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Automatic Control of Lighting During Video Capture

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ABSTRACT

This disclosure describes techniques to automatically optimize lighting conditions around a subject of a video or photograph to produce a better lit image. With user permission, ambient light conditions are analyzed by using image processing and machine learning and available light sources are adjusted to optimize the lighting of the scene. In contrast to traditional techniques that passively adapt to existing light conditions, the described techniques actively modify the light falling on the subject. Effectively, the techniques extend and improve AAA algorithms (auto exposure, auto white balance, autofocus) to include auto lighting. The techniques can be applied in any image or video capture application such as video chat, video conferencing, content creation for social media or video sharing sites, live streaming, etc.

KEYWORDS

- Video capture
- Lighting condition
- Ambient light
- Automatic exposure
- Automatic white balance
- Auto-focus
- AAA algorithm
- Color tone
- Brightness compensation
- Webcam lighting
- Color temperature
- Video conferencing
- Lighting enhancement
- Lighting adjustment
- Machine learning
- Color test card

BACKGROUND

Good lighting in a video, e.g., of a video conferencing participant or a streaming video content creator, significantly improves the quality of the video and conveys a better impression of the participant/ content creator to viewers. Although some video cameras can automatically control exposure, focus, and white balance (color correction) using the so-called triple-A (or AAA) algorithms (auto exposure, auto white balance, autofocus), such techniques can only provide improvements that are feasible within the constraints of the existing ambient lighting as also the constraints of camera optics and sensors.

While triple-A algorithms can improve the quality of the captured video or image, these algorithmic techniques do not modify the ambient light conditions to suit the subject of the video. Rather, the algorithms passively adapt to existing lighting conditions as captured by the camera.

Some cameras can automatically adjust flash intensity but do so only in response to the total light measured in the field-of-view. There is no optimization of lighting to suit the subject. Lights traditionally used for video capture, e.g., monitor lights, do not generally automatically adapt their intensity. Skilled photographers and videographers can manually and laboriously adjust light conditions in a studio. The average user has neither the skill nor the time to adjust artificial lighting every time they join a video call or recording session. Light conditions can change over a short period, such as an hour or two within which a video conference takes place, e.g., due to changes in natural light over the course of a day, changes in weather (e.g., clouds), etc. These changes can be in light intensity as well as color. In such a case, manually adjusted artificial light settings that were optimal at the start of a call may be less suitable as time progresses.

DESCRIPTION

This disclosure describes techniques to automatically optimize lighting near a subject of a video or photograph to suit the subject. In contrast to traditional techniques that passively adapt to existing light conditions, the described techniques actively modify the light falling on the subject by analyzing ambient light conditions and by using image processing and machine learning to optimize the lighting of the scene. Effectively, the techniques extend and improve the AAA algorithms (auto exposure, auto white balance, autofocus) to include auto lighting. The techniques can be utilized for video capture in applications such as video chat, video conferencing, content creation for social media or video sharing websites, live streaming, etc.

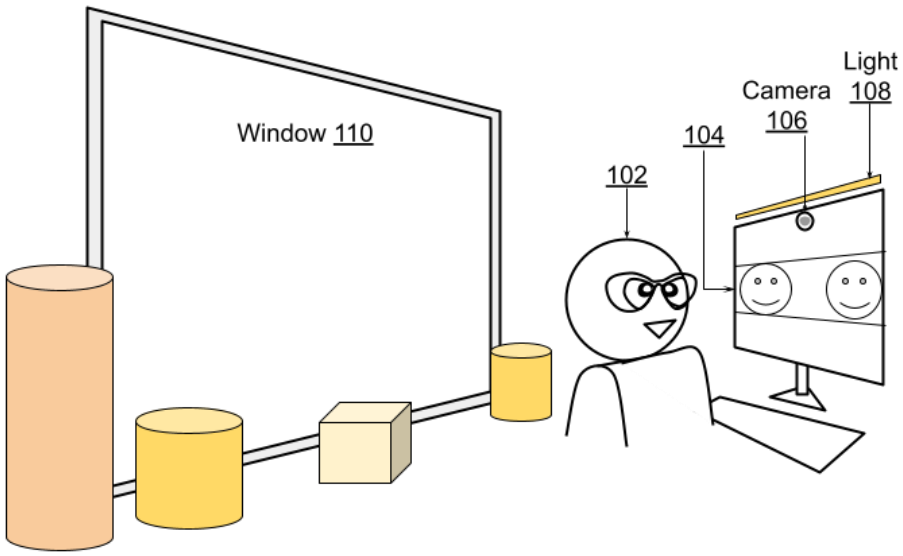

Fig. 1: Example of automatic control of lighting during video capture

Fig. 1 illustrates an example of automatic control of lighting during video capture. A user (102) participates in a video conference using a computer (104) with a camera (106) and a source of parametrically tunable artificial light (108), e.g., a monitor light. The user's background (110) in this example includes a large source of natural light, e.g., a window. The camera can be an accessory (controllable, e.g., via USB or WiFi), or built into the computer. The source of

artificial light can be, e.g., a smart light (LED) appliance with adjustable brightness and color temperature that can be turned on or off. The artificial light can be remotely controlled over a variety of channels, e.g., universal serial bus (USB), universal asynchronous receiver-transmitter (UART), WiFi, Bluetooth, etc.

The video recording or video chat software (or other software) can implement the described techniques. With user permission, the captured video is analyzed, e.g., brightness histograms are computed and tools such as object detectors, face detectors, etc. are utilized to detect objects within the scene. Regions of the frame that can benefit from improved lighting are identified.

In the example of Fig. 1, detection of the large window behind the user, which lets in a lot of daylight, can result in automatic narrowing of the camera aperture (to compensate for excessive total light) and a consequent darkening of the user's face in the captured video. Video analysis can determine that artificial light of a certain color temperature and brightness can improve the clarity and appearance of the user in captured video, e.g., by filling in shadows or by throwing light at a face darkened by a narrowed camera aperture. The artificial light is automatically tuned to the optimal color temperature and brightness.

A machine learning model trained to detect good image quality (indicated by such as face in focus, well-lit faces, neutral (natural) tones, uniform exposure across the frame, etc.) can be used to tune the artificial light until an optimal look materializes. The procedure to optimize the user's appearance using tunable artificial light can happen in as little as seconds after startup and can be nearly invisible to the user. The optimal lighting for a given user can depend on a variety of factors such as facial features, skin tone, eye color, hair color, facial position (e.g., front-facing versus side-facing), etc.

The machine learning model can be suitably trained with adequate training data for multiple classes of users and settings (office, bedroom, living room, porch, cafeteria, etc.) such that the model can automatically determine the optimal lighting parameters for various kinds of users and settings. Additionally, a teaching mode for the machine learning model can guide the user through adjusting artificial light to achieve an optimal look in various ambient lighting conditions (room lights, window blinds/curtains/ shades, desk lamps, etc.). The teaching mode can also provide the user suggestions for lighting options. Users can also directly adjust lights to better fit their preference. With user permission, such adjustment of lights can be recorded and provided as feedback to the machine learning model as an additional input.

The use of good lighting in a video call can make a substantial difference to the quality of the call. A well-lit face, not over-exposed or under-exposed, with lighting appropriate to the complexion, can focus the viewer's attention and reduce their cognitive load. Automated tuning of artificial light parameters, as described herein, makes it convenient for a user to achieve optimal looks for a video call. With user permission, the techniques described herein automatically modify the lighting as the brightness and/or color temperature of ambient light changes over the course of the duration of video capture. Since lower light results in noisy video that is harder to compress, a well-lit video can also result in reduced data usage for a video call or during live streaming. The techniques leverage existing hardware, e.g., cameras, tunable monitor lights, etc., such that additional investment in hardware is unnecessary; rather, light conditions can be adjusted using control loops running in software.

Further to the descriptions above, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs, or features described herein may enable the collection of user information (e.g., information about a user's context such as

ambient light, available light sources, room type, video or still images captured by a user device; a user's preferences; or a user's current location), and if the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level) so that a particular location of a user cannot be determined. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques to automatically optimize lighting conditions around a subject of a video or photograph to produce a better lit image. With user permission, ambient light conditions are analyzed by using image processing and machine learning and available light sources are adjusted to optimize the lighting of the scene. In contrast to traditional techniques that passively adapt to existing light conditions, the described techniques actively modify the light falling on the subject. Effectively, the techniques extend and improve AAA algorithms (auto exposure, auto white balance, autofocus) to include auto lighting. The techniques can be applied in any image or video capture application such as video chat, video conferencing, content creation for social media or video sharing sites, live streaming, etc.

REFERENCES

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