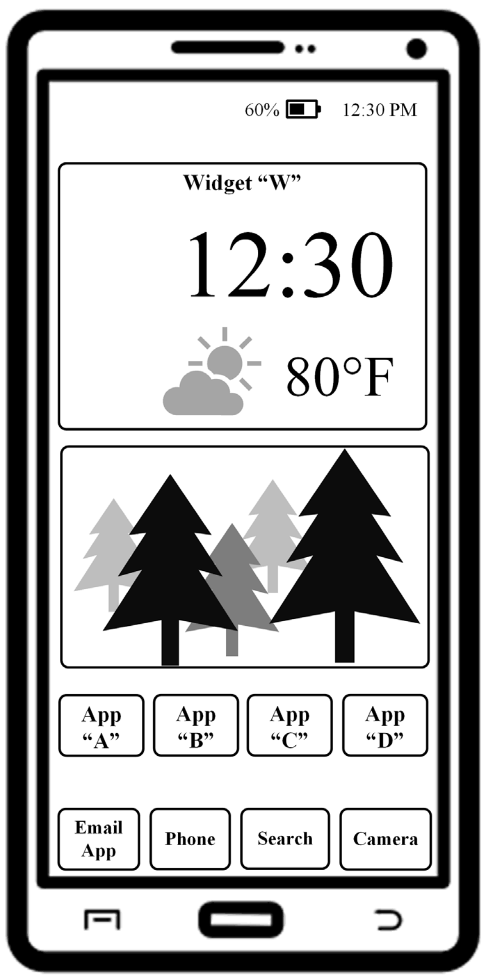

Figure 1

Figure 1 illustrates Jane's smartphone. The UI provides a widget "W" in the top portion of the smartphone's screen. The widget "W" provides the time and local weather. A widget is a small application view that can be embedded in other applications (*e.g.*, the home screen) and displays periodically updated information. The UI also includes a background photograph of a pine forest and several application icons. The background is a passive element. In contrast, the application icons are interactive elements. When Jane touches one of the application icons, the application is launched and opens on the UI. The widget "W" may be interactive, passive, or a combination of both. For example, Jane may be able to touch the temperature display to request a 10-day forecast. Without prior experience with the widget, Jane may be unsure if the widget "W" is an interactive element.

Although portable electronic devices have become a ubiquitous part of modern life, users still encounter uncertainty in readily recognizing which UI elements are interactive. In general, users identify interactive elements based on prior experience or trial-and-error (*e.g.*, randomly touching or clicking on elements to see the reaction, if any). For some types of content, portable electronic devices may apply various visual treatments to the UI to make interactive elements stand out (*e.g.*, underlining and changing the font color of a link). UI elements, however, are generally portrayed as flat, two-dimensional objects. Because interactive elements are not intuitively identifiable, user discovery of interactive elements is frequently not intuitive.

It is desirable to provide a UI on portable electronic devices that display elements as a virtual part of the user's environment to improve user understandability.

Description:

This publication describes systems and techniques for providing virtual ambient lighting of UI elements on a portable electronic device. Engineers can design the UI with depth and adaptive lighting, which improves user understandability of interactivity within the UI. Figure 2 illustrates an example of the described portable electronic device.

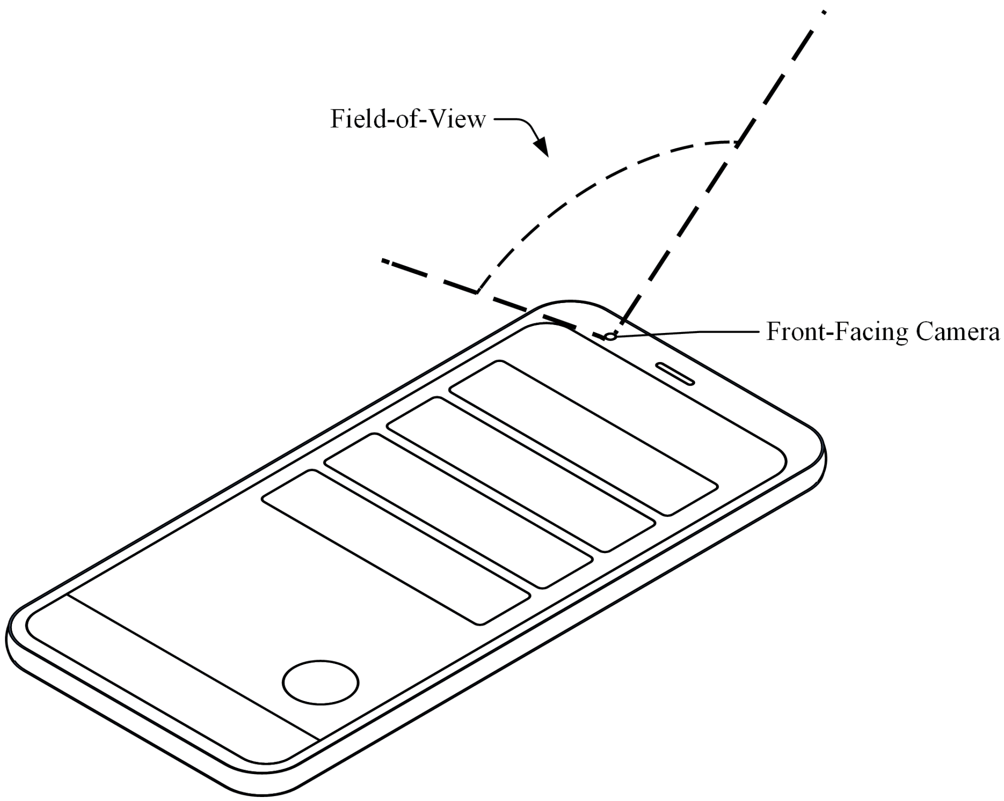

Figure 2

As illustrated in Figure 2, the portable electronic device can be a smartphone with a front-facing camera. The smartphone also includes a display screen, a processor, and sensors. The sensors detect and measure a variety of input data. For example, the sensors can include an accelerometer and a compass.

A front-facing camera is a standard feature on portable electronic devices. Portable electronic devices generally include multiple cameras, with at least one front-facing camera and at least one rear-facing camera. The front-facing camera allows users to take self-portrait photographs (colloquially referred to as “selfies”) and participate in video teleconferencing. Front-facing cameras have a particular field-of-view, which represents the volume of space that the camera lens can detect and capture. In Figure 2, the front-facing camera has about a 90° field-of-view.

An accelerometer measures the relative acceleration of a portable electronic device. Accelerometers detect the movement and orientation of a device. Portable electronic devices can use the movement and orientation data from an accelerometer to count user steps, orient the UI in portrait or landscape mode depending on how the user is holding the device, and detect if the device is falling. Portable electronic devices can also include a compass. The compass detects orientation along x-, y-, and z-axes. The orientation data can be used to determine the direction the screen is facing.

The smartphone illustrated in Figure 2 can utilize the front-facing camera to capture images of the user’s environment. The smartphone analyzes light data in the captured images to determine the existence of light sources. The smartphone also uses accelerometer and compass data to approximate the orientation of the device and detect any movement. By combining the light data with the orientation and movement data, the smartphone can calculate the position of the light sources relative to the device and determine whether the light sources are static or moving. Figure 3 illustrates an example of the smartphone detecting nearby light sources.

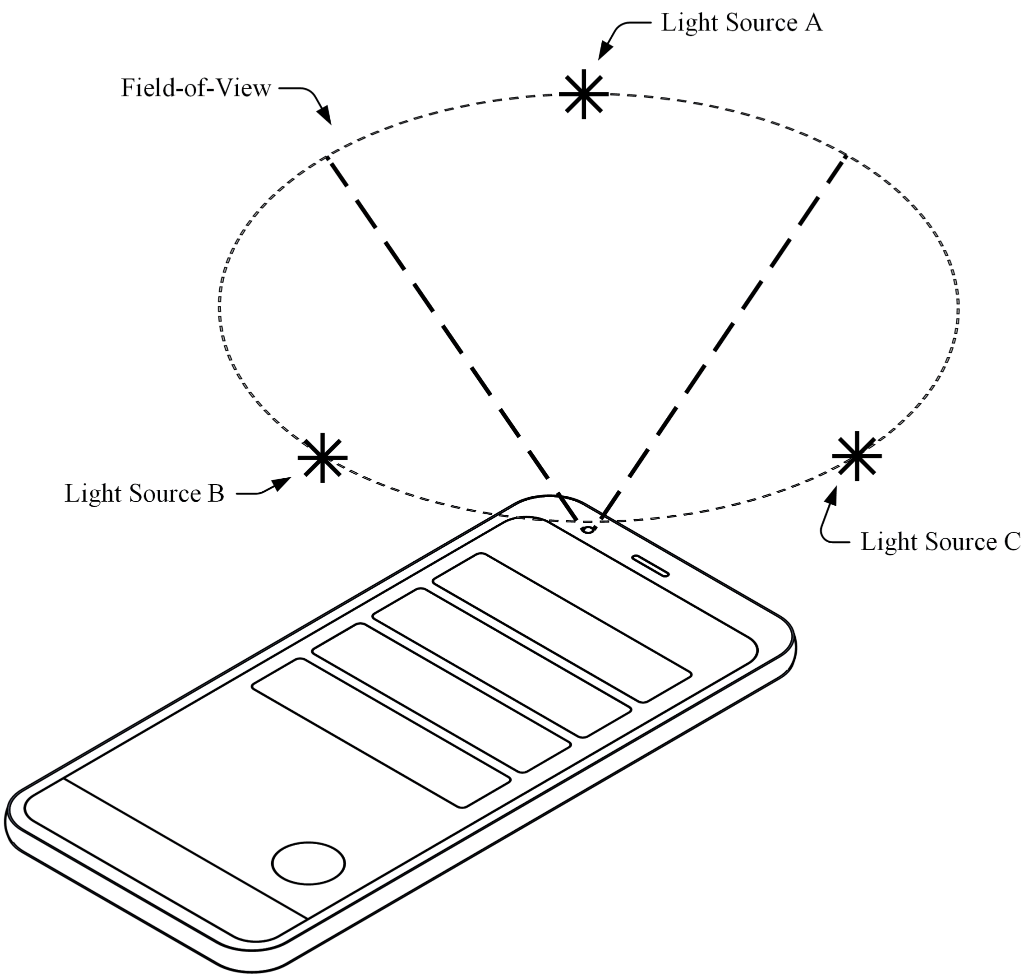

Figure 3

In Figure 3, the smartphone uses the front-facing camera to detect light source A, light source B, and light source C within its field-of-view. The light sources can include a lamp, a ceiling light fixture, or the sun. The smartphone also utilizes the on-board accelerometer and compass data to determine the approximate location of the light sources within the user's environment and to determine that each light source is static. The smartphone consolidates the location and type of light source data into light-source information. In this example, light source B and light source C are relatively close to the smartphone, while light source A is farther away. As the user moves the smartphone, the device tracks the light sources relative to the UI over time. For example, as the user moves the smartphone toward herself in a vertical, portrait orientation, light source A is positioned behind the device. In another example, light source B may be a lamp, and the smartphone periodically confirms that the lamp is still on.

The portable electronic device uses the light-source information to project virtual ambient light into the UI. The application of virtual lighting allows the UI to adapt to and fit into the user's surroundings, approximating how the virtual light sources would illuminate onscreen elements. For example, the UI can include shadows cast by interactive elements relative to real-world light sources to give the interactive elements depth and reflectivity. The UI can also not give passive elements shadows and depth to interactive elements to distinguish them from passive elements. An example of virtual lighting in a smartphone UI is illustrated in Figure 4.

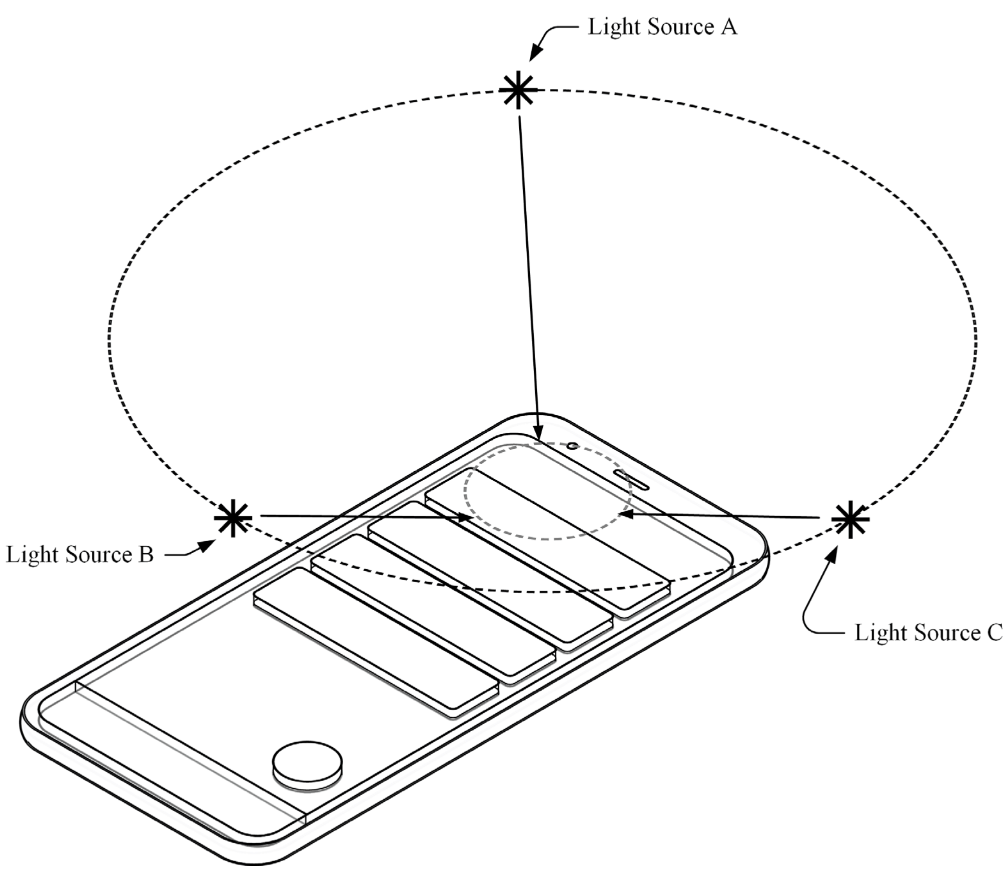

Figure 4

In Figure 4, the smartphone uses the light-source data to brighten a portion of the UI, which is represented by the smaller dashed circle in the top-left portion of the display screen. The light-source data is also used to add relative depth and shadowing to the rectangular and circular interactive elements in the UI. As the smartphone moves, the UI will appropriately alter the virtual lighting. For example, if the user orients the smartphone away from light source A, the shadowing of the interactive elements will be determined based on the relative position and brightness of only light source B and light source C.

The described systems and techniques provide virtual ambient lighting for UI elements on a portable electronic device. The portable electronic device can adaptively adjust, based on movement and orientation data, the virtual lighting to integrate the UI into the user's environment. These systems and techniques improve the user's identification and understanding of interactive elements within the UI.

References:

[1] Patent Publication: US20150106768A1. Three Dimensional User Interface Effects On A Display By Using Properties Of Motion. Priority Date: August 4, 2010.

[2] Patent Publication: US20130332843A1. Simulating physical materials and light interaction in a user interface of a resource-constrained device. Priority Date: June 8, 2012.