US00RE46758E

(19) **United States**
(12) **Reissued Patent**
Dowdy et al.

(10) **Patent Number: US RE46,758 E**
(45) **Date of Reissued Patent: Mar. 20, 2018**

(54) **ANIMATION OF GRAPHICAL OBJECTS**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Thomas Dowdy**, Sunnyvale, CA (US); **David Heller**, San Jose, CA (US); **Anne Jones**, Emerald Hills, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(21) Appl. No.: **13/890,934**

(22) Filed: **May 9, 2013**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **7,941,758**
Issued: **May 10, 2011**
Appl. No.: **11/899,036**
Filed: **Sep. 4, 2007**

(51) **Int. Cl.**
G06F 3/048 (2013.01)
G06F 3/0481 (2013.01)
G06F 9/44 (2018.01)
G06F 3/0488 (2013.01)

(52) **U.S. Cl.**
CPC ***G06F 3/0481*** (2013.01); ***G06F 3/04883*** (2013.01); ***G06F 9/4443*** (2013.01); *G06F 2203/04802* (2013.01)

(58) **Field of Classification Search**
CPC G06T 13/40; G06F 1/1626; G06F 3/0488; G06F 3/0481; G06F 9/4443; G06F 9/44543; G06F 3/0482; G06F 3/4443; G06F 2203/04802; G06F 3/04883
USPC 715/700, 744, 764, 765, 781, 810, 835, 715/839, 846, 864, 766, 767, 775, 785, 715/802, 828–831, 834, 838, 848, 850; 345/169, 173, 473–475, 902
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,379,057	A	1/1995	Clough et al.	
5,619,628	A *	4/1997	Fujita et al.	345/427
5,675,362	A	10/1997	Clough et al.	
6,130,679	A *	10/2000	Chen et al.	345/473
6,133,914	A *	10/2000	Rogers et al.	345/661
RE37,418	E *	10/2001	Tindell et al.	715/202
6,411,307	B1 *	6/2002	Rosin et al.	715/716
6,469,723	B1 *	10/2002	Gould et al.	715/837
7,262,775	B2 *	8/2007	Calkins et al.	345/473
7,283,138	B2	10/2007	Tremblay	
7,412,660	B2 *	8/2008	Donalson	715/777
7,593,015	B2 *	9/2009	Rao	345/473
7,941,758	B2	5/2011	Tremblay	

(Continued)

OTHER PUBLICATIONS

Darrel Plant, "What's a Besier Curve?", Feb. 1, 2001, http://www.moshplant.com/direct-or/bezier/index.html.*

(Continued)

Primary Examiner — Joshua Campbell
(74) *Attorney, Agent, or Firm* — Robert C. Kowert; Meyertons, Hood, Kivlin, Kowert & Goetzel, P.C.

(57) **ABSTRACT**

A method for animating graphical objects is provided. In one embodiment, the method includes providing a plurality of graphical objects and displaying a subset of the objects in a viewport. In this embodiment, the method may also include calculating a virtual destination for one of the graphical objects based on a received user input, and moving the graphical object to the virtual destination over a period of time. Various additional methods, machine-readable media, and devices for animating graphical objects and controlling operational characteristics of a device are also provided.

41 Claims, 9 Drawing Sheets

(56) **References Cited**

U.S. PATENT DOCUMENTS

2002/0008703	A1*	1/2002	Merrill et al.	345/473
2002/0033848	A1*	3/2002	Sciammarella et al.	345/838
2002/0191029	A1*	12/2002	Gillespie et al.	345/810
2004/0036711	A1*	2/2004	Anderson	345/701
2004/0100479	A1*	5/2004	Nakano et al.	345/700
2005/0012723	A1*	1/2005	Pallakoff	345/173
2005/0140694	A1*	6/2005	Subramanian et al.	345/619
2005/0181349	A1*	8/2005	Bardige et al.	434/362
2006/0268100	A1*	11/2006	Karukka et al.	348/14.01
2007/0028267	A1*	2/2007	Ostojic et al.	725/52
2007/0165031	A1*	7/2007	Gilbert et al.	345/473
2007/0186154	A1*	8/2007	Anthony et al.	715/517
2008/0158231	A1*	7/2008	Lee et al.	345/473
2008/0256466	A1*	10/2008	Salvador et al.	715/762
2008/0303827	A1*	12/2008	Schiff	345/473

OTHER PUBLICATIONS

Dave Caolo "Browse iTunes cover art with CoverFlow" published Aug. 11, 2005, pp. 1-4.

"CoverFlow" downloaded from www.steelskies.com/coverflow/homepage.html via the Wayback Machine, Jan. 10, 2006. p. 1.

Brian Benzinger "CoverFlow—Find and view album art" published Aug. 24, 2005 pp. 1-4.

"CoverFlow FAQ" downloaded from www.steelskies.com/coverflow/faq.html via the Wayback Machine, Jan. 11, 2006 p. 1.

"CoverFlow Features" downloaded from www.steelskies.com/coverflow/features.html via the Wayback Machine, Jan. 11, 2006 p. 1.

"CoverFlow : my visual album browser needs your help" Ars Technica Forum discussion, Jun. 27-28, 2005, pp. 1-44.

"CoverFlow" revised Jul. 4, 2005, downloaded from www.steelskies.com/coverflow/homepage.html p. 1.

Ben Whitehouse "CoverFlow: Better Digital Music Navigation" published Aug. 15, 2005, downloaded from wandco.com, pp. 1-2.

Jonathan del Strother "CoverFlow, Tech Demo Dec. 2005" Dec. 2005, pp. 1-4.

Tremblay, Christopher, U.S. Appl. No. 11/899,033, filed Sep. 4, 2007.

Tremblay, Christopher, U.S. Appl. No. 11/899,166, filed Sep. 4, 2007.

* cited by examiner

10
18
14
12
15
16
Menu
18

FIG. 1

10
30
Network Device
20
User Interface
14
Display
28
Expansion Card
22
Processor(s)
32
Power Source
26
Storage
24
Memory
18
I/O Ports

FIG. 2

40
42
Define Plurality of Evaluators
44
Define Rendering Function Including Evaluators
46
Storing Evaluators and Rendering Function
48
Animate Graphical Object

FIG. 3

FIG. 4

70
Y
X
(0,0)
1
2
3
4
5
6
7
8
74
72
76
78
62
P_0
P_1
P_2
P_3
P_4
t_0
t_1
t_2
t_3
t_4
b_0
b_1
b_2
b_3
b_4
b = (8, 4 - t)

FIG. 5

70
Y
X
(0, 0)
1
2
3
4
5
6
7
8
74
72
76
78
62
P_0
P_1
P_2
P_3
P_4
t_0
t_1
t_2
t_3
t_4
b_0
b_1
b_2
b_3
b_4
b = (8, 4 - t)

FIG. 6

90
92
Provide Graphical Objects
94
Display Subset of Graphical Objects
96
Receive User Input
98
Calculate Virtual Destination
100
Animate Graphical Object Toward Virtual Destination
102
New User Input During Animation?
Yes
No
104
End

FIG. 7

FIG. 8

124
112
O_1
O_5
O_{10}
O_{15}
O_{20}
P_5
P_{10}
P_{15}
P_{20}
P_{25}
P_{30}
P_{35}
126
126
138
120
112
X_1
132
130
110

FIG. 9

136
112
O_1
O_5
O_{10}
O_{15}
O_{20}
P_5
P_{10}
P_{15}
P_{20}
P_{25}
P_{30}
P_{35}
126
126
112
138
120
132
130
110

FIG. 10

FIG. 11

FIG. 12

FIG. 13

ANIMATION OF GRAPHICAL OBJECTS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

BACKGROUND

1. Technical Field

The present invention relates generally to image processing and, more particularly, to the animation of graphical objects within graphical user interfaces.

2. Description of the Related Art

This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present invention, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

Electronic devices and systems increasingly include display screens as part of the user interface of the device or system. As may be appreciated, display screens may be employed in a wide array of devices and systems, including desktop computer systems, notebook computers, and handheld computing devices, as well as various consumer products, such as cellular phones and portable media players. Such display screens may be useful for displaying status information about the device or for displaying information about an operation being performed by the device. For example, portable music and/or video players may display information about a music or video file being played by the device, such as the title of the song or video being played, the time remaining, the time elapsed, the artist or cast, or other information of interest. Alternatively, the display of such a device may display a piece of artwork or an arbitrary design during operation of the device.

In some instances, it may be desirable to show an image including one or more graphical objects on the display screen, and to allow a user to pan through a relatively large set of such graphical objects. Further, in some cases, the number of graphical objects may exceed that which may be conveniently displayed at one time. In these cases, the display screen may depict only a subset of the total number of graphical objects, and the particular displayed subset may change as a user pans through the total number of graphical objects. Further, the animation of images and graphical objects may consume a significant amount of memory and processing resources, which may negatively impact performance of the electronic device.

SUMMARY

Certain aspects of embodiments disclosed herein by way of example are summarized below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of certain forms an invention disclosed and/or claimed herein might take and that these aspects are not intended to limit the scope of any invention disclosed and/or claimed herein. Indeed, any invention disclosed and/or claimed herein may encompass a variety of aspects that may not be set forth below.

The present disclosure generally relates to techniques for animating graphical objects and images, and for controlling other operational aspects of a device or system. In accordance with one disclosed embodiment, an exemplary method may include controlling and adjusting display characteristics of an image via one or more evaluators. Such display characteristics, in various embodiments, may include position, velocity, acceleration, size, and/or opacity, for example. In some embodiments, multiple evaluators may be incorporated into a rendering function to create complex visual animation effects of one or more graphical objects. In other embodiments, evaluators may be used to control other operational aspects of a device, such as a sound generated by the device. In accordance with another disclosed embodiment, an exemplary method may include displaying a portion of a set of images, and moving one or more of the images to a virtual destination in response to a user input. Further, in some embodiments, the virtual destination may be updated in mid-animation upon the receipt of an additional user input, facilitating a smooth animation of the object from its original position to the updated virtual destination.

Various refinements of the features noted above may exist in relation to various aspects of the present invention. Further features may also be incorporated in these various aspects as well. These refinements and additional features may exist individually or in any combination. For instance, various features discussed below in relation to one or more of the illustrated embodiments may be incorporated into any of the above-described aspects of the present invention alone or in any combination. Again, the brief summary presented above is intended only to familiarize the reader with certain aspects and contexts of embodiments of the present invention without limitation to the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description of certain exemplary embodiments is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. **1** is a perspective view illustrating a portable media player in accordance with one embodiment of the present invention;

FIG. **2** is a simplified block diagram of the portable media player of FIG. **1** in accordance with one embodiment of the present invention;

FIG. **3** is a flowchart depicting a process for animating a graphical object in accordance with one embodiment of the present invention;

FIG. **4** illustrates the animation of a graphical object through use of an evaluator accordance with one embodiment of the present invention;

FIG. **5** generally depicts the movement of a graphical object through use of a time-varying evaluator in accordance with one embodiment of the present invention;

FIG. **6** depicts the animation of a graphical object in which values for the location of the object and the opacity of the object are output from time-dependent evaluators in accordance with one embodiment of the present invention;

FIG. **7** is a flowchart depicting a process for animating a series of images in accordance with one embodiment of the present invention;

FIG. **8** illustrates an exemplary viewport including images that include cover art associated with one or more media files in accordance with one embodiment of the present invention;

FIG. **9** is a diagram generally illustrating a series of image objects in relative positions and the calculation of a virtual destination for a particular image object in accordance with one embodiment of the present invention;

FIG. **10** is a diagram illustrating the movement of the series of image objects of FIG. **9** such that the particular image object is located at its virtual destination in accordance with one embodiment;

FIG. **11** is a diagram generally illustrating a series of image objects and the calculation of a first virtual destination and a second, updated virtual destination for a particular image object in accordance with one embodiment of the present invention;

FIG. **12** is a diagram illustrating the position of the image objects of FIG. **11** at the time the second virtual destination is calculated in one embodiment of the present invention; and

FIG. **13** is a diagram illustrating the movement of the series of image objects of FIGS. **11** and **12** such that the particular image object is located at its updated virtual destination in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

One or more specific embodiments of the present invention will be described below. These described embodiments are only exemplary of the present invention. Additionally, in an effort to provide a concise description of these exemplary embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

An exemplary electronic device **10** is illustrated in FIG. **1** in accordance with one embodiment of the present invention. In some embodiments, including the presently illustrated embodiment, the device **10** may be a portable electronic device, such as a media player, a cellular phone, a personal data organizer, or the like. Indeed, in such embodiments, a portable electronic device may include a combination of the functionalities of such devices. In addition, the electronic device **10** may allow a user to connect to and communicate through the Internet or through other networks, such as local or wide area networks. For example, the portable electronic device **10** may allow a user to access the internet and to communicate using e-mail, text messaging, instant messaging, or using other forms of electronic communication. By way of example, the electronic device **10** may be a model of an iPod having a display screen or an iPhone available from Apple Inc.

In certain embodiments, the device **10** may be powered by one or more rechargeable and/or replaceable batteries. Such embodiments may be highly portable, allowing a user to carry the electronic device **10** while traveling, working, exercising, and so forth. In this manner, and depending on the functionalities provided by the electronic device **10**, a user may listen to music, play games or video, record video or take pictures, place and receive telephone calls, communicate with others, control other devices (e.g., via remote control and/or Bluetooth functionality), and so forth while moving freely with the device **10**. In addition, device **10** may be sized such that it fits relatively easily into a pocket or a hand of the user. While certain embodiments of the present invention are described with respect to a portable electronic device, it should be noted that the presently disclosed techniques may be applicable to a wide array of other, less portable, electronic devices and systems that are configured to render graphical data, such as a desktop computer.

In the presently illustrated embodiment, the exemplary device **10** includes an enclosure or housing **12**, a display **14**, user input structures **16**, and input/output connectors **18**. The enclosure **12** may be formed from plastic, metal, composite materials, or other suitable materials, or any combination thereof. The enclosure **12** may protect the interior components of the electronic device **10** from physical damage, and may also shield the interior components from electromagnetic interference (EMI).

The display **14** may be a liquid crystal display (LCD), a light emitting diode (LED) based display, an organic light emitting diode (OLED) based display, or some other suitable display. In accordance with certain embodiments of the present invention, the display **14** may display a user interface and various other images, such as logos, avatars, photos, album art, and the like. Additionally, in one embodiment, the display **14** may include a touch screen through which a user may interact with the user interface. The display may also include various function and/or system indicators to provide feedback to a user, such as power status, call status, memory status, or the like. These indicators may be incorporated into the user interface displayed on the display **14**.

In one embodiment, one or more of the user input structures **16** are configured to control the device **10**, such as by controlling a mode of operation, an output level, an output type, etc. For instance, the user input structures **16** may include a button to turn the device **10** on or off. Further the user input structures **16** may allow a user to interact with the user interface on the display **14**. Embodiments of the portable electronic device **10** may include any number of user input structures **16**, including buttons, switches, a control pad, a scroll wheel, or any other suitable input structures. The user input structures **16** may work with the user interface displayed on the device **10** to control functions of the device **10** and/or any interfaces or devices connected to or used by the device **10**. For example, the user input structures **16** may allow a user to navigate a displayed user interface or to return such a displayed user interface to a default or home screen.

The exemplary device **10** may also include various input and output ports **18** to allow connection of additional devices. For example, a port **18** may be a headphone jack that provides for the connection of headphones. Additionally, a port **18** may have both input/output capabilities to provide for connection of a headset (e.g., a headphone and microphone combination). Embodiments of the present invention may include any number of input and/or output ports, such as headphone and headset jacks, universal serial

bus (USB) ports, IEEE-1394 ports, and AC and/or DC power connectors. Further, the device **10** may use the input and output ports to connect to and send or receive data with any other device, such as other portable electronic devices, personal computers, printers, or the like. For example, in one embodiment, the device **10** may connect to a personal computer via an IEEE-1394 connection to send and receive data files, such as media files.

Additional details of the illustrative device **10** may be better understood through reference to FIG. **2**, which is a block diagram illustrating various components and features of the device **10** in accordance with one embodiment of the present invention. In the presently illustrated embodiment, the device **10** includes the display **14** and the I/O ports **18** discussed above. In addition, as discussed in greater detail below, the exemplary device **10** may include a user interface **20**, one or more processors **22**, a memory device **24**, a non-volatile storage **26**, card interface(s) **28**, a networking device **30**, and a power source **32**.

As discussed further herein, the user interface **20** may be displayed on the display **14**, and may provide a means for a user to interact with the electronic device **10**. The user interface may be a textual user interface, a graphical user interface (GUI), or any combination thereof, and may include various layers, windows, screens, templates, elements, or other components that may be displayed in all or in part of the display **14**. The user interface **20** may, in certain embodiments, allow a user to interface with displayed interface elements via one or more user input structures **16** and/or via a touch sensitive implementation of the display **14**. In such embodiments, the user interface provides interactive functionality, allowing a user to select, by touch screen or other input structure, from among options displayed on the display **14**. Thus the user can operate the device **10** by appropriate interaction with the user interface **20**.

The processor(s) **22** may provide the processing capability required to execute the operating system, programs, user interface **20**, and any other functions of the device **10**. The processor(s) **22** may include one or more microprocessors, such as one or more "general-purpose" microprocessors, one or more special-purpose microprocessors and/or ASICS, or some combination thereof. For example, the processor **22** may include one or more reduced instruction set (RISC) processors, such as a RISC processor manufactured by Samsung, as well as graphics processors, video processors, and/or related chip sets.

As noted above, embodiments of the electronic device **10** may also include a memory **24**. The memory **24** may include a volatile memory, such as random access memory (RAM), and/or a non-volatile memory, such as read-only memory (ROM). The memory **24** may store a variety of information and may be used for various purposes. For example, the memory **24** may store the firmware for the device **10**, such as an operating system, other programs that enable various functions of the device **10**, user interface functions, processor functions, and may be used for buffering or caching during operation of the device **10**.

The non-volatile storage **26** of device **10** of the presently illustrated embodiment may include ROM, flash memory, a hard drive, or any other suitable optical, magnetic, or solid-state storage medium, or a combination thereof. The storage **26** may store data files such as media (e.g., music and video files), software (e.g., for implementing functions on device **10**), preference information (e.g., media playback preferences), lifestyle information (e.g., food preferences), exercise information (e.g., information obtained by exercise monitoring equipment), transaction information (e.g., information such as credit card information), wireless connection information (e.g., information that may enable the device **10** to establish a wireless connection, such as a telephone connection), subscription information (e.g., information that maintains a record of podcasts, television shows, or other media to which a user subscribes), telephone information (e.g., telephone numbers), and any other suitable data.

The embodiment illustrated in FIG. **2** also includes one or more card slots **28**. The card slots may be configured to receive expansion cards that may be used to add functionality to the device **10**, such as additional memory, I/O functionality, or networking capability. Such an expansion card may connect to the device through any type of suitable connector, and may be accessed internally or external to the enclosure **12**. For example, in one embodiment, the card may be flash memory card, such as a SecureDigital (SD) card, mini- or microSD, CompactFlash card, Multimedia card (MMC), or the like. Additionally, in an embodiment including mobile telephone functionality, a card slot **28** may receive a Subscriber Identity Module (SIM) card.

The exemplary device **10** depicted in FIG. **2** also includes a network device **30**, such as a network controller or a network interface card (NIC). In one embodiment, the network device **30** may be a wireless NIC providing wireless connectivity over any 802.11 standard or any other suitable wireless networking standard. The network device **30** may allow the device **10** to communicate over a network, such as a LAN, WAN, MAN, or the Internet. Further, the device **10** may connect to and send or receive data with any device on the network, such as portable electronic devices, personal computers, printers, and so forth. For example, in one embodiment, the device **10** may connect to a personal computer via the network device **30** to send and receive data files, such as media files. Alternatively, in some embodiments, the portable electronic device may not include a network device **30**. In such an embodiment, a NIC may be added into card slot **28** to provide similar networking capability as described above.

Further, the device **10** may also include a power source **32**. In one embodiment, the power source **32** may be one or more batteries, such as a Li-Ion battery, may be user-removable or secured to the housing **12**, and may or may not be rechargeable. Additionally, the power source **32** may include AC power, such as provided by an electrical outlet, and the device **10** may be connected to the power source **32** via the I/O ports **18**.

[In**]** *It* should again be noted that various images and data, including graphical data, may be processed and displayed by the device **10**. Keeping this in mind, a flowchart of an exemplary method **40** for animating graphical objects is illustrated in FIG. **3** in accordance with one embodiment of the present invention. The exemplary method **40** may include defining a plurality of evaluators associated with a graphical object, as generally indicated in block **42**. As used herein, an evaluator is a function that returns a value associated with some operational characteristic of a device or system. In various embodiments, such operational characteristics may include a display characteristic of a graphical object in display screen, a characteristic of a sound generated by the device, an internal property, or the like. In some embodiments, evaluators are components containing a mathematical function that is sampled along with various parameters. For instance, in one embodiment, an evaluator may include a function that calls for a linear interpolation between two values. In this case, the parameters may include a time evaluator that interpolates time from start to end, as

well as the beginning and end value for the interpolation. Additionally, in some instances, the evaluators can also be defined recursively. For example, instead of using two constant values for the linear interpolation, the start and/or end points themselves could also be defined as a linear interpolation between two sets of unique values, which may create what is known as a Bezier curve with the fundamental definition of evaluators.

In some embodiments, a basic set of evaluators (e.g., addition, subtraction, multiplication, linear interpolation, trigonometric interpolation, spherical interpolation, or the like) may be defined with various parameters, such as time, or simply two evaluators (i.e., defined recursively). Once a working set of evaluators has been defined, these evaluators may be used in various combinations to create desired effects. Consequently, in one embodiment, a given task (e.g., animating an object, controlling a sound or internal process, or the like) may be accomplished via selection of an appropriate combination of evaluators, rather than requiring the creation of entirely new functions or substantial modification of existing functions. Moreover, in one embodiment, the evaluators can also be used in an animation design tool where each component, or "box", defines a single function that can be combined with other components to perform complex tasks attached to a selected property.

As noted above, in some embodiments, an evaluator may return a constant value, or may include a time-based function such that the value returned by or sampled from the evaluator varies with respect to time. Both constant evaluators and time-varying evaluators may return a value associated with any number of display characteristics of a graphical object. For instance, an evaluator may return a value associated with the position, size, velocity, acceleration, color, opacity, or some other characteristic of the display object. Specific exemplary uses of some such evaluators are discussed below with respect to FIGS. **4-6**.

The exemplary method **40** may also include defining a control function, such as a rendering function (in those embodiments relating to control of graphical animation), that includes such evaluators, as generally indicated in block **44**. In other embodiments, however, the control function may be defined to modify other, non-display characteristics, such as those noted above. In the presently illustrated embodiment, the method **40** also includes storing the evaluators and the rendering (or other control) function, as generally depicted in block **46**. As will be appreciated, the evaluators and the rendering function may be stored in any suitable memory and/or storage device, such as the memory **24** and/or the non-volatile storage **26** of device **10**, as described above. In some embodiments, the method **40** may also include animating a graphical object via the rendering function, as generally provided in block **48**. In various embodiments, the animated graphical object may be a photograph, cover art, avatars, icons, an individual pixel, or any other desired graphical or image object.

While numerous aspects of a graphical object may be manipulated via the evaluators and the rendering function noted above, specific examples of such evaluators and animation are discussed below with reference to FIGS. **4-6** for illustrative purposes. It will be appreciated, however, that these examples are merely provided for the sake of clarity, and other animations and operations may be performed via evaluators in full accordance with the present techniques.

With reference to an exemplary graph **60** of FIG. **4**, and by way of example, it may be desirable to animate a graphical object **62** from a starting point (a) to a destination point (b) over a desired period of time (t). Although the graph **60** is generally illustrated as a two-dimensional rectangular coordinate system, with units of distance along the horizontal and vertical axes **64** and **66**, respectively, it will be appreciated that the present techniques may also be applied in various other coordinate systems, including a three-dimensional system. In the exemplary graph **60**, point a is located at coordinates (0,0) and point b is located at coordinates (8,4). In one embodiment, an evaluator "A" may be defined to return the location of point a, and an evaluator "B" may be defined to return the location of point b. A rendering function for animating the graphical object **62** from point a to point b may then be defined as a linear interpolation from the value returned by evaluator A to the value returned by evaluator B over a desired period of time, such as four seconds, or:

$$R(t)=\text{lerp}(A,B),\ \text{over } t=0 \text{ to } t=4.$$

In this embodiment, execution of the rendering function results in the movement of the graphical object **62** from point a to point b along a path **68** over the course of four seconds. Thus, counting in one second intervals (e.g., times t_1, t_2, t_3, and t_4), the graphical object **62** may be located at coordinates (2,1), (4,2), (6,3), and (8,4) at respective times t_1, t_2, t_3, and t_4.

In another embodiment, the evaluators may be used to render a more complex animation effect, as generally illustrated in the exemplary graph **70** of FIG. **5**. As in graph **60**, graph **70** may be a two-dimensional rectangular coordinate system with horizontal and vertical axes **72** and **74**, respectively. In this embodiment, however, rather than defining evaluators A and B as functions that return set points and/or values, evaluator A may be defined to return the location of the graphical object **62** at a given time, and the evaluator B may defined as a linear time-based function that returns the location of a point b that moves with respect to time along a path **76**, as generally indicated in FIG. **5**. Further, an evaluator "D" may be defined as a recursive linear interpolation function over a given time period, such as four seconds. With the evaluators defined in this manner, the rendering function:

$$R(t)=D(A,B),\ \text{over } t=0 \text{ to } t=4,$$

may result in the animation of the graphical object **62** along a path **78**, as also generally illustrated in FIG. **5**.

Further, additional evaluators may be defined and utilized by the rendering function to adjust other display characteristics of the graphical object **62**. For example, an evaluator "C" may be defined to control the opacity of the graphical object **62** over a period of time. For instance, the evaluator C may include the function:

$$f(t)=(4-t)/4,\ \text{from } t=0 \text{ to } t=4$$

such that the evaluator returns an opacity value between 0 and 1, inclusive, where an opacity value of 1 corresponds to fully opaque and the opacity value 0 corresponds to fully transparent (i.e., not visible). The rendering function for the graphical object **62** may then be defined as:

$$R(t)=[D(A,B)],C;\ \text{from } t=0 \text{ to } t=4,$$

resulting in the gradual fading of the graphical object **62** as it travels along the path **78**, as generally illustrated in FIG. **6**. Particularly, as the evaluator C includes a linear function from fully opaque to fully transparent, the graphical object is fully opaque at its initial position P_0 at time t_0, is 75% opaque at position P_1, and time t_1, 50% opaque position P_2 and time t_2, 25% opaque at position P_3 and time t_3, and is fully transparent at position P_4 and time t_4. As noted above,

while these particular examples have been provided for illustrative purposes, it will be appreciated that a wide array of various characteristics, whether display characteristics or other characteristics, may be adjusted through the use of evaluators and/or rendering functions via the techniques described above. Further, while linear interpolations were implemented in some of the evaluators discussed above, it will be appreciated that other forms of interpolation, such as polynomial, exponential, trigonometric, logarithmic, or the like, may be used in full accordance with the present techniques.

An exemplary method **90** for animating a series of graphical objects or images is depicted in FIG. **7**. In one embodiment, the method **90** includes providing a plurality of graphical objects or images, and displaying a subset or a portion of the graphical objects in a viewport of the display, such as the display **14** of the device **10**, as generally indicated in blocks **92** and **94**. In various embodiments, the graphical objects may include photographs, icons, avatars, cover art, or the like, which a user may be able to browse through by panning or scrolling through the plurality of graphical objects.

In one embodiment, the exemplary method **90** includes receiving a user input, such as via a user input structure **16**, and calculating a virtual destination for one or more displayed graphical objects based on the user input, as generally indicated in blocks **96** and **98** of FIG. **7**. In some embodiments, the user input structure **16** is a touch-sensitive device, and the calculation of the virtual destination depends on some aspect of the user interaction with the touch-sensitive device. For instance, a fast motion by a user against the touch-sensitive input device may result in the calculation of a virtual destination that is further from the graphical object that that which would be calculated in response to a slower motion. It should be noted that, as used herein, the term "virtual destination" refers to a calculated destination for an image object, and may include an actual display position within the viewport or a virtual display position falling outside the edges of the viewport, as discussed in greater detail below with respect to FIGS. **8-13**.

Once the virtual destination is calculated for a graphical object, the graphical object may be animated toward its virtual destination over any desired time period, as generally indicated in block **100**. If an additional user input is received during animation of the graphical object toward its virtual destination (block **102**), a new, updated virtual destination for the graphical object may be calculated based on the new user input and the graphical object may proceed from its present location to its new virtual destination over a new time period. In one embodiment, the receipt of a new user input during an animation sequence initiated by a previous user input results in the cancellation of the original animation sequence and the beginning of a new animation sequence. Such cancellation may be performed such that the graphical object is essentially "handed-off" from the first animation sequence to the second animation sequence without any, or any significant, perceptible break in the animation of the graphical object from its original position to its updated virtual destination.

In some embodiments, the time periods associated with the animation sequences in response to original and new user inputs may be substantially equivalent, although differing time periods may be used in full accordance with the present techniques. The moving or animating of the graphical object may be performed according to a function including an evaluator, such as generally described above with respect to FIGS. **3-6**. With or without the use of evaluators, such animation may also be performed through interpolation between the location the graphical object prior to receipt of the user input and the virtual destination calculated following the user input. In one embodiment, such interpolation is a linear interpolation, although other forms of interpolation, such as polynomial, exponential, trigonometric, or the like, may be used. Once the graphical object reaches its virtual destination, the method **90** ends (block **104**).

An exemplary viewport **110**, in which graphical objects may be displayed, is provided in FIG. **8**. In some embodiments, the viewport **110** may be provided on the display **14**. As noted above, the viewport **110** may display a subset of a plurality of graphical objects **112**, such as cover art, photos, or the like. In one embodiment, the viewport **110** may be configured to display a subset of the plurality of graphical objects **112**, wherein the subset is of a certain size. For instance, in the presently illustrated embodiment, the viewport **110** is generally configured to display five graphical or image objects **112**, although a greater or lesser number of such objects may be displayed within the viewport **110** in other embodiments. Additionally, a user may scroll or pan through the graphical objects **112** via the scroll bar **114**. As the viewport **110** displays only a subset of the graphical objects **112**, other graphical objects **112** may be considered to be in virtual positions **116** (i.e., in positions that are not displayed in the viewport **110**) on either side of the viewport **110**.

The animation of a particular graphical or image object **120** of the plurality of graphical objects **112** may be better understood with reference to the diagrams illustrated in FIGS. **9-13**. For example, the diagram **124** of FIG. **9** generally illustrates a plurality of graphical objects O_1-O_{20} and their respective location with respect to a series of positions **126** (P_5-P_{37}) in accordance with one embodiment. The depiction of the graphical objects **112** in FIG. **9** generally corresponds to that of FIG. **8**, with the particular graphical object **120** occupying a generally central position within the viewport **110**. In the presently illustrated embodiment, the positions P_{20}-P_{24} generally correspond to the actual display positions of the subset of the graphical objects **112** within the viewport **110**, while the remaining positions **126** may be considered to be virtual positions as discussed above.

Once a user input is received, a virtual destination **130**, at a distance x_1 from a starting location **132** (at P_{22}) of the graphical object **120** may be calculated. The graphical object **120** may then be moved or animated from the location **132** to the virtual destination **130** over a given period of time, such as one second, three seconds, or some other amount of time. At the conclusion of such animation, the sequence of graphical objects **112** may be located within the positions **126** as illustrated in diagram **136** of FIG. **10**. As illustrated in the exemplary diagram **136**, the plurality of graphical objects **112** have been shifted to the right with respect to the viewport **110**, such that the graphical object **120** is now located at its virtual destination **130**, while an additional graphical object **138** has been animated into the location **132** previously occupied by the graphical **120** prior to the animation. As noted above, the virtual destination calculated for a given graphical object **112** may correspond to an actual display position within the viewport **110** or a virtual position outside of the viewport **110**.

In an additional embodiment, an additional user input may be received during animation of the graphical object **120** from its starting location **132** to its virtual destination **130**, as generally illustrated in diagram **142** of FIG. **11**. In such an embodiment, the graphical object **120** may have

only traversed a portion of the distance x_1 between the starting location **132** and the virtual destination **130** when the additional user input is received. For instance, if the graphical object **120** is to be animated from the location **132** to the virtual destination **130** over a period of one second, an additional user input may be received 0.4 seconds into the animation, at which time the graphical objects **112** are generally located in the positions illustrated in the diagram **144** of FIG. **12**. Notably, at the time of receipt of new user input, the graphical object **120** is located at a position **146** and a new, updated virtual destination **148** may be calculated based on the new user input. Subsequently, the graphical object **120** may be animated from the location **146** to the updated virtual destination **148**, as generally illustrated in the exemplary diagram **152** of FIG. **13**.

Additionally, although the examples provided above include the movement of the graphical object **120** (in accordance with a calculated virtual destination) from an actual display position within the viewport **110** to a virtual display position outside of the viewport **110** (FIGS. **9** and **10**), and from one virtual display position to another (FIGS. **12** and **13**), it should be noted that other types of movement may also be performed in other embodiments. For instance, in other embodiments, a graphical object may be animated from its virtual display position to an actual display position, or between two actual display positions, in full accordance with the present techniques. Still further, a graphical object may be animated from a virtual display position on one side of the viewport **110** to a virtual display position on the opposite side of the viewport **110**.

While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

What is claimed is:

1. A method comprising:

defining a plurality of evaluators associated with respective operational characteristics of a device;

defining a control function dependent on time and including first and second evaluators of the plurality of evaluators, wherein at least one of the first or second evaluators includes an additional function dependent on time; and

storing the plurality of evaluators and the control function in a memory of the device, wherein **[**the device is configured to vary**]** the operational characteristics associated with the first and second evaluators *vary* based at least in part on the control function;

wherein the operational characteristics associated with the first and second evaluators comprise one or more display characteristics of a *given* graphical object**[**,**]** *and* the control function comprises a rendering function**[**, and the device is configured to animate**]***;*

the method further comprising:

determining a target position for a graphical object outside of a display of the device based on a user input;

animating the graphical object **[**and to vary**]***;*

varying the one or more display characteristics associated with the first and second evaluators during animation of the graphical object *over a pre-determined period of time* based at least in part on the rendering function;

determining another target position for the graphical object or another graphical object outside of the display of the device based on another user input, wherein the target position and the other target position are different distances from a position of the graphical object or the other graphical object;

animating the graphical object or the other graphical object; and

varying the one or more display characteristics associated with the first and second evaluators during animation of the graphical object or the other graphical object over the pre-determined period of time based at least in part on the rendering function,

wherein the rendering function comprises a recursive interpolation function for animating the *given* graphical object*, over the pre-determined period of time,* between a source position *on the display of the device* and a target position *outside the display of the device*; and wherein **[**the target**]** *a current* position *for the given graphical object being animated between the source position and the target position at a given time within the pre-determined period of time* is defined at least in part by one of the first or second evaluators including the additional function dependent on time such that the **[**target**]** *current* position varies with respect to time, and the *given* graphical object is animated from the source position to the target position over **[**a**]** *the pre-determined* period of time such that the *given* graphical object arrives **[**substantially**]** at the **[**current**]** target position at the end of the *pre-determined* period of time.

2. The method of claim **1**, wherein the one or more display characteristics associated with the first and second evaluators comprise a position of the *given* graphical object.

3. The method of claim **1**, wherein the additional function dependent on time includes at least one of a linear function, a polynomial function, an exponential function, a logarithmic function, or a trigonometric function.

4. The method of claim **1**, wherein the rendering function **[**is configured to adjust**]** *adjusts* a plurality of display characteristics of the *given* graphical object via evaluators, the display characteristics comprising two or more of position, velocity, acceleration, size, opacity, or color.

5. The method of claim **1**, wherein the first and second evaluators of the control function operate concurrently.

6. A method comprising:

providing a plurality of graphical objects;

displaying a subset of the plurality of graphical objects in a viewport of a display;

receiving a user input;

calculating a virtual destination for at least one graphical object of the subset based on the user input; and

moving the at least one graphical object to the virtual destination over a *pre-determined* time period *according to a time dependent function as time elapses during the pre-determined time period*, wherein moving the at least one graphical object comprises moving the at least one graphical object from an actual display position within the viewport to a virtual display position *outside of the viewport of the display such that the at least one graphical object arrives at the virtual display position at the end of the pre-determined time period;*

receiving another user input;

calculating another virtual destination for another at least one graphical object of the subset based on the other user input, wherein a distance between the at least one graphical object and the virtual destination

and another distance between the other at least graphical object and the other virtual destination are different distances;

moving the other at least one graphical object to the other virtual destination over the pre-determined time period according to the time dependent function as time elapses during the pre-determined time period, wherein moving the other at least one graphical object comprises moving the other at least one graphical object from an actual display position within the viewport to the other virtual display position outside of the viewport of the display such that the other at least one graphical object arrives at the other virtual display position at the end of the pre-determined time period.

7. The method of claim **6**, comprising:

receiving an additional user input *while moving the at least one graphical object* during the *pre-determined* time period;

updating the virtual destination for the at least one graphical object based on the additional user input; and

moving the at least one graphical object to the updated virtual destination over an additional *pre-determined* time period.

8. The method of claim **6**, wherein moving the at least one graphical object comprises moving the at least one graphical object according to a function including an evaluator.

9. The method of claim **6**, wherein moving the at least one graphical object comprises moving the at least one graphical object according to an interpolation between its original position and its virtual destination.

10. The method of claim **[6]** *9*, wherein the interpolation comprises a **[**linear**]** *non-linear* interpolation.

[11. The method of claim **6**, wherein the virtual destination is outside of the viewport.**]**

12. The method of claim **6**, comprising:

calculating virtual destinations for each graphical object of the plurality of graphical objects based on the user input; and

animating the sequence of graphical objects of the plurality of graphical objects within the viewport over the *pre-determined* time period such that each graphical object of the plurality of graphical objects is moved to its respective virtual destination **[**over**]** *at the end of* the *pre-determined* time period.

13. A device comprising:

a housing;

a display disposed in the housing;

a memory device disposed in the housing, the memory device including executable application instructions stored therein; and

a processor disposed in the housing **[**and configured to execute**]**, *wherein* the application instructions stored in the memory device**[**;

wherein the device is configured to**]**, *when executed by the processor, cause the device to:* pan through a plurality of images in response to a user input,

wherein to pan through the plurality of images the application instructions when executed by the processor cause the device to:

calculate, based on the user input, a virtual destination outside of the viewport of the display;

move at least one image **[**is moved**]** *of the plurality of images* over a *pre-determined* period of time to **[**a**]** *the* virtual destination **[**that is calculated from the user input,**]** *according to a time dependent function as time elapses during the pre-determined period of time;* and

[the**]** *move* at least one *other* image **[**is moved**]** *of the plurality of images* at least between a virtual display position outside of the display and an actual display position within the display *according to the time dependent function as time elapses during the pre-determined period of time, and*

wherein to perform another pan through the plurality of images the application instructions when executed by the processor cause the device to:

calculate, based on another user input, another virtual destination outside of the viewport of the display, wherein a distance to the virtual destination and a distance to the other virtual destination are different distances;

move at least one image of the plurality of images over the pre-determined period of time to the other virtual destination according to the time dependent function as time elapses during the pre-determined period of time; and

move at least one other image of the plurality of images at least between a virtual display position outside of the display and an actual display position within the display according to the time dependent function as time elapses during the pre-determined period of time.

14. The device of claim **13**, wherein the device comprises a touch-sensitive user interface, and the virtual destination *or the other virtual destination* calculated depends on **[**the**]** *a* speed of **[**the**]** *a* user movement on the touch-sensitive interface.

15. The device of claim **13**, wherein the plurality of images comprises **[**at least one of**]** a photograph **[**or cover art for a media file**]**.

16. One or more *non-transitory* machine-readable storage media having application instructions encoded thereon, the application instructions comprising:

instructions for displaying a portion of a sequence of images;

instructions for calculating a virtual destination for a particular image of the sequence of images based on a user input; **[**and**]**

instructions for animating the sequence of images over a first *pre-determined* time period *according to a time dependent function as time elapses during the first pre-determined time period* such that the particular image arrives at **[**its**]** *the* virtual destination at the end of the first *pre-determined* time period*;*

instructions for calculating another virtual destination for the particular image or for another particular image of the sequence of images based on another user input, wherein the other virtual destination is outside of a display of a device displaying the portion of the sequence of images and wherein the other virtual destination is further away from or closer to the particular image or the other particular image in the sequence of images than is the virtual destination in the sequence of images from the particular image; and

instructions for animating the sequence of images over another predetermined time period having a same duration as the first pre-determined time period according to the time dependent function as time elapses during the other pre-determined time period such that the particular image or the other particular image arrives at the other virtual destination at the end of the other pre-determined time period.

17. The one or more *non-transitory* machine-readable storage media of claim **16**, wherein the application instruc-

tions comprise instructions for updating the virtual destination *or the other virtual destination* in response to an additional user input, wherein the instructions for updating comprise instructions to cancel any animation process remaining for the first *pre-determined* time period *or the other pre-determined time period* in favor of a new animation process to move the particular image *or the other particular image* to the updated virtual destination over a second *pre-determined* time period.

18. The one or more *non-transitory* machine-readable storage media of claim **16**, wherein the one or more *non-transitory* machine-readable storage media comprise a flash memory device.

19. The method of claim 6, further comprising adjusting a plurality of display characteristics of the at least one graphical object or the other at least one graphical object, wherein the display characteristics include position, velocity, acceleration, size, opacity, or color.

20. The method of claim 6, wherein at least some of the subset of graphical objects are displayed at an angle relative to the display.

21. The method of claim 6, wherein the virtual destination or the other virtual destination is calculated in three dimensions.

22. The method of claim 6, wherein said moving the at least one graphical object or said moving the other at least on graphical object is performed about a virtual axis.

23. The method of claim 6, wherein an opacity of the at least one graphical object at the actual display position is different than an opacity of the at least one graphical object at the virtual display position or the other virtual display position; or

an opacity of the other at least one graphical object at the actual display position is different than an opacity of the other at least one graphical object at the other virtual display position.

24. The method of claim 6, wherein the calculated virtual destination includes the virtual display position and the other calculated virtual destination includes the other virtual display position.

25. The device of claim 13, wherein the plurality of images comprises cover art for a media file.

26. The device of claim 13, wherein the application instructions when executed by the processor further cause the device to adjust display characteristics of the at least one image, wherein the display characteristics include position, velocity, acceleration, size, opacity, or color.

27. The device of claim 13, wherein the at least one image or the other at least one image is moved over an additional pre-determined time period to an updated virtual destination that is calculated from an additional user input received during the pan through the plurality of images or the other pan through the plurality of images.

28. The device of claim 13, wherein the user input or the other user input is received as an input to a touch-sensitive user interface.

29. The device of claim 13, wherein at least some of the plurality of images are displayed at an angle relative to the display.

30. The device of claim 13, wherein the virtual destination or the other virtual destination is calculated in three-dimensions.

31. The device of claim 13, wherein the at least one image is moved about a virtual axis.

32. The device of claim 13, wherein an opacity of the at least one image at the actual display position is different than an opacity of the at least one image at the virtual display position or the other virtual display position.

33. The device of claim 13, wherein the calculated virtual destination includes the virtual display position, wherein the virtual display position includes coordinates outside of the display.

34. The one or more non-transitory machine-readable storage media of claim 16, wherein the application instructions further comprise:

instructions for adjusting display characteristics of the particular image or the other particular image, wherein the display characteristics include at least one of position, velocity, acceleration, size, opacity, or color.

35. The one or more non-transitory machine readable storage media of claim 16, wherein the application instructions further comprise:

instructions for updating the virtual destination for the particular image based on an additional user input; and

instructions for animating the sequence of images over a second pre-determined time period such that the particular image arrives at the updated virtual destination at the end of the second pre-determined time period.

36. The one or more non-transitory machine-readable storage media of claim 16, wherein the user input or the other user input is received via a touch-sensitive user interface, and wherein the calculated virtual destination or the other calculated virtual destination depends on a speed of a user movement on the touch-sensitive user interface.

37. The one or more non-transitory machine-readable storage media of claim 16, wherein at least some of the images in the sequence of images are displayed at an angle relative to the display.

38. The one or more non-transitory machine-readable storage media of claim 16, wherein the virtual destination or the other virtual destination is calculated in three dimensions.

39. The one or more non-transitory machine-readable storage media of claim 16, wherein said animating is performed about a virtual axis.

40. The one or more non-transitory machine-readable storage media of claim 16, wherein an opacity of the particular image at its virtual destination is different than an opacity of the particular image at another destination and an opacity of the particular image or the other particular image at its other virtual destination is different than an opacity of the particular image or the other particular image at another destination.

41. A non-transitory computer-readable storage medium storing program instructions, wherein the program instructions are computer-executable to implement:

displaying a subset of graphical objects of a plurality of graphical objects, wherein the plurality of graphical objects are associated with respective coordinates;

in response to user input, determining a virtual position for at least one graphical object of the subset of graphical objects, wherein the virtual position is associated with coordinates corresponding to a location outside of a display area;

moving the at least one graphical object from its respective coordinates to the coordinates of the virtual position over a pre-determined period of time according to a time dependent function as time elapses during the pre-determined period of time; and

in response to another user input, determining another virtual position for the at least one graphical object or

another at least one graphical object of the subset of graphical objects, wherein the other virtual position is associated with coordinates corresponding to a location outside of the display area;

moving the at least one graphical object or the other at least one graphical object from its respective coordinates to the coordinates of the other virtual position over the pre-determined period of time according to the time dependent function as time elapses during the pre-determined period of time, wherein a distance to move the at least one graphical object to the virtual position and a distance to move the at least one graphical object or the other at least one graphical object to the other virtual position are different distances.

42. A method, comprising:

performing, by a computing device:

displaying a subset of graphical objects of a plurality of graphical objects, wherein the plurality of graphical objects are associated with respective coordinates;

in response to a user input, determining a virtual position for at least one graphical object of the subset of graphical objects, wherein the virtual position is associated with coordinates corresponding to a location outside of a display area; and

moving the at least one graphical object from its respective coordinates to the coordinates of the virtual position over a pre-determined period of time according to a time dependent function as time elapses during the pre-determined period of time;

in response to another user input, determining another virtual position for the at least one graphical object or another at least one graphical object of the subset of graphical objects, wherein the other virtual position is associated with coordinates corresponding to a location outside of the display area; and

moving the at least one graphical object or the other at least one graphical object from its respective coordinates to the coordinates of the other virtual position over the pre-determined period of time according to the time dependent function as time elapses during the pre-determined period of time, wherein a distance to move the at least one graphical object to the virtual position and a distance to move the at least one graphical object or the other at least one graphical object to the other virtual position are different distances.

* * * * *