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# Predicted Image-Capture Device Settings through Machine Learning

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# Predicted Image-Capture Device Settings through Machine Learning

**Abstract:**

This publication describes an image-capture manager, which uses machine-learning algorithms modeled after neural networks to predict image-capture device settings that a user desires when capturing an image with an image-capture device. Based on training neural network models, the image-capture manager can dynamically predict and configure the image-capture device settings to match those that the user desires the image-capture device to use when capturing an image under detected conditions.

**Keywords:**

smart image-capture, image-capture mode, machine learning, neural network

**Background:**

An image-capture device, such as a digital camera or a smartphone with image-capturing capabilities, often offers to a user of the image-capture device different modes to capture images of different scenes under different conditions. For example, one offered mode may best apply to the image-capture device capturing an image of a waterfall at sunset while another offered mode may best apply to capturing an image of a sporting event mid-day. Each mode may include a combination of image-capture device settings that impacts how the image-capture device captures an image and subsequently renders the image to the user. Examples of such image-capture device settings include aperture settings, white-balance settings, exposure-time settings, auto-focus behavior settings, and zoom-level settings but to name a few.

In one example instance, a mode may be selectable by the user, requiring the user to determine a mode he would like the image-capture device to use when capturing an image. In this

example instance, the user may not be familiar with image-capture device settings of respective, available modes and may be burdened with gaining knowledge of the available modes relative to capturing different images under different conditions. In another example instance, the image-capture device may determine a mode based on surrounding conditions detected by the image-capture device and ignore image-capture device settings the user desires for capturing an image under a certain condition. Furthermore, and in both example instances, the image-capture device settings of respective, available modes may be pre-programmed into the image-capture device and, subsequently, be inflexible to a user's individual preferences.

**Description:**

This publication describes an image-capture manager, which uses machine-learning algorithms modeled after neural networks to predict image-capture device settings that a user desires when capturing an image with an image-capture device. Based on training neural network models, the image-capture manager can dynamically predict and configure the image-capture device settings to match those that the user desires the image-capture device to use when capturing, under a detected condition, the image.

To train the neural network models, the image capture manager takes into consideration variables that can include one or more conditions surrounding capturing of images, content anticipated in a captured image (*e.g.*, content detected while a user is preparing to capture the image), image-capture device settings that are selected or adjusted by a user of the image-capture device when capturing the images, image-capture device settings associated with a selection or deletion of an image from the captured images, and/or image-capture device settings corresponding to post-processing of the captured images.

Fig. 1 illustrates example image-capture devices having the image-capture manager:

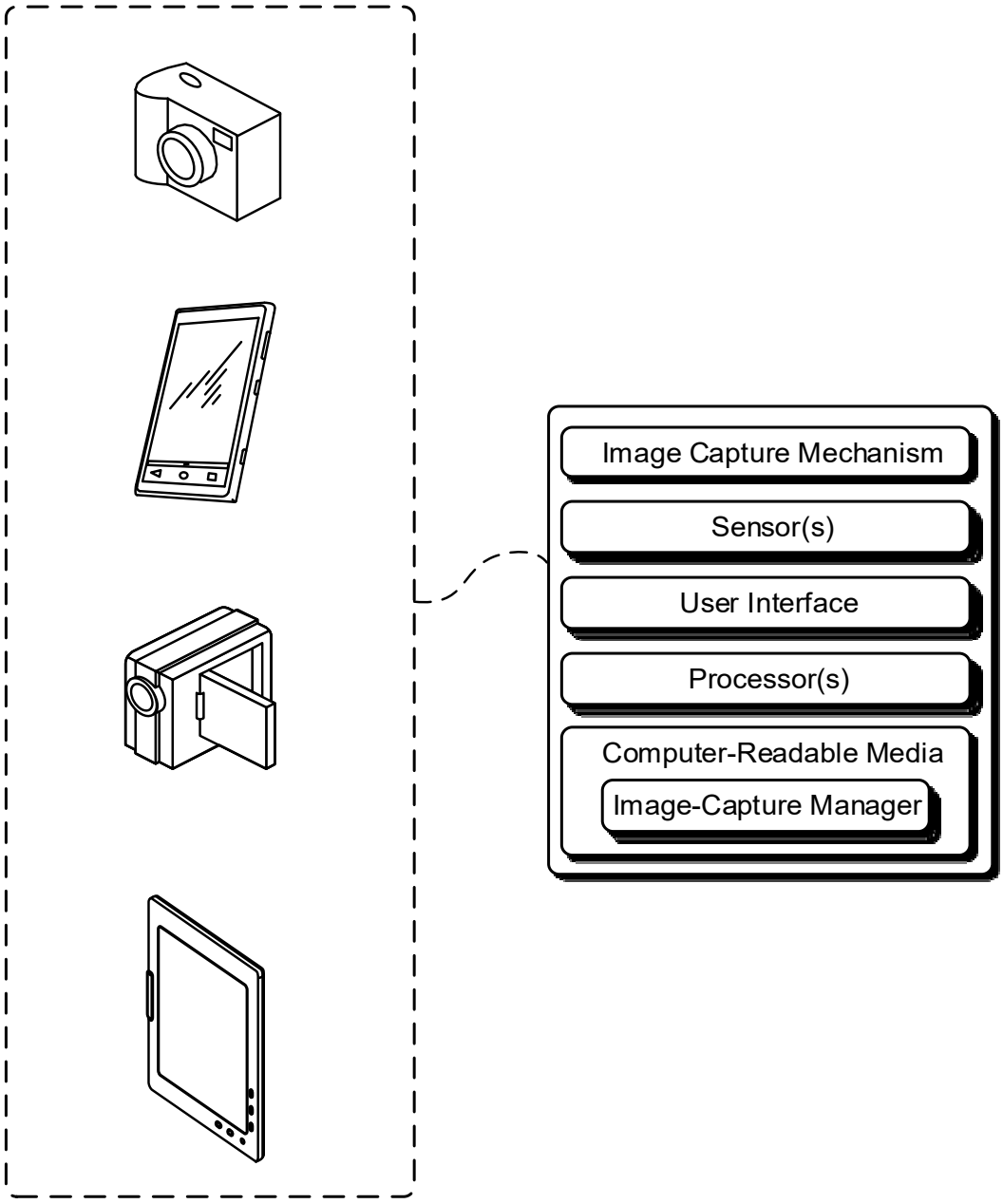


**Figure 1**

As illustrated, an image-capture device having the image-capture manager may be a camera, a smartphone, a video recorder, or a tablet. The image-capture device includes an image-

capture mechanism that may include one or more elements of a lens, a filter, and an aperture. In some instances, the elements of the image-capture mechanism may be integrated into an imager sensor, such as a complementary metal-oxide semiconductor (CMOS) imager sensor or a charge-coupled device (CCD) imager sensor.

The image-capture device also includes one or more sensors for detecting surrounding conditions. Examples of sensors for detecting the surrounding conditions include an imager sensor (*e.g.*, either the imager sensor that is part of the image-capture mechanism or another imager sensor that is separate from the image-capture mechanism), a radar sensor, and a proximity sensor. As an example, the image-capture device may use the sensors, individually or in combination, to determine a condition such as a lighting condition or a motion of an object within a field of view of the image-capture device.

The image-capture capture device includes a user interface, which may include one or more of a touchscreen, a button, a dial, a keypad, or a microphone for receiving input from a user of the image-capture device. Inputs may include, for example, parameters that are associated with one or more image-capture device settings, a selection or deletion of a captured image, or activities associated with post-processing the captured image (*e.g.*, change a rendered depth of focus of the captured image, crop the captured image, change a brightness of the captured image, change contrasting in the captured image, and the like).

The image-capture device also includes a processor and a computer-readable medium (CRM). The processor may be a single core processor or a multiple core processor composed of a variety of materials, such as silicon, polysilicon, high-K dielectric, copper, and so on. The CRM may include any suitable memory or storage device such as random-access memory (RAM), static

RAM (SRAM), dynamic RAM (DRAM), non-volatile RAM (NVRAM), read-only memory (ROM), or Flash memory.

The CRM includes executable instructions of an image-capture manager. The instructions of the image-capture manager, when executed by the processor, cause the image-capture device to perform multiple operations that manage image-capture device settings. Such operations include training a neural network model to predict image-capture device settings that are intended by a user of the image-capture device while the image-capture device is capturing the image under detected conditions.

Figure 2 illustrates an example neural network:

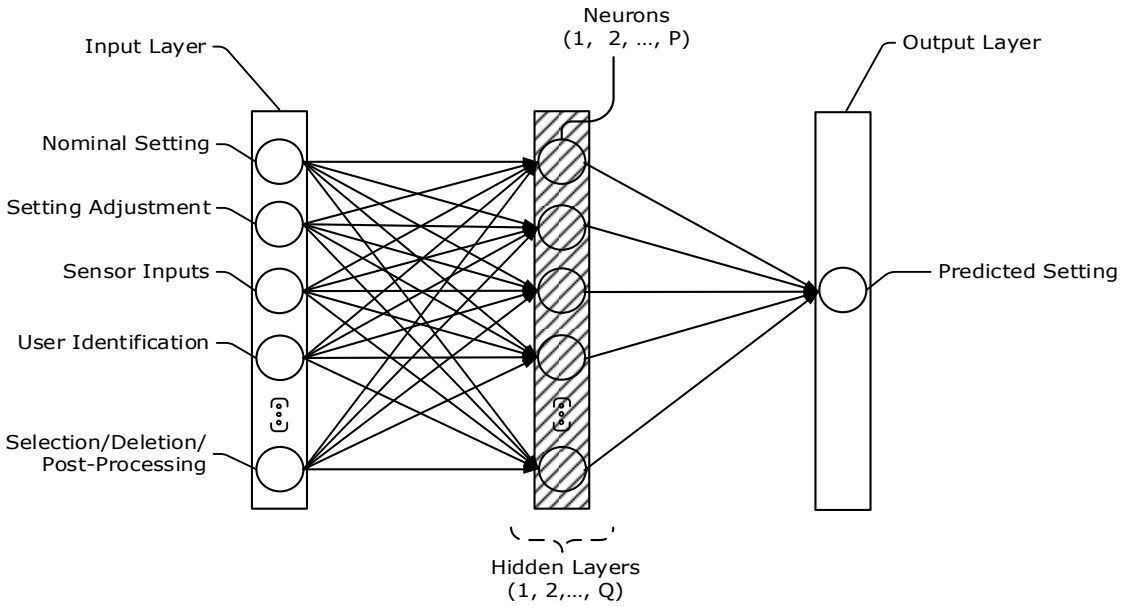


**Figure 2**

The neural network of Figure 2 illustrates an input layer, hidden layers, and an output layer. The input layer captures one or more inputs and passes the one or more inputs to nodes, or "neurons", within hidden layers of the neural network. The hidden layers of the neural network may include one or more layers of different types, such as a recurrent layer, a convolutional layer,

or classification layer. The hidden layers may use a combination of algorithms for exchanging information and ultimately converge on one or more outputs for the output layer. The one or more outputs of the output layer may change dynamically based on the one or more inputs received into the input layer and processed by the hidden layers.

The neural network may include multiple output layers, with each output layer of the multiple output layers dedicated to a predicted image-capture device setting. In general, the neural network may use the one or more inputs received through the input layer to predict image-capture device settings in accordance with the user's preferences. In the context of training a neural network model (*e.g.*, a model in accordance with the neural network of Fig. 2), functions performed through executing the instructions of the image-capture manager predict image-capture device settings that correspond to the user's preferences.

Consider example scenarios, a first in which a photographer who is capturing images of a soccer game prefers a first configuration of image-capture device settings and a second in which another photographer who is capturing images of wildlife prefers a second configuration of image-capture device settings. Although at some level the scenarios may include the photographers capturing, under similar conditions, images that have similar content (*e.g.*, outdoors, green backgrounds, and objects that are moving), preferences of each photographer with regards to image-capture device settings may differ.

For each user, the image-capture manager (*e.g.*, the neural network) may use a history of inputs that include nominal image-capture device settings that may be associated with a selected mode that is offered by the camera (*e.g.*, a mode such as a low-light mode, a portrait mode, a high-speed mode, a high-definition mode, or the like), adjustments made to image-device capture settings (either within the mode or manually), and sensor feedback (*e.g.*, detected lighting

conditions or detected motion). The image-capture manager may also use inputs that are related to post-processing of images, including the user selecting or deleting an image, or modifying how an image is rendered (changing a rendered depth of focus of a captured image, cropping features from a captured image, changing a rendered brightness of a captured image, or the like).

For each scenario, and for each user, the image-capture manager may then predict a combination of settings reflecting the user's preferences and configure the image-capture device to capture the image in accordance with the predicted combination of settings. Each respective combination of settings may include one or more of an aperture setting, a white-balance setting, an exposure-time setting, an auto-focus behavior setting, and a zoom-level setting to name but a few.

In some aspects, the image-capture manager enables an autonomous and continual mode of operation by an image-capture device. This autonomous and continual mode is flexible and configurable to a user's preferences and ensures that the image-capture device is ready to capture an image in accordance with the user's preferences without delay. The aforementioned systems and techniques are applicable to capturing still images as well as capturing moving images (*e.g.*, video), and may be incorporated into any device with image-capturing capabilities. Furthermore, machine-learning algorithms other than those modeled after neural networks may be used.