pages are often somewhat wider and considerably taller. Almost anyone who has tried accessing the Web on a PDA with a 240×320 pixel display (which is a common PDA displays size) recognizes how frustrating it can be to access the Web on a device with a display that can only show a small fraction of a typical Web page at any given moment.

[0066] One might think that a simple solution for a device designer would be to incorporate a very high pixel-count display onto the device—such as 1000×1000 pixel display. However, contrary to common-wisdom, displaying more pixels (i.e. having a higher pixel count) does not necessarily improve image quality. In fact, having higher pixel counts can degrade image quality, depending on other characteristics of the display and device. For example, squeezing 1000×1000 pixels into a pocketsize device requires using a very high pixel density (i.e. very small pixels), but when content is rendered at the native resolution of a display with very high pixel density, content appears very small (so, for example, text on many Web pages will appear too small to comfortably read).

[0067] One might then assume that the device could simply display images at a larger scale (i.e. magnify it), at least when the user wanted to read smaller text. A scaling function is a useful feature in a Web browser, but there are two negative consequences to using a display with very high pixel counts and densities and then expecting the user to magnify images when they want to make pages legible:

[0068] First, bitmapped images on Web pages (such as photographs) degrade when magnified at a non-integer multiple (such as at 1.3-times scale [i.e. 130%] rather than 2-times scale [i.e. 200%]), because the magnification algorithm must interpolate the color of the fractional pixels. For example, if a two-pixel snippet of an image consists of a black pixel next to a white pixel, and that image is scaled by 50%, those two pixels become three pixels—e.g. one black pixel, one white pixel, and a third pixel whose color must be determined by the scaling algorithm. Regardless of the algorithm's choice of color for the third pixel, the magnified snippet will not look like the original snippet, because by definition the display cannot render half of that third pixel black and half of it white. The third pixel will have to be all black or all white (making the snippet unevenly colored compared to the original snippet), or the pixel will have to be some other color that was not in the original snippet. Users tend to perceive these transformations as making the new image blurry compared to the original, especially when the original bitmapped image includes text (as is common on many Web pages today). One can verify this with many image editing programs by scaling a crisp photograph or poster by a non-integer multiple. For text rendered by the device using fonts, intelligent font-size substitution may allow more graceful scaling, but it will generally still be imperfect because (as Web developers know well) not every size of every font renders equally well.

[0069] Second, the net result of this approach will be that users will generally scale Web pages on displays that use very high pixel counts and densities so they can read text better, attempting (imperfectly) to simulate a display with a more moderate pixel count and pixel density. However, everything else being equal, displays with higher pixel counts and densities cost more than displays with lower pixel counts and densities (often substantially more), and displays can represent a large portion of the overall device's cost, so using a display with very high pixel counts and densities would make the device less affordable without necessarily improving the user experience (and in many cases, degrading the user experience.)

[0070] Based on these considerations and significant experimentation using accurate simulations of ranges of display counts, display densities, and overall device sizes, it is observed that the careful balance of display characteristics of the embodiments of the present invention result in a substantially better Web experience on pocketsize devices than today's conventional pocket size devices while optimizing device costs as well. To optimize Web access while keeping the device pocketsize, pixel counts and pixel densities must be substantially higher than found on most of today's conventional pocketsize hand-held devices, but substantially lower than found on larger-than-pocketsize tablets or on the few high-end PocketPCs that have not used pixel counts and densities that are too low.

[0071] Some novel and "counter-common-wisdom" aspects of the present invention's man-machine-interface innovations are addressed next. Most conventional handheld devices borrow a "desktop" user-interface metaphor form personal computers, where the user uses a stylus (or a finger) to select and move items; and the user generally scrolls content by either manipulating tiny scroll bars displayed on the device, or by operating a tiny roller or switch (generally only able to scroll in a single dimension).

[0072] Several of the embodiments of the present invention relate to the use of touch sensors along edges or back of the device (used for scrolling) and the incorporation of modifier spots (which can be operated while simultaneously clicking a displayed item on the touch screen to generate a different result than would occur if that item were clicked without simultaneously pressing the modifier spot). These types of device design elements are referred to herein as man-machine-interface elements.

[0073] As with the display related elements of the present invention, the man-machine-interface innovations of the present invention substantially improve the user experience when accessing content (particularly Web content) on handheld devices, compared to today's conventional hand-held devices. The modifier spot elements allow users to instantly access features that would otherwise require extra clicks or steps to access. The edge- or back-located touch sensor elements allow users to sweep around Web pages almost as effortlessly as sweeping one's eyes around a printed page, simply by sliding fingers along the edges or back of the device—while also improving the device aesthetics and feel, and leaving more room on the surface of the device for a larger display. These man-machine-interface innovations help move from a desktop metaphor to a handheld-tool metaphor, which is more appropriate for handheld devices.

[0074] Note throughout that with respect to pixel counts, the relevant characteristic thereof is the pixel count at which images (such as Web page content) are effectively displayed and viewable. For example, a device with a 200 ppi, 800×600 pixel display can easily render Web page content at 100 ppi by "binning" the 200 ppi pixels into 2×2 squares and treating each little 2×2 square as a single "virtual" pixel: But then the device would only effectively be displaying 400×300 pixels—too small to display a full Web page. (This is