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Relative Color Commands for Smart Lights and Color Interrogatives for Smart Lights

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Abstract

Techniques are set forth that relate to user interactions with smart lights using an automated assistant. Some techniques enable an automated assistant to appropriately respond to a user request to change the color of smart light(s), such as requests where the color is indicated in the request in relative terms (*e.g.*, "more blue", "a touch redder", "a lot greener"). For example, a user can request an automated assistant to make one or more smart lights "more red". The automated assistant can determine an appropriate command for making the smart light(s) "more red", and transmit that command to the smart light(s) and/or agent(s) controlling the smart lights, to cause the light output of the smart light(s) to become "more red". For example, the automated assistant can request the current color of the smart light(s) (*e.g.*, a color in a predefined color space), determine a target color of the smart light(s) using the current color and the "more red" request (*e.g.*, determining a mapping within the color space from the current color to a "more red" target color), and generate the command to cause the target color to be achieved.

Some techniques additionally or alternatively respond to a user's request for a current color of smart light(s), with a natural language representation of the color. For example, in response to such a request submitted to an automated assistant, the automated assistant can interface with the smart light(s) (directly or via an agent) to obtain an indication of state(s) of the light(s). The state(s) can directly or indirectly indicate color(s) for the smart light(s) (*e.g.*, in a predefined color space), and a mapping of colors to natural language representations of the colors utilized to determine the natural language representation to provide in response to the user's request. For instance, in response to a user request of "what color are the kitchen lights", the automated assistant can audibly and/or graphically render "light blue" based on the color(s)

of the kitchen lights being mapped to a “light blue” natural language representation.

Description

Smart lights are lights included in the Internet of Things (“IoT”), a network of physical devices where each device can include: electronics, software, sensors, actuators, etc. Smart lights can connect over a network to exchange information, where each light (i.e. a thing in the Internet of Things) can be uniquely identifiable and operate within the existing Internet structure. In general, the IoT allows devices such as smart lights to be remotely controlled across an existing network infrastructure including: an IEEE 802.11 network, an IEEE 802.15.1 network, a mesh network, a cellular network, etc. For example, an automated assistant can remotely control a variety of devices including: a smart light, a group of smart lights, smart thermostats, smart keyless door locks, smart doorbells, smart security cameras, smart electrical outlets, smart smoke detectors, smart flood sensors, smart vacuums, smart window shades, etc.

Humans can engage with interactive software applications referred to herein as “automated assistants” (also referred to as “chat bots”, “interactive personal assistants,” “intelligent personal assistants”, “personal voice assistants”, “conversational agents,” etc.). For example, humans (which when they interact with automated assistants may be referred to as “users”) may provide commands, queries, and/or requests using natural spoken language input which may in some cases be converted into text and then processed, and/or by providing textual natural language input.

In some instances, automated assistants can directly control a smart light. In other instances, third party agents (also referred to as “third party applications”) can facilitate interactions between an automated assistant and the user including controlling a smart light. For example, automated assistants can submit a command to a third party agent associated with a

smart light, where the command causes the third party agent to control the smart light in a particular manner. Third party agents can be hosted on computer system(s) that are external to those hosting the automated assistant, and can be controlled by parties that are distinct from the party controlling the automated assistant.

In some instances, color models can be used to describe a color. Simple color models can be used to create a full range of colors from a small set of primary colors. For example, the RGB color model is an additive color model where red light, blue light, and green light are added together in varying combinations to create a wide spectrum of colors. In other words, an individual color is produced by adding a combination of red, green, and blue colored lights. The generation of white light and black light are generally special cases in color models. In an RGB color model, white light can be produced by increasing the intensity of all three colors of lights to a full intensity. In contrast, black light can be produced by an RGB color model by reducing the intensity of all three colors of lights to zero. In some instances, a red light emitting diode ("LED"), a blue LED, and a green LED can be used in a RGB color model. In some instances, an individual smart light can contain multiple colored LEDs. For example, a smart light can contain a red LED, a blue LED, and a green LED to can change the color of the smart light using RGB based color models.

A color space is a set of colors that can be displayed (e.g. on a screen of a computing device) or reproduced (e.g. by printing). In some instances, a color space can use a color model, such as the RGB color model, to represent what colors to display within the color spaces. In some instances, a smart light can use the CIE color space to display the color of the smart light. Several variants of the CIE color space exist including: the CIE RBG color space, the CIE XYZ color space, etc. Both the CIE RGB and CIE XYZ color spaces share many similarities and can

both use an RBG color model to represent colors within the color space. Both an automated assistant directly controlling a smart light and a smart light associated with a third party agent in communication with an automated assistant can use the CIE color space. For example, if an automated assistant directly controlling a smart light receives a user request to make a light "more purple", the automated assistant can generate a mapping, between the smart light's current color in the CIE color space and the user request, to generate the requested lighting condition. A user request in the CIE color space to make a light more purple will generally include increasing the blue LED value, increasing the red LED value, and decreasing the green LED value.

Similarly, if a user requests an automated assistant to make a smart light associated with a third party agent "more red", the third party agent can create a mapping between the current color of the light and the user request to generate the requested lighting condition. A user request in the CIE color space to make a light "more red" will generally increase the red LED value (and can potentially decrease the green LED value and the blue LED value).

In some instances, a smart light can use a color temperature color space. Color temperature is a characteristic of visible light that is conventionally expressed in kelvin (K). Color temperatures generally over 5000 K are called "cool colors" and lower color temperatures generally 2700-3000K are called "warm colors". It should be noted that warm is analogous to radiant heat flux of traditional incandescent lighting and not temperature. In some instances, a color temperature color space can use an RGB color model. For example, a user can request an automated assistant directly controlling a smart light to make the lighting "warmer". The automated assistant will make a mapping using the current color value of the light and the users request to make the light "warmer" in the color temperature color space. For example, yellow light from the yellow LED (i.e., a "warm" color) can be added to make the current lighting color

"warmer".

Similarly, a user can request a smart light integrated with a third party agent to make the lighting "cooler". The third party agent can determine the mapping using the current color value of the light and the user request to determine how to make the light "cooler" in the color temperature color space. For example, the third party agent can request the automated assistant add blue light from the blue LED (i.e., a "cool" color) to the smart light to make the current lighting color "cooler".

In some instances, a user can request the color of a smart light from an automated assistant. The automated assistant or a third party associated with the smart light can determine a mapping from the color space of the smart light into a natural language representation of the color. In many instances, a variety of color spaces can be divided into sections that correspond to a predefined natural language color label. For example, a CIE color space can be divided into sections that correspond to different colors including: blue, light blue, dark blue, etc. Similarly, a color temperature color space can be divided into sections that correspond to how warm and/or cool colors are including: warm grey, cool gray, warm red, cool red, etc. In some instances, a variety of color spaces can be divided into sections that correspond to the natural language of a natural language color label. For example, English language color labels can divide the RBG color space into different sections than Mandarin Chinese color labels. In other words, color labels in different languages do not always have a direct mapping between color names.

Automated assistants and third party agents can receive the current color of a smart light in a variety of ways for use in techniques described herein. In some instances, an automated assistant can receive periodic updates of the current color of a smart light. In other instances, an automated assistant can request the current color of a smart light on demand. Similarly, in some

instances a third party agent associated with a smart light can receive period updates of the current color of a smart light and in other instances can request the current color of a smart light on demand.

In some instances, a group of smart lights can be treated as a single smart light for use in techniques described herein. For example, a group of six smart lights in a living room can be assigned a label "living room lights". In some instances, automated ~~assistances~~ assistants can directly control the group of lights labeled "living room lights" as it would a single smart light. In some instances, the group of lights labeled "living room lights" can be associated with a third party agent, and the third party agent can interact with the automated assistant as if the group of lights were a single smart light.

FIG. 1 below illustrates a system diagram 100 that includes an example of one or more client devices 102. Client device 102 can include, for example, a display device, a desktop computer, a laptop computer, a tablet computer, a mobile phone, a computing device in a vehicle of the user, and/or a wearable device that includes a computing device (e.g. a watch with an integrated computing device, a virtual or augmented reality computing device, etc.). Client device 102 may execute a respective instance of an automated assistant client 108, and in some instances a user can engage with an automated assistant client 108 executing on client device 102. In some instances, an instance of an automated assistant client 108, by interacting with one or more cloud-based automated assistant components 116 via one or more local and/or wide area networks (e.g. the internet, an IEEE 802.11 network, an IEEE 802.15.1 network, a mesh network, a cellular network, etc.) indicated generally as 114, may form what appears to be from the user's perspective, a logical instance of an automated assistant 112. One such instance of an automated assistant 112 is depicted in FIG. 1 by a dashed line.

In some instances, automated assistant 112 can connect to one or smart lights 104 (e.g. a peripheral device) via network 114 to facilitate transactions between a user and one or more smart lights 104. In other instances, automated assistant 112 can use the third party agent 106 to facilitate transactions between the user and one or more smart lights 104.

In some instances, the automated assistant 112 can directly control a user requested change of color to the one or more smart lights 104 and/or request the current color of the one or more smart lights 104 in a natural language format. In some instances, the automated assistant 112 can interface with the third party agent 106 to facilitate a user requested change of color of one or more smart lights 104 and/or request the current color of the one or more smart lights in a natural language format.

In some instances, automated assistant 112 may engage in a dialog session with one or more users via user interface and output devices of client device 102. In some instances, the user interface input is explicitly directed to automated assistant 112. For example, a user may speak a predetermined invocation phrase, such as “OK, Assistant”, or “Hey, Assistant” to cause automated assistant 112 to begin actively listening. In some instances, a user may request automated assistant 112 to make a smart light 104 “more red”. In some instances, a user may request automated assistant 112 provide the current color of smart light 104 in a natural language format from the automated assistant 112 in a number of ways including: a verbal description of the color, textual natural language information regarding the color on a display, etc.

In some instances, each automated assistant client 108 may include a corresponding speech/capture/text-to-speech(“TTS”)/speech-to-text(‘STT”) module 110. In other instances, one or more aspects of speech capture/TTS/STT module 110 may be implemented separately from the automated assistant client 108. In some instances, each speech capture/TTS/STT

module 110 may be configured to perform one or more functions: capture a user's speech, e.g., via a microphone; convert that captured audio to text (and/or to other representations or embeddings); and/or convert text to speech. In other instances, speech input may be sent to cloud-based automated assistant components 116, which may include cloud-based TTS module 118 and cloud based STT module 120.

In some instances, cloud-based STT module 120 can leverage the virtually limitless resources of the cloud to convert audio data captured by speech capture/TTS/STT module 110 into text (which may then be provided to natural language processor 122). Cloud-based TTS module 118 may be configured to leverage the virtually limitless resources of the cloud to convert textual data (e.g., natural language responses formulated by automated assistant 112) into computer-generated speech output.

In some instances, natural language processor 122 of automated assistant 112 processes natural language input generated by users via client device 102 and may generate annotated output for use by one or more components of automated assistant 112. In some instances, automated assistant 112 and/or third party agent 106 may receive output from natural language processor 112 describing the current color of a smart light in a natural language form.

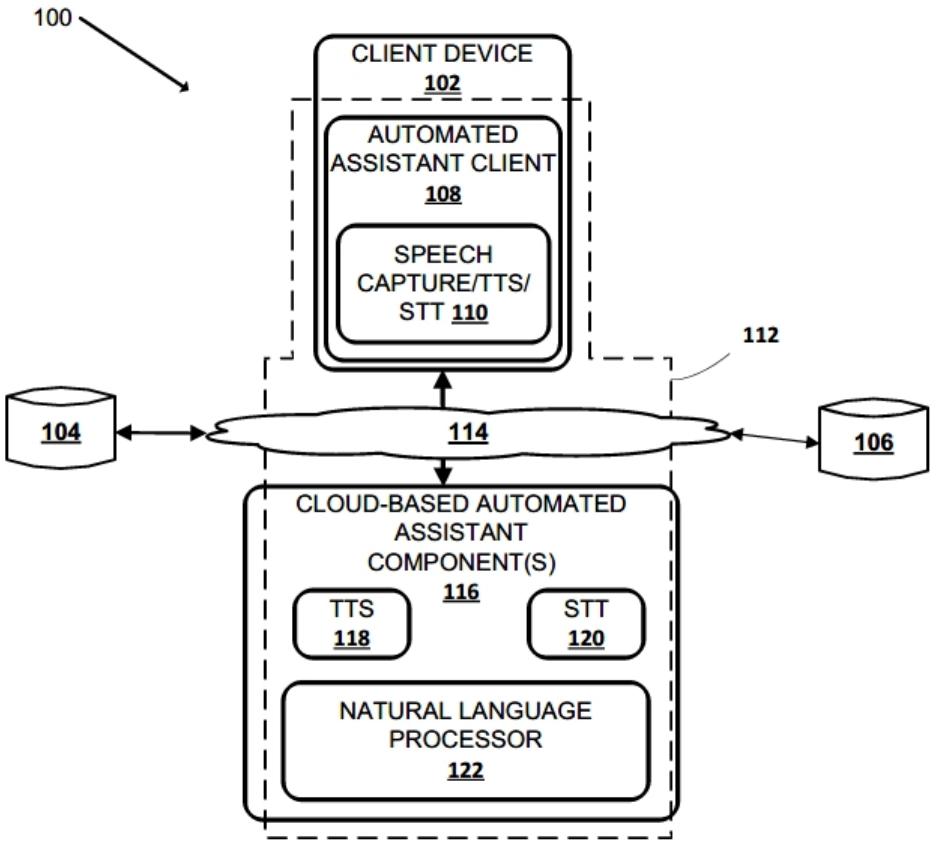
100
CLIENT DEVICE
102
AUTOMATED ASSISTANT CLIENT
108
SPEECH CAPTURE/TTS/ STT 110
112
104
114
106
CLOUD-BASED AUTOMATED ASSISTANT COMPONENT(S)
116
TTS
118
STT
120
NATURAL LANGUAGE PROCESSOR
122

Fig. 1