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Context-Sensitive Display Adaptation

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CONTEXT-SENSITIVE DISPLAY ADAPTATION

Introduction

The present disclosure provides systems and methods to provide for dynamically adapting the display of content (e.g., image content, etc.) based on the content type and the ambient environment. Generally, consumer electronics hardware displays are tuned to provide a certain ambient brightness, color, contrast, and the like. The systems and methods of the present disclosure can enable dynamically adjusting the display parameters, such as white point, color, saturation, contrast, and/or the like, based on the ambient conditions and the content itself so as to enhance the end user experience.

Summary

According to an aspect of the present disclosure, parameters of a display device can be adapted based on the content being displayed and/or the ambient environment of the display device to enhance the user experience. A display device can obtain content (e.g., an image, etc.) that is to be displayed. The ambient environment of the display device and/or the context of the content can be determined, for example, by the display device and/or a remote computing system. Based on the content to be displayed and/or the ambient environment, one or more display parameter adjustments can be determined, such as adjustments to white point, color, saturation, contrast, and/or the like. The determined display parameter adjustments can be used to tune the display device to provide for improved display of the content.

Detailed Description

According to an aspect of the present disclosure, systems and methods can provide for dynamically tuning the display parameters of a display device based on the context of the content being displayed and/or the ambient conditions. The systems and methods of the present

disclosure can enable dynamically adjusting one or more parameters of a display, such as the white point, color, saturation, contrast of pixels, intensity, and/or the like, based on the ambient conditions and/or the content itself, to enhance the display of the content. The present disclosure allows for subtly adjusting the display of content (e.g., images, etc.) to provide for improved display perception and an enhanced user experience.

According to an example implementation of the present disclosure, a device, such as a handheld device, smartphone, digital assistant, home assistant, laptop, personal computer, and/or the like, can provide for displaying content to a user. The device can obtain content, such as image content and/or the like, that is to be displayed. The context in which the content is to be displayed, such as the ambient environment, location of the device, and/or the like, can be determined for use in identifying display parameters that should be adjusted to enhance display of the content. Data associated with the content, such as subject matter, content metadata, and/or the like, can also be determined for use in identifying display parameters that should be adjusted to enhance display of the content.

The display parameters for a device, such as the white point, color, saturation, contrast of one or more pixels, and/or the like, can be adjusted to dynamically modify colors, tune an image, and/or the like, based on the context of the device environment and/or the content itself to enhance the end user experience. For example, content to be displayed on a device may comprise images of food and it may be desirable for the food to pop in the image display. As such, the display parameters may be adjusted to make the colors of the food more vibrant. As another example, the content to be displayed may comprise a castle or winter landscape. As such, the display parameters may be adjusted to provide more muted colors or reduced intensity.

In some implementations, one or more display parameters can be adjusted based on one or more of geo-location, day/night context, ambient lighting level, ambient lighting color, when/where content was captured, the desired mood, content-specific factors, and or the like. For example, based on the geo-location of the user/device, it can be determined that the general preference in that location is for higher gloss and color saturation and the display parameters can be adjusted accordingly. In some implementations, preferences for a region or geo-location can be determined using crowdsourcing or other correlation methods. As another example, display parameters can be adjusted based on a day/night context to provide for dimming and/or compensating for light levels. In another example, display parameters can be adjusted based on an ambient lighting color, such as adjusting white point based on the real-time room lighting. As another example content metadata can be used to determine when and/or where content was captured, which can be used to adjust display parameters, such as by adjusting to best display the season, weather, location, etc. at the time the content was captured. In another example, display parameters can be adjusted based on a desired mood, such as adjusting the white point to foster a user waking up in the morning or adjusting parameters to be more soothing while relaxing in the evening. As another example, display parameters can be adjusted based on the sound environment of the device. For example, if holiday music is playing the color tone can be adjusted versus a color tone that would be used if rock music is playing in the environment.

Display parameters can also be adjusted based on the content itself. For example, in displaying images such as flowers, food, and/or the like, it may be desirable to adjust display parameters to use more vibrant colors. As another example, display parameters may be adjusted to display winter scenes with more muted colors whereas spring scenes may cause display

parameters to be adjusted to provide more intensity. As another example, in displaying portraits, display parameters may be adjusted to display improved skin tones, softer colors, and/or the like.

In some implementations, the factors used in identifying and adjusting display parameters may have a hierarchy or priority. For example, in some implementations, the ambient lighting and/or content specific factors may be considered first in determining how the display parameters can be adjusted, with other factors having lower weight.

In various implementations, the environment context of the display device and/or data associated with the content to be used in identifying display parameters can be determined by the device itself, by a remote computing system (e.g., a cloud server, etc.), or by a combination of the device and a remote computing system. As an example, in some implementations, a device may provide the content and/or context data to a remote computing system and the remote computing system may determine one or more display parameters that should be adjusted on the device to enhance display of the content. For example, the remote computing system can determine the subject of the content and/or the preferences associated with the context of the environment, such as by using machine-learned models, and identify one or more display parameters that should be adjusted to enhance display of the content. The remote computing system can then provide data to the device that can be used to implement the display parameter adjustments.

In some implementations, the end user can further modify the display parameters based on user preferences, etc. once the display adaptation has been executed.

Figure 1 depicts an example system 100 according to an implementation of the present disclosure. Figure 1 illustrates one example computing system that can be used to implement the present disclosure. Other computing systems can be used as well. The system 100 may

comprise one or more user computing devices, such as user computing device 102, one or more server computing systems, such as server computing system 140, coupled over one or more networks, such as network 180. The user computing device 102 can include one or more processors 104 and a memory 106. The one or more processors 104 can be any suitable processing device and can be one processor or a plurality of processors that are operatively connected. The memory 106 can include one or more non-transitory computer-readable storage mediums, such as RAM, ROM, EEPROM, EPROM, flash memory devices, magnetic disks, etc., and combinations thereof. The memory 106 can store data 108 and instructions 110 which are executed by the processor 104 to cause the user computing device 102 to perform operations.

According to an aspect of the present disclosure, the user computing device 102 can include a display adaptation system 112 that can implement the features of the present disclosure. For example, the display adaptation system 112 can determine content to be displayed as well as data associated with the content to be displayed (e.g., metadata, etc.). The display adaptation system 112 can also determine data regarding the context of the environment (e.g., geo-location, time of day, ambient lighting, etc.). In some implementations, the display adaptation system 112 can identify context factors and/or content factors that can be used in determining how display parameters can be adjusted to enhance display of the content, as discussed herein. The display adaptation system 112 can then provide instructions for adjusting the display parameters. Optionally, in some implementations, one or more machine-learned models 114 can be stored on the user computing device 102 to assist in determining content factors and/or context factors that can be used in determining display parameters. In some implementations, the display adaptation system 112 (e.g., via the user computing device 102) may provide data to a remote computing system (e.g., server computing system 140, etc.) to

determine display parameters that should be adjusted based on the context and/or content to enhance the display.

The user computing device 102 can also include one or more input/output interface(s) 116. One or more input/output interface(s) 116 can include, for example, devices for receiving information from or providing information to a user, such as a display device, touch screen, touch pad, mouse, data entry keys, an audio output device such as one or more speakers, a microphone, haptic feedback device, etc. The user computing device 102 can also include one or more communication/network interface(s) 118 used to communicate with one or more systems or devices, including systems or devices that are remotely located from the user computing device 102.

The server computing device 140 can include one or more processors 142 and a memory 144. The one or more processors 142 can be any suitable processing device and can be one processor or a plurality of processors that are operatively connected. The memory 144 can include one or more non-transitory computer-readable storage mediums, such as RAM, ROM, EEPROM, EPROM, flash memory devices, magnetic disks, etc., and combinations thereof. The memory 144 can store data 146 and instructions 148 which are executed by the processor 142 to cause the server computing device 140 to perform operations, for example, to implement operations as discussed herein. In some implementations, the server computing device 140 may include one or more machine-learned models 150 that can assist in determining content factors and/or context factors that can be used in determining how display parameters of a device can be adjusted.

Figure 2 depicts a flowchart illustrating example operations 200 for providing context-sensitive display adaptation in accordance with aspects of the present disclosure. Although

operations 200 are shown and described in a particular order for purposes of illustration and discussion, the operations are not limited to the particularly illustrated order or arrangement and certain operations can be performed in different orders or simultaneously.

The operations begin at block 202 where a device obtains content to be displayed by the device. For example, a user may wish to have a device, such as a home assistant, handheld device, etc. display one or more images. At block 204, a device (e.g., the local device, a remote device, etc.) may determine one or more factors associated with the content (e.g., subject, metadata, etc.) that can be used in determining how the display can be adjusted to enhance display of the content.

At block 206, the device may determine the current context of the environment where the content is to be displayed. For example, the device may determine the location of the display device, the ambient lighting, the time of day, the desired mood, other ambient conditions, and/or the like. In some implementations, the device may determine one or more preferences for display of content based on the location or other context factors.

At block 208, the device may identify one or more display parameters that should be adjusted based on the content and/or context. For example, the device may determine how display parameters such as white point, color, saturation, contrast, intensity, and/or the like, should be adjusted to enhance the display of the content. At block 210, one or more instructions can be provided to the display device to adjust the device display parameters accordingly.

Figures

Figure 1

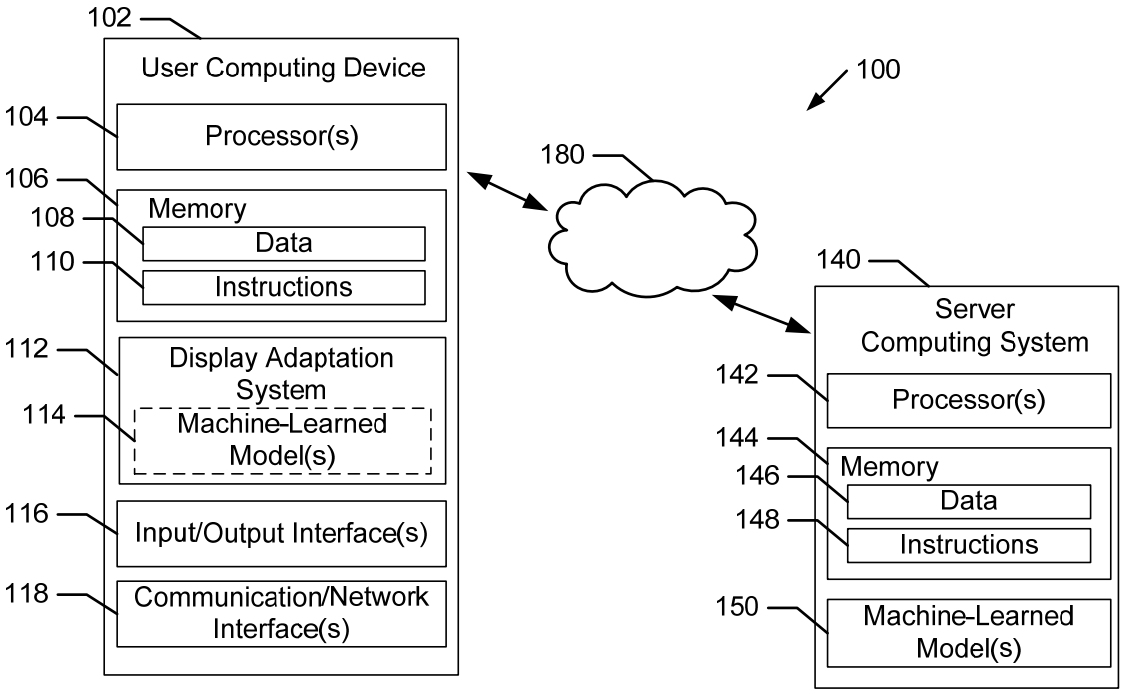
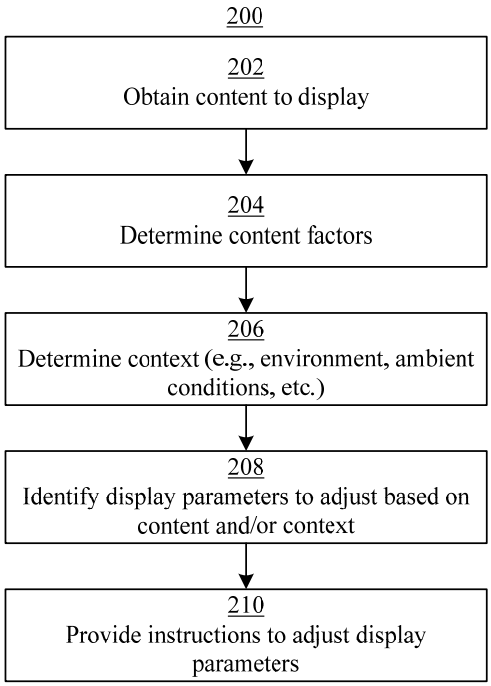


Figure 2



Abstract

The present disclosure describes systems and methods that provide for dynamically adapting the display of content based on the content and/or the environment context. More particularly, the present disclosure provides for adjusting the parameters of a display device based on the content being displayed and the context of the display device to enhance a user experience. In some implementations, a device can obtain content to be displayed. The context of the display device and factors associated with the content to be displayed can be determined. Based on the content factor(s) and the context, one or more display parameter adjustments can be determined, such as adjustments to white point, color, saturation, contrast, intensity, and/or the like. The determined display parameter adjustments can be used to adapt the display device to provide for improved display of the content.