

various types of inputs on a handheld digital device such as a Personal Digital Assistant or cellular phone. Further objectives include provision of such an input device that can be sensed by touch, and that allows a larger display on handheld digital devices, and that provides functionality for a Personal Digital Assistant with high capability.

[0016] These objectives are met with an input plate located on the back of a handheld portable digital device. The plate has projections that sense the touch of a moving fingertip, and encode a corresponding input signal. There is no need to turn the handheld portable digital device around or move the user's wrist to operate this input device. The input projections are arranged in an egg-shaped surface area where a fingertip of the right or left hands can reach it equally. The egg-shaped area is of a size that supports various inputs by touch and provides tactile feedback.

[0017] A Personal Digital Assistant using this invention has a display screen on the front of the case, and the present tactile sense input device on the back of the case. This arrangement allows provision of both a large display and fingertip entry of a variety of inputs, thus offering a Personal Digital Assistant with high capability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The drawings illustrate the principles of the invention with examples of preferred arrangements and suggested dimensions of the invention. Actual product dimensions can be determined from these principles for a particular population of users. Front views of the input plate are normally seen from the back view of a Personal Digital Assistant on which the plate is mounted, since the plate is normally mounted on the back of a PDA.

[0019] FIG. 1A is a perspective front view of a Personal Digital Assistant being operated with a fingertip input device on the back according to this invention.

[0020] FIG. 1B is a perspective back view of a Personal Digital Assistant being operated with a fingertip input device on the back according to this invention.

[0021] FIG. 2A shows an array of projections and two generally egg-shaped outlines that define an area of usable projections C1 and an area of more easily usable projections C2, either of which area can be used for the input plate of this invention.

[0022] FIG. 2B shows projections of FIG. 2A that can be included on the input plate, with example outline dimensions and projection spacing.

[0023] FIG. 3 shows the process of designing an area outline for the input projections.

[0024] FIG. 4 shows a front view of a fingertip tactile sense input device according to the invention. Note that this view is normally seen from the back view of the PDA on which the input device is mounted.

[0025] FIG. 5A is a side sectional view of the input device of FIG. 4 showing an example of pressure distribution of a fingertip when activating projection 12.

[0026] FIG. 5B is a display screen corresponding to FIG. 5A allowing the user to check the input from the front of the PDA.

[0027] FIG. 6 shows suggested size relationships between a fingertip and the projection array of this invention.

[0028] FIG. 7A1 is a view of an array of input projections protruding through individual holes in a surface that has a circular depressed portion.

[0029] FIG. 7A2 is a side sectional view of FIG. 7A1.

[0030] FIG. 7B1 is a view of an array of projections protruding through individual holes in a surface that has an oval depressed portion.

[0031] FIG. 7B2 is a side sectional view of FIG. 7B1.

[0032] FIG. 7C1 is a view of an array of projections protruding through individual holes in a depressed portion of a surface.

[0033] FIG. 7C2 is a side sectional view of FIG. 7C1.

[0034] FIG. 7D1 is a view of an array of projections protruding through individual holes in a surface that has a raised ridge portion.

[0035] FIG. 7D2 is a side sectional view of FIG. 7D1.

[0036] FIG. 8 is a side sectional view of a tactile-sense input device with input projections molded integrally on a flexible plate.

[0037] FIG. 9 is a block diagram of components of a Personal Digital Assistant using the present tactile-sense input device.

[0038] FIG. 10A is a front view of a tactile-sense input device according to the invention with additional keys.

[0039] FIG. 10B is a view similar to FIG. 10A with smaller spacing between the input projections.

[0040] FIG. 11 is a prior art side sectional view of the structure of a conventional key button array.

[0041] FIG. 12A is a prior art back perspective view of a conventional cellular phone with a handwriting pad on the back.

[0042] FIG. 12B is a prior art front perspective view of a conventional cellular phone.

[0043] FIG. 13 is a prior art block diagram of components of a conventional cellular phone that perform handwriting input on a pad on the back.

DETAILED DESCRIPTION

[0044] The invention is a touch sensitive input device 1 for portable handheld digital devices. It has plural projections that provide fingertip input and tactile feedback. An input controller codes an input signal when a moving fingertip presses a projection. The input projections are arranged in an egg-shaped plate area located where a fingertip of either the right or left hand can reach it, as shown in FIGS. 2B and 2C.

[0045] A plate size suitable for a touch input by minimal movement of a finger without wrist movement is within 3 times an average index fingerprint size, or about 24 mm-30 mm high and 22 mm-28 mm wide as shown by egg-shaped curve C1 in FIG. 2A. At least 12 input projections are provided in the input area, corresponding to ten alphanu-