

intersects display 1020 or, equivalently, image 1044. In doing so it uses absolute data 1028 as well as relative motion data 1016, in accordance with any suitable combination or data fusion technique that is efficient. Such sensor fusion and corresponding data fusion techniques are well known in the art.

[0276] The computation and displaying of cursor 1046 is performed periodically at a sufficiently high rate (e.g., 60 Hz or higher) to be acceptable to a human viewer of display 1020. Note that cursor 1046 is a visual element that forms a part of the output of the application running on circuitry 1034 of device 1032. In addition, cursor 1046 defines a center of rotation for a visual element 1048. Element 1048 is also a part of the output of the application running on circuitry 1034. In this case element 1048 is an icon originally located at the lower left corner of display 1020.

[0277] A user moves wand 1012 in environment 1018 and by doing so interacts with visual elements 1046, 1048 of the output of the application displayed as image 1044 on display 1020. First, user holds wand 1012 such that its center axis C.A. intersects image 1044 at the original location of icon 1048. Thus, cursor 1046 is displayed on top of icon 1048 at that time. By subsequently depressing a button 1050, user informs controller 1030 that he or she wishes to select icon 1048 produced by the application. The corresponding button depressed signal (not shown) can be communicated to controller 1030 and then the application by using up-link 1040. The operations required to implement such selection are well known in the art.

[0278] Once icon 1048 is selected in the application, the user moves wand 1012 diagonally and up such that the motion of cursor 1046, which traces the point of intersection between center axis C.A. and display 1020, executes movement M1. At the end of movement M1, icon 1048 is within image portion 1044A. Now, the user depresses button 1050 again to instruct the application running on device 1032 to leave or stop dragging icon 1048. At this point, user executes a motion S1 with wand 1012 during which only cursor 1046 is displaced to the point of intersection between center axis C.A. and display 1020.

[0279] The user now depresses button 1050 twice to inform the application that he or she wishes to fix the location of cursor 1046 on display 1020. This fixed location will be the center of rotation for visual elements in image portion 1044A. Presently, only icon 1048 has been placed in portion 1044A.

[0280] At this point, the user rotates icon 1048 about the center of rotation defined by the location of cursor 1046. In particular, the user simply twists wand 1012 clockwise around its central axis C.A. as shown in the figure. Correspondingly, icon 1048 undergoes clockwise rotation. This rotation is broken down into two stages M2 and M3 for better understanding.

[0281] While rotating icon 1048 by turning wand 1012 clockwise, the user also moves wand 1012 in or along the Z_o axis. Of course, this axis is orthogonal to axes X_o , Y_o that define the plane (X_o , Y_o) of image 1044. Specifically, at the start of stage M2 wand 1012 is at absolute position $z1$ along the Z_o world coordinate axis. At the end of stage M2 it is at $z2$, and finally it is at absolute position $z3$ at the end of stage M3. It should be noticed that reference point 1012' is instrumental in expressing the absolute positions. In fact, the absolute positions in Z_o correspond to the absolute positions $z1$, $z2$, $z3$ of reference point 1012'.

[0282] Controller 1030 generates signals corresponding to absolute positions $z1$, $z2$, $z3$ of wand 1012 in the third axis Z_o for zooming. Specifically, since these values are increasing, the user is moving away. Hence, the application zooms in on portion 1044A of image 1044 shown on display 1020 to enlarge it. As a result, icon 1048 grows in size. When the absolute position values in Z_o decrease, the application zooms out of portion 1044A. Of course, this convention could be inverted or otherwise changed depending on the application.

[0283] To simplify and reduce the processing required, controller 1030 can be configured to first determine the absolute position of wand 1012 in third axis Z_o . Then, controller 1030 can determine a change in a position of wand 1012 in Z_o by combining the initial absolute position with relative motion data 1016 that encode the change in position. This represents an efficient and wise usage of interpolation under the assumption that the user does not appreciably change the orientation part (i.e., the inclination angles) of the absolute pose of wand 1012. In particular, if the user changes one or more of the orientation parameters, then more frequent reliance on absolute pose data obtained from raw image data 1028 will be necessary.

[0284] The above embodiment can be further enhanced by addition of more controllers and wands. In addition, other subsets of absolute and relative orientation and position data can be used to produce useful input for the application of system 1010.

[0285] FIG. 25B shows system 1010 with another application running on: circuitry 1034 of electronic device 1032. Parts of system 1010 corresponding to those in FIG. 25A are referenced by the same reference numbers. In fact, the hardware and operation of system 1010 in FIG. 25B is very similar to system 1010 of FIG. 25A with the following exceptions.

[0286] The application supported by device 1032 is a gallery and painting touch-up application. Hence, the output of the application includes visual elements 1052A, 1052B, 1052C displayed on display 1020. Elements 1052 represent a gallery in cyberspace. Specifically, element 1052A is a gallery wall, element 1052B is a re-touching station, and element 1052C is a specific painting taken off wall 1052A. As before, cursor 1046 is located at the instantaneous intersection of center axis C.A. of wand 1012 and image 1044 presented on display 1020. Note that the instantaneous pose (position and orientation) of wand 1012 is drawn in solid lines, while prior and later poses are drawn in dashed lines.

[0287] To alert the user that the gallery application is running, an icon 1054 is enlarged and displayed on display 1020. Other icons, representing non-active applications are posted in the lower left corner of display 1020 for user reference.

[0288] During operation, controller 1030 uses all absolute pose data ($x, y, z, \phi, \theta, \psi$) in the subset for generating signals. It also uses all relative motion data 1016 for interpolation between measurement times t_i . FIG. 25B shows the movement of center axis C.A. from a start time t_o through a stop time t_s . During time interval from t_o to t_1 , the user is executing free movements denoted by FM. Controller 1030 uses the absolute pose data supplemented by relative motion data 1016 during that time to track the position of cursor 1046.

[0289] At time t_1 , when cursor was at location 1046', the user depressed button 1050. This informed controller 1030 to generate input for interacting with the gallery application. Specifically, motion RM during the time interval t_1 to t_n , while button 1050 remains depressed is used to drag painting 1052C from gallery wall 1052A to re-touching station 1052B. At the