[0014] The movable unit moves horizontally beyond the range in which the actuators control projecting or retracting of the tactile pins, and the movable unit moves vertically while moving horizontally beyond the range in which projecting or retracting of the tactile pins is controlled. Hence, even when the timing of vertical movements is not set strictly, the movable unit can move horizontally and vertically in turn in a smooth fashion.

[0015] Further, the vertical movement mechanism of the movable unit may be formed by an actuating member which moves horizontally as one unit with the movable unit, a fixed member which is fixed to the case body of the tactile display apparatus, and a one-way clutch mechanism which moves the movable unit vertically as the actuating member moving horizontally interferes with the fixed member.

[0016] In this case, the fixed member may be disposed at both ends of the range in which the movable unit moves horizontally. The movable unit is caused to move vertically during interference of the actuating member with the fixed member which is caused as the movable unit moves horizontally toward one side, whereas the movable unit does not move vertically during interference of the actuating member with the fixed member which is caused as the movable unit moves horizontally toward the other side.

[0017] The invention also provides for a control method for a tactile display apparatus in which tactile pins disposed in a matrix arrangement on a display board portion are capable of freely projecting or retracting and information, such as an image, is displayed in accordance with concavities and convexities formed as the tactile pins project or retract, comprising a movable unit which is capable of freely moving in the vertical direction and the horizontal direction relative to the display board portion; actuators disposed at the movable unit so as to control projecting or retracting of the tactile pins; a control part which controls the driving of the actuators in accordance with an information signal, such as an image, received from outside; movement mechanisms which move the movable unit in the vertical direction and the horizontal direction, in the tactile display apparatus; and an external control part for outputting information signals, such as an image, to the tactile display apparatus, the external control part pixelating information fed to the external control part into the respective pixels in accordance with the number of tactile pins which are disposed, binarizing the respective pixels so that the pixels will correspond to the projecting or retracting of the tactile pins, sorting thus binarized signals in the order of driving the actuators, and outputting thus binarized signals. This makes it possible to precisely display, using differences in elevation among the tactile pins, image information fed to the external control part.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention will be described with reference to the drawings, in which:

[0019] **FIG. 1** is a schematic diagram of a tactile display apparatus and a host computer;

[0020] **FIG. 2** is a plan view which shows the inside of a case of the tactile display apparatus, except for a certain portion;

[0021] **FIG. 3** is a front view which shows the inside of the case of the tactile display apparatus, except for a certain portion;

[0022] **FIG. 4** is a partially expanded drawing of **FIG. 3**;

[0023] **FIG. 5** is a diagram for describing movements of tactile pins upward and downward;

[0024] **FIG. 6** is a side view of a portion where solenoids are disposed;

[0025] FIGS. **7**(A), **7**(B), **7**(C), **7**(D) and **7**(E) are explanatory operation diagrams of a movable unit;

[0026] **FIG. 8** is a side view of a portion where a motor is disposed;

[0027] **FIG. 9** is a side view of a portion where a rotation axis is disposed;

[0028] **FIG. 10** is a drawing which shows actuation of a vertical movement mechanism while the movable unit moves to the left;

[0029] **FIG. 11** is a drawing which shows actuation of the vertical movement mechanism while the movable unit moves to the right; and

[0030] **FIG. 12** is a drawing which shows ratchet arms as they are reset.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0031] An exemplary embodiment of the invention will now be described with reference to the drawings. In the drawings, **1** denotes a tactile display apparatus (**FIG. 1**) which displays, as differences in elevation, image information such as a photograph, a graphic and/or a letter output from a host computer (which corresponds to the external control part of the invention) PC so that a visually handicapped person can recognize the image with his tactile sense at the fingertips. The tactile display apparatus **1** comprises components, such as a case body **2** which defines a hull, a display board portion **3** which displays differences in, elevation, a movable unit **5** (**FIG. 2**) seating solenoids (which correspond to the actuators of the present invention) **4** (**FIG. 3**) which give rise to differences in elevation on the display board portion **3**, a horizontal movement mechanism **6** which moves the movable unit **5** in the horizontal direction and a vertical movement mechanism **7** (**FIG. 2**) which moves the movable unit **5** in the vertical direction, and a control part **8** (**FIG. 3**) which receives a signal from the host computer PC and outputs a control command to the solenoids **4**, the horizontal movement mechanism **6**, the vertical movement mechanism **7**, and the like based on the signal.

[0032] For the convenience of description, assuming that the tactile display apparatus **1** is placed on a desk or the like, the front being the side facing a visually handicapped person who touches the display board portion **3** will be hereinafter referred to as the front, the back as the rear side, the left as the left-hand side, the right as the right-hand side, the left/right direction as the horizontal direction and the front/back direction as the vertical direction hereinafter. However, the vertical direction and the horizontal direction referred to in the invention are not limited to the defined directions of course.

[0033] The case body **2** is shaped like a box having a top surface **2***a*, a bottom surface **2***b* and side surfaces **2***c*, **2***d*, **2***e* and **2***f* on the front, the back, the left and the right (based on a point of view described above, i.e., as the visually impared