Title: PROJECTOR WITH MOTORIZED LEGS FOR IMAGE ROTATION CONTROL

Abstract: The invention provides an image projection device including an image projector (10) with a projector housing (20) the projector housing having a first leg opening (32) and a second leg opening (42) formed therein. A first extendable leg member (34) is received in the first leg opening, and a second extendable leg member (44) is received in the second leg opening. A first translation device (30) is attached to the projector housing and is operably coupled to the first extendable leg member. A second translation device (40) is attached to the projector housing and is operably coupled to the second extendable leg member. A controller (60) is electrically coupled to the translation devices. The controller receives a position input signal and sends a translation control signal to the first translation device or the second translation device based on the position input signal to provide image rotation control.
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— as to the applicant’s entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations

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PROJECTOR WITH MOTORIZED LEGS FOR IMAGE ROTATION CONTROL

This invention relates generally to image projectors, and more particularly, to correction and control of projected image rotation.

Optical projecting systems are often employed to display enlarged images on a projecting screen or a wall for presentations, displays and signage. An exemplary projection optical system, which projects a magnified optical image onto a projection plane via a projection lens, requires the size, position, and tilt of the projected image to be adjusted whenever the projector is moved or relocated.

When a projector is placed on a surface that is not perfectly level, the resulting picture projected on the wall or screen makes this very visible—the projected image appears slightly rotated with one top corner of the projected image higher then the other top corner. The further away the projector is from the wall/screen the more magnified this difference is.

Methods of adjusting the position of the magnified optical image have included manually changing the projection angle by tilting the projector body, or by changing the height of the projector body. A common and somewhat crude adjustment method includes using an item like a book to raise the front, back or one side of the projector, which helps in the placement of the projected image on the intended area of the projection surface.

Some projectors can be raised or lowered by small legs on the underside of the projector, which are adjusted by manually loosening or tightening a screwing mechanism. Certain projector designs achieve finer adjustments with thumbscrews that are mechanically linked to extendible/retractable legs. Positioning systems for a projector adjust height coarsely by a first adjuster, and more finely by the second adjuster as exemplified in “Projector,” Arai et al., United States Patent 6,302,543 issued October 16, 2001 and “Projector Tilt Adjust System Comprising a Latching Mechanism for a Height-Adjusting System,” Su, U.S. Patent 6,461,002 issued October 8, 2002. Unfortunately, any significant adjustment in height may require multiple turns of one or more screws and these systems do not control horizontal leveling at the chosen height. In addition, many systems using mechanical screwing mechanisms take inordinate time to adjust and sometimes
require a user to lift a portion of the projector or to place the projector on its side so that the feet are not in contact with a surface, and hence are easier to turn.

Some current projector designs have a single retractable foot or leg that moves in coarse and large steps to control height. A mechanical button, link and lever system for adjusting such a foot is described in “Adjustable Height Apparatus of a Horizontal Projector,” Huang et al., U.S. Patent Application 2002/0113951 published August 22, 2002. A motorized expansible leg is used to adjust height in “Tilt Device for Projector,” Hiroyuki, JP2003005279 published January 8, 2003. Regrettably, when these feet, which are located on the front underside of a projector, rest on an uneven surface, they have trouble leveling the projectors as well as the projected pictures. One unsatisfactory solution to the leveling problem has been to insert items like pieces of paper at different places under the projector foot.

Accordingly, an improved projector rotation system that overcomes the challenges and obstacles described above would adjust the rotation as well as the height of an image projector to level a projected image. This improved system would provide a level projected image even when the surface on which a projector sits is uneven or the surface on which the image is projected is tilted, and would ensure that the projector platform could remain in a stable condition no matter how far the legs extend. Additionally, the projector would be compact and easily transportable, and not require that a user handle the projector directly when making adjustments, particularly when the projector is placed in an overhead cradle mounted on a ceiling.

One aspect of the invention is an image projection device, comprising an image projector including a projector housing, the projector housing having a first leg opening and a second leg opening formed therein, a first extendable leg member received in the first leg opening, and a second extendable leg member received in the second leg opening. A first translation device is attached to the projector housing and operably coupled to the first extendable leg member. A second translation device is attached to the projector housing and operably coupled to the second extendable leg member. A controller electrically coupled to the translation devices receives a position input signal and sends a translation control signal to the first translation device or the second translation device based on the position input signal to provide image rotation control.
Another aspect of the invention is a method of controlling image rotation from an image projection device. An image is projected onto a projection surface, and a position input signal is received. A translation control signal based on the position input signal is sent and the projected image rotation is adjusted based on the translation control signal.

Another aspect of the invention is a system for controlling image rotation from an image projection device, including means for projecting an image onto a projection surface, means for receiving a position input signal, means for sending a translation control signal based on the position input signal, and means for adjusting a projected image rotation based on the translation control signal.

The aforementioned, and other features and advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims and equivalents thereof.

Various embodiment of the present invention are illustrated by the accompanying figures, wherein:

FIG. 1 shows an illustration of an image projection device, in accordance with one embodiment of the current invention;

FIG. 2 shows a block diagram of a system for controlling image rotation from an image projection device, in accordance with one embodiment of the current invention;

FIG. 3a - FIG. 3c show frontal views of an image projection device, in accordance with one embodiment of the current invention;

FIG. 4 shows an illustration of an image projection device, in accordance with another embodiment of the current invention;

FIG. 5 shows an illustration of an image projection device, in accordance with another embodiment of the current invention;

FIG. 6 shows an illustration of an image projection device, in accordance with another embodiment of the current invention;

FIG. 7 shows a flow chart of a method for controlling image rotation from an image projection device, in accordance with one embodiment of the current invention; and

FIG. 8 shows a block diagram of a system for controlling image rotation from an image projection device, in accordance with one embodiment of the current invention.
FIG. 1 shows an illustration of an image projection device, in accordance with one embodiment of the present invention. The image projection device includes an image projector 10 such as a portable liquid crystal display (LCD) projector or a deflectable mirror array projector. Image projector 10 has a projector housing 20 with a first leg opening 32 and a second leg opening 42. A first extendable leg member 34 extends through and is received in first leg opening 32, and a second extendable leg member 44 extends through and is received in second leg opening 42. A first translation device 30 is attached to projector housing 20 and operably coupled to first extendable leg member 34. A second translation device 40 is attached to projector housing 20 and operably coupled to second extendable leg member 44. Electrical translation devices 30 and 40, such as a linear stepper motor or a motor having a gear assembly, extend or retract extendable leg members 34 and 44 when the linear stepper motor or a motor having a gear assembly is actuated. Footpads 36 and 46, when used, are attached to the ends of extendable leg members 34 and 44, respectively.

A controller 60 is electrically coupled to translation devices 30 and 40. Controller 60 receives a position input signal and sends a translation control signal to first translation device 30 or second translation device 40 based on the position input signal, thereby providing rotation control of a projected image. Rotation of the projected image allows the user to line up the projected image with, for example, a projection surface such as a projection screen. The motorized mechanisms allow a user to correct and control rotation of the projected region by tilting or rotating the projector side to side. Small, vertical movements of the motorized legs allow control of the projected image rotation. The motorized mechanisms may also be used to adjust image height by tilting image projector 10 upwards or downwards with input signals received from devices attached or remotely coupled to image projector 10.

Position input signals may be received from an input device such as a wired or wireless remote control device, an image rotation control button 24 attached to image projector 10, a menu selection from a menu projected by image projector 10, or an image rotation application running on a computer operably coupled to image projector 10.

For example, the projected image may be rotated clockwise or counterclockwise on a projection screen by extending or retracting extendable leg member 34, by extending or retracting extendable leg member 44, or a combination thereof. Similarly, the height of the
projected image may be adjusted and controlled by extending or retracting extendable leg members 34 and 44 simultaneously. Image projector 10 may be positioned, for example, on a table, an overhead cradle, or a projector support structure.

In one configuration, first leg opening 32 with first extendable leg member 34 and second leg opening 42 with second extendable leg member 44 are located in the two front corners of projector housing 20, providing support and balance for the heavier lens elements normally extending from the front of the projector. A fixed leg member 64 is attached to the bottom of projector housing 20 towards the rear, triangularly configured with extendable leg members 34 and 44 to stabilize projector housing 20. In another configuration, first leg opening 32 with first extendable leg member 34 and second leg opening 42 with second extendable leg member 44 are located in the two rear corners of projector housing 20, with a fixed or an extendable third leg member or foot pad located on the bottom and approximately centered near the front of projector housing 20 to stabilize the projector.

In another configuration, image projector 10 has a fourth leg opening (not shown) with a fourth extendable leg member (not shown) received in the fourth leg opening in projector housing 20 and a fourth translation device (not shown) attached to projector housing 20 and coupled to the fourth extendable leg member. First extendable leg member 34, second extendable leg member 44, third extendable leg member 54 and the fourth leg member are located, for example, at four corners of projector housing 20, where they provide projector stabilization and flexibility in height and image rotation adjustment. The fourth translation device is electrically coupled to controller 60. Controller 60 receives position input signals and sends control signals to the fourth translation device accordingly to provide image height control and image rotation control.

FIG. 2 shows a block diagram of a system for controlling image rotation from an image projection device, in accordance with one embodiment of the present invention. An image projector 10 for projecting an image onto a projection surface includes a projector housing 20 with one or more electrical translation devices 30 and 40 attached to projector housing 20. Translation device 30 and 40 are attached to extendable leg members that may be used to adjust the height and rotation of the projected image. A controller 60 is electrically coupled to translation device 30 and 40. Position input signals are received by controller 60 from an input device such as a wired or wireless remote control device, an
image rotation control button attached to the image projector 10, or a menu selection.
Translation control signals are sent to one or more translation devices 30 and 40 based on
the position input signal, thereby providing image rotation control. For example, controller
60 executes coded instructions contained in memory within image projector 10 to interpret
the position input signals and to provide translation control signals to the translation
devices corresponding to the desired input, extending or retracting one or more extendable
leg members and thereby adjusting projected image height or rotation.

Image projector 10 may include a third extendable leg member 54 in projector
housing 20. Third extendable leg member 54 is coupled to a third translation device 50,
and third translation device 50 is attached to projector housing 20. Third extendable leg
member 54 extends through and is received in a third leg opening 52. A footpad 56 may
be attached to one end of third extendable leg member 54, and translation device 50 is
electrically coupled to the other end of third extendable leg member 54. Third translation
device 50 is electrically coupled to controller 60. Controller 60 receives a position input
signal and sends a control signal to third translation device 50 based on the position input
signal, thereby providing image height control. Third extendable leg member 54 may be in
the front or in the rear of projector housing 20, triangularly configured with extendable leg
members 34 and 44 to stabilize projector housing 20 and to allow image rotation and image
height adjustments with extensions and retractions of extendable leg members 34, 44 and
54. When desired, each extendable leg member may be retracted into image projector 10
based on a position input signal. For example, a position input signal to shut down the
projector is received from a button attached to projector housing 20, and extendable leg
members 34, 44 and 54 are retracted.

In another embodiment, a fourth extendable leg member (not shown) received in a
fourth leg opening (not shown) in projector housing 20 and a fourth translation device (not
shown) attached to projector housing 20 cooperate with other extendable leg members 34,
44, and 54 and translation devices 30, 40, and 50 to provide image height control and
image rotation control based on position input signals to controller 60 and control signals
sent from controller 60 to the translation devices.

In another embodiment, an image projection device with automated image rotation
control includes an image projector 10 with a tilt sensor 62 such as an accelerometer or an
inclinometer attached to projector housing 20. Tilt sensor 62 is electrically coupled to
controller 60. Tilt sensor output signals from tilt sensor 62 are provided as position input signals to controller 60. Controller 60 receives position input signals from tilt sensor 62 and sends a translation control signal to the translation devices, thereby providing image rotation control. For example, tilt sensor 62 provides a tilt sensor output signal indicating that image projector 10 is tilted to one side or the other, and extendable leg members 34 and 44 are adjusted accordingly to reduce the rotation of the projected image. The projected image may be automatically leveled based on position input signals from tilt sensor 62.

FIG. 3a, FIG. 3b and FIG. 3c show frontal views of an image projection device, in accordance with another embodiment of the present invention. In FIG. 3a, image projector 10 is placed on a table 38a with a counterclockwise slant. Extendable leg member 44 is extended further than extendable leg member 34 to control and correct rotation of a projected image. Furthermore, extendable leg members 34 and 44 may cooperate to raise the height or lower the height of the projected image in response to a position input signal. An additional fixed leg member or an extendable leg member (not shown) provides stability and may be used to control image rotation and image height. In FIG. 3b, image projector 10 is placed on a relatively flat table 38b. Extendable leg members 34 and 44 are extended similar amounts to provide the desired image height in response to a position input signal, though extension or retraction is not needed for image rotation. In FIG. 3c, image projector 10 is placed on a table 38c with a clockwise slant. Extendable leg member 34 is extended further than extendable leg member 44 to compensate the rotation of the projected image for the tilted table. Thus, extendable leg members 34 and 44 may be extended or retracted to independent and varying heights for adjusting the image height and image rotation as desired.

FIG. 4 shows an illustration of an image projection device, in accordance with another embodiment of the present invention. In this embodiment, position input signals are received from a remote control device 22 or from an image rotation control button 24 attached to image projector 10. Position input signals may be transmitted from remote control device 22 to image projector 10 using ultrasonic signals, radio-frequency (RF) signals, infrared (IR) signals, a multi-conductor cable, or other remotely transmittable signals corresponding to key entries from, for example, an image rotation control button 24a for counterclockwise image rotation and 24b for clockwise image rotation. Extendable
leg members 34 and 44 are extended or retracted to provide image rotation and height adjustments corresponding to the received position input signals.

FIG. 5 shows an illustration of an image projection device, in accordance with another embodiment of the present invention. In this embodiment, position input signals are received from a menu selection of an on-screen menu 26a projected by image projector 10 onto a projection surface 12 such as a projection screen, or from a menu selection of a menu 26b shown on a display device 72. Display device 72 is coupled to a computer 70 that is operably coupled to image projector 10. Computer 70 runs an image rotation application 76 for displaying menu 26a and for responding to selections from computer input device 74 such as a keyboard. Menus 26a and 26b may have a plurality of options and submenus, some of which may be selected, for example, to command image projector 10 to rotate an image right or left to a desired rotation angle, or to activate an automatic image rotation correction function that automatically rotates the image to a level position based on tilt sensor output signals from a tilt sensor attached to image projector 10. Menus 26a and 26b may provide menu selections for adjusting the height of the projected image and selecting other projector functions.

FIG. 6 illustrates an image projection device, in accordance with another embodiment of the present invention. In this embodiment, image projector 10 is placed in an overhead cradle 14, which is often coupled to a ceiling, for projecting images onto a projection surface 12. Translation devices 30, 40 and 50 attached to extendable leg members 34, 44 and 54 respectively may be used to control the height and rotation of the projected image. A wired or wireless remote control device is desired in this situation to avoid the user from standing on chairs or other structures and to circumvent potentially undesirable situations.

FIG. 7 shows a flow chart of a method for controlling image rotation from an image projection device, in accordance with one embodiment of the present invention. The method includes various steps to manually or automatically set up an image projector including controlling and correcting image rotation.

An image projector is set up, as seen at block 80. The image projector is placed, for example, on a table, an overhead cradle, or other projector support structure.

An image is projected from the image projector onto a projection surface, as seen at block 82. The image is projected using, for example, an LCD projector or a deflectable
mirror array projector. In one example, the image projector is portable, weighing less than five kilograms with a maximum brightness of 2000 lumens or more.

The image height is adjusted based on a position input signal to change the image height, as seen at block 84. The image height may be adjusted, for example, by extending or retracting extendable leg members with electrical translation devices coupled to the extendable leg members and attached to the projector housing based on a position input signal to raise or lower the image height. Translation devices such as a linear stepper motor or a motor having a gear assembly may be attached to the image projector and coupled to the extendable leg members. For example, two extendable leg members in the front corners of the image projector are extended to raise the image, or retracted to lower the image. In another example, a third extendable leg member in the rear of the image projector may be raised or lowered to adjust the image height. In another example, a fourth extendable leg member cooperates with other extendable leg members positioned near the corners of the projector housing to provide image height control, image rotation control and projector stability.

The image rotation is adjusted by receiving a position input signal to change the image rotation, as seen at block 86. The position input signal is received, for example, from an input device such as a wired or a wireless remote control device, an image rotation control button attached to the image projector, a menu selection from a menu projected by the image projector, or an image rotation application running on a computer operably coupled to the image projector. A controller within the image projector receives the position input signals, and generates at least one translation control signal to be sent to one or more translation devices based on the position input signal. For example, a position input signal may direct the projected image to be tilted or rotated in a clockwise direction, and the controller will generate a translation control signal to extend an extendable leg member on one side of the image projector while generating a translation control signal to retract an extendable leg member on the other side of the image projector while keeping the image height approximately constant.

When the position input signal is received to rotate the projected image, a translation control signal is sent to one or more translation devices coupled to extendable leg members. The projected image rotation is adjusted based on the translation control signal. At least one extendable leg member is extended or retracted based on the position
input signal to adjust the projected image rotation. Retracting or extending another extendable leg member provides additional image rotation. Updates to the image height and rotation may be made by viewing again the projected image as seen at block 82, and generating position input signals to update the image height and image rotation.

In embodiments where automatic leveling is available, the projected image rotation may be automatically leveled or adjusted, as seen at block 88. Automatic leveling of the projected image rotation is based on a position input signal received, for example, from a tilt sensor attached to the image projection device. The tilt sensor, such as an accelerometer or an inclinometer, provides a tilt sensor output signal to indicate when the tilt sensor coupled to the image projection device is level or rotated one direction or another. The controller within the imaging projection device receives the position input signal from the tilt sensor and sends a translation control signal to one or more of the translation devices, thereby providing image rotation control. In one example, automatic adjustments to the projected image are continuously made. In another example, automatic adjustments to the projected image are made only during initialization or when prompted by the user, which can be updated with additional selections from the user. Updates can be made to projected image rotation and image height, and to other projector functions during use as desired while viewing the projected image, as seen back at block 82.

When the projector is to be turned off, each extendable leg member may be retracted into the position device based on the position input signal, as seen at block 90. For example, the extendable leg members are retracted into the image projection device when a movie, program or presentation is completed, and the image projector is being packed up to make the projector more compact. A transport mode is selected whereby each leg member is retracted into the projector housing for projector transportation. Motorized retraction of the extendable leg members avoids excessive jostling of the image projector while the bulb is hot that may cause early bulb burnout.

While the embodiments of the invention disclosed herein are presently considered to be preferred, various changes and modifications can be made without departing from the spirit and scope of the invention. The scope of the invention is indicated in the appended claims, and all changes that come within the meaning and range of equivalents are intended to be embraced therein.
CLAIMS:

1. An image projection device, comprising:
an image projector including a projector housing, said projector housing
having a first leg opening and a second leg opening formed therein;
a first extendable leg member received in said first leg opening;
a second extendable leg member received in said second leg opening;
a first translation device attached to said projector housing and operably
coupled to said first extendable leg member;
a second translation device attached to said projector housing and operably
coupled to said second extendable leg member; and
   a controller electrically coupled to said translation devices,
   wherein said controller receives a position input signal and sends a
translation control signal to at least one of said first translation device and said second
translation device based on the position input signal to provide an image rotation control.

2. The image projection device of claim 1,
   wherein said image projector constitutes one of a liquid crystal display
projector and a deflectable mirror array projector.

3. The image projection device of claim 1,
   wherein said translation device includes a linear stepper motor; and
   wherein said extendable leg member operably coupled to said translation
device is either extended or retracted when said linear stepper motor is actuated.

4. The image projection device of claim 1,
   wherein said first leg opening with said first extendable leg member and
said second leg opening with said second extendable leg member are located in at least two
corners of said projector housing.
5. The image projection device of claim 1,
   wherein the position input signal is received from an input device selected
   from a group consisting of: a remote control device, an image rotation control button
   attached to said image projector, a menu selection from a menu projected by said image
   projector, and an image rotation application running on a computer operably coupled to
   said image projector.

6. The image projection device of claim 1,
   wherein said image projector is positioned on one of a table, an overhead
   cradle, and a projector support structure.

7. The image projection device of claim 1, further comprising:
   a fixed leg member attached to said projector housing, said fixed leg
   member triangularly configured with said first extendable leg member and said second
   extendable leg member to stabilize said projector housing.

8. The image projection device of claim 1, further comprising:
   a third extendable leg member received in a third leg opening in said
   projector housing,
   wherein said third extendable leg member is triangularly configured with
   said first extendable leg member and said second extendable leg member to stabilize said
   projector housing; and
   a third translation device attached to said projector housing and operably
   coupled to said third extendable leg member,
   wherein said third translation device is electrically coupled to said
   controller, and wherein said controller receives a position input signal and sends a control
   signal to said third translation device based on the position input signal to provide an image
   height control.

9. The image projection device of claim 1, further comprising:
a third extendable leg member received in a third leg opening in said projector housing;
a fourth extendable leg member received in a fourth leg opening in said projector housing;
wherein said third extendable leg member and said fourth extendable leg member are configured with said first extendable leg member and said second extendable leg member to stabilize said projector housing;
a third translation device attached to said projector housing and operably coupled to said third extendable leg member; and
a fourth translation device attached to said projector housing and operably coupled to said fourth extendable leg member,
wherein said third translation device and said fourth translation device are electrically coupled to said controller, and wherein said controller receives a position input signal and sends a control signal to said third translation device and said fourth translation device based on the position input signal to provide an image height control.

10. The image projection device of claim 1, further comprising:
a tilt sensor attached to said projector housing and electrically coupled to said controller, wherein the position input signal includes a tilt sensor output signal.

11. A method of controlling image rotation from an image projection device, comprising:
projecting an image onto a projection surface;
receiving a position input signal;
sending a translation control signal based on the position input signal; and
adjusting a projected image rotation based on the translation control signal.

12. The method of claim 11,
wherein the position input signal is received from an input device selected from a group consisting of: a remote control device, an image rotation control button attached to the image projection device, a menu selection from a menu projected by the
image projection device, and an image rotation application running on a computer operably coupled to said image projection device.

13. The method of claim 11, further comprising:
   extending or retracting at least one extendable leg member based on the position input signal,
   wherein an extension or a retraction of the at least one extendable leg member adjusts the projected image rotation.

14. The method of claim 11, further comprising:
   automatically leveling the projected image rotation based on the position input signal, the position input signal received from a tilt sensor attached to the image projection device.

15. The method of claim 11, further comprising:
   adjusting a projected image height based on the position input signal.

16. The method of claim 11, further comprising:
   retracting each extendable leg member into the image projection device based on the position input signal.

17. A system for controlling image rotation from an image projection device, comprising:
   means for projecting an image onto a projection surface;
   means for receiving a position input signal;
   means for sending a translation control signal based on the position input signal; and
   means for adjusting a projected image rotation based on the translation control signal.

18. The system of claim 17, further comprising:
means for extending or retracting at least one extendable leg member based on the position input signal,
wherein an extension or a retraction of said at least one extendable leg member adjusts said projected image rotation.

19. The system of claim 17, further comprising:
means for automatically leveling the projected image rotation based on the position input signal, the position input signal received from a tilt sensor attached to the image projection device.

20. The system of claim 17, further comprising:
means for adjusting a projected image height based on the position input signal.

21. The system of claim 17, further comprising:
means for retracting each extendable leg member into the image projection device based on the position input signal.
# INTERNATIONAL SEARCH REPORT

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC 7:** \(H04N5/74\)

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC 7:** \(H04N \ G03B\)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**EPO-Internal, PAJ**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>PATENT ABSTRACTS OF JAPAN vol. 2000, no. 12, 3 January 2001 (2001-01-03) 11-13, 15-18, 20,21</td>
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<td>--&amp; JP 2000 241875 A (FUJITSU GENERAL LTD), 8 September 2000 (2000-09-08) abstract; figures 3,5,6</td>
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<td>--&amp; JP 2003 005279 A (FUJITSU GENERAL LTD), 8 January 2003 (2003-01-08) cited in the application abstract; figures 1,2,4</td>
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**Data of the actual completion of the international search**

28 January 2005

**Data of mailing of the international search report**

04/02/2005

**Name and mailing address of the ISA**

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<th>Relevant to claim No.</th>
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<tr>
<td>X</td>
<td>PATENT ABSTRACTS OF JAPAN vol. 2003, no. 09, 3 September 2003 (2003-09-03) - &amp; JP 2003 149729 A (SEIKO EPSON CORP), 21 May 2003 (2003-05-21) abstract; figures 1-5</td>
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### INTERNATIONAL SEARCH REPORT

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<tr>
<td>JP 2000241875 A</td>
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