

## DISPLAY SYSTEM WITH TACTILE GUIDANCE

### FIELD OF THE INVENTION

[0001] The invention relates to a display system comprising a display screen for displaying a graphical representation on a display screen, the display screen providing tactile and/or visual guidance to the user by means of relief.

[0002] The invention further relates to a data processing system comprising the above display system.

### BACKGROUND OF THE INVENTION

[0003] An example of such a display system is disclosed in U.S. Pat. No. 6,072,475. The known system comprises a touch screen which extends in three physical dimensions. When a user slides his finger over the active surface area of the touch screen, the tactile feedback gives him information about the position of the finger. The use of the touch screen is facilitated especially when the user is on the move or when the touch screen is out of sight. A problem of the known system is that it can be applied to a very limited range of applications, all obeying to the same design rules as regards the screen layout.

### OBJECT AND SUMMARY OF THE INVENTION

[0004] It is an object of the invention to provide an improved system of the type defined in the opening paragraph. To this end, the display system according to the invention comprises a relief generator for dynamically generating the relief on the display screen. It is thus achieved that the relief can be changed dynamically in accordance with the graphical output of the current application. For example, one application may require tactile guidance at the top of the screen, while another application may require tactile guidance at the bottom of the screen. Furthermore, within a single application the location where tactile guidance is desired may change during the execution. For example, if the application comprises multiple transaction screens, a first screen may require tactile guidance at the top of the screen while a second screen may require tactile guidance at the bottom of the screen. By providing a relief generator for dynamically generating relief on the display screen, a very flexible system for providing tactile guidance is obtained.

[0005] In an embodiment of the display system according to the invention the relief generator comprises piezo electrical material to provide said relief in response to electrical signals. Such materials are generally used to generate an electrical signal in response to a mechanical deformation. However, the reverse can also be achieved with these materials: a mechanical deformation results from supplying an electrical signal to it. Alternatively or additionally, other means for generating mechanical deformations may be used, e.g. electromechanical constructions, shape memory alloys, fluid reservoirs etc.

[0006] An embodiment of the display system according to the invention is further arranged to detect user actuations from electrical signals received from the relief generator. Generating relief on a display screen is particularly useful if the user can interact with the system by touching or pressing the screen. Various techniques for creating touch screens are well known and widely applied, for example in computers,

personal digital assistants and cell phones. Generally, a graphical display, e.g. an LCD, is combined with a sensitive layer for sensing the position of a touch with a finger or a stylus. The relief generator of the present invention may very well be utilized as such a sensitive layer. As described above, means for providing a mechanical deformation in response to electrical signals often show the reverse behavior as well. For example, piezo electrical material generates an electrical signal in response to a mechanical deformation. It is thus achieved that a dedicated touch sensitive layer can be omitted.

[0007] In an embodiment of the display system according to the invention the relief generator is arranged to produce protrusions or depressions at selected locations of the display screen. Such protrusions or depressions are easily sensed when sliding a finger across the screen, giving the user information about which areas of the screen are currently relevant, e.g. sensitive to touch input.

[0008] In a preferred embodiment of the display system according to the invention the relief generator comprises individually addressable relief elements each of which is arranged to cause a displacement in a direction substantially perpendicular to the display screen. It is thus achieved that tactile guidance can be provided at specific locations and at specific moments. For example, a matrix of piezo electrical elements may be provided, capable of generating relief at any desired location of the screen. The elements may have various dimensions, but preferably they have the same size of a single graphical pixel or of a small group of graphical pixels.

[0009] In an embodiment of the display system according to the invention the relief generator comprises transparent material and is located at the front of the display screen. If the relief generator is substantially transparent, it can advantageously be mounted at the front of the display screen. The graphical representation remains visible through the transparent material, while the relief is well sensible by the user.

[0010] In an alternative embodiment of the display system according to the invention the relief generator is located at the rear of the display screen, the display screen being a flexible display capable of following the relief provided by the relief generator. If an opaque material is chosen for producing the relief generator, it should be mounted at the rear of the display screen. With the advent of flexible displays, for example based on organic LED's or electronic ink, it becomes possible to generate relief at the rear of the screen which is still perceptible at the front. If, for example, the relief is generated by electromechanical means, e.g. by means of magnets and coils, it is unlikely that a transparent implementation is feasible. In such cases, the relief generator can be located at the rear of the display screen.

[0011] In an embodiment of the display system according to the invention the relief generator is capable of automatically determining a relief for predetermined graphical objects, such as buttons and sliders. The invention is particularly useful for enhancing the graphical representation with tactile guidance. For example, a graphical representation of a button can be enhanced by a protrusion (or a depression) behind or in front of that representation, so the user can actually feel the button, as distinct from its environment. In general this enhancement can be generated by the software application generating the graphical represen-