SELF-LEVELING PIECE OF FURNITURE AND OPERATING METHOD

The invention describes a self-levelling piece of furniture with three or more legs, e.g. a table or chair, which stands on uneven and sloping ground with the aid of individually motor-driven extendable and shortenable legs and which additionally brings the usable furniture surface into a horizontal or defined sloping position by means of inclination sensors and a control system. Furthermore, the invention concerns an operating procedure for a self-levelling piece of furniture.

With paved terraces or room floors, on lawns or on sloping sidewalks, the floor is often uneven or even, but not horizontal. Or the floor may change its inclination, as with ships. In all the cases mentioned, a piece of furniture placed on it can wobble and/or its useful surface, such as a tabletop, is not horizontal. This can cause liquids in glasses or soup plates to spill over unintentionally, or glasses or bottles to tip over, or you can sit uncomfortably crooked on an inclined floor in the case of chairs.

In these cases one usually tries to correct the wobbling and standing at an angle with beer coasters pushed under the feet or with other documents. For the removal of the wobbling a base pushed under one foot is sufficient, since thereby an always wobble-free three-legged piece of furniture is supplemented quasi by a fourth leg fitting in the length.

However, in order to additionally obtain a horizontal table top, for example, one needs up to three under certain circumstances differently thick underlays that have to be pushed under up to three feet.

This procedure is complex, the available documents often do not have the right thickness, they wear out or soften when it rains and they disturb the appearance. Because of the frequent pushing back and forth, the procedure is usually not carried out at all on chairs because it is too cumbersome. The same applies to manually adjustable legs. Even more difficult is wobbly standing and levelling for furniture with more than four legs.

Many methods are known (IPC A47B e.g. 91 and others) to make tables shake-free, for example.

In patent EP 1 696 765 B1, a table contains a rigid and a movable pair of legs, which should adapt to the floor by manually moving the table back and forth. However, this does not automatically bring the tabletop into a horizontal position.

In the utility model DE 20 2014 005 589 U1, each table foot contains a hydraulic cylinder which is hydraulically connected to the hydraulic cylinders of the other table feet via hoses. Although this allows the table to be set up without wobbling, the table top is not automatically brought into a horizontal position as a useful surface here either.

Also in patent AT 0186714 B1 a multi-port valve has to be brought manually into three different positions for levelling and the table has to be adjusted twice manually and the table top has to be brought into the horizontal position by eye measurement or auxiliary means.

Even with other known devices, there is no automatic levelling of the usable surface on uneven or sloping floors.

The present invention is therefore based on the task of automatically solving both the problem of wobbling and levelling the useful surface of furniture (e.g. table top or seat) without manual action in the case of pieces of furniture on uneven or sloping floors.

The task is essentially solved by the fact that all legs of the piece of furniture, except for at most one leg, can be adjusted in length by motor and that the piece of furniture contains a device that detects whether the foot of each leg exerts a minimum force on the floor. If this is not the case, the corresponding leg is extended by a motor or the remaining legs are shortened. The piece of furniture also contains tilt sensors that detect a deviation of the usable surface from the horizontal and signal this to a control unit. The control then changes the length of each adjustable leg so that all legs press against the floor with a minimum force and at the same time the usable surface of the piece of furniture is horizontal or can be set at an angle.

Examples of the invention are explained using the following figures:

Fig. 1: Elements of a self-levelling table

Fig. 2: Multi-part leg with force sensor

Fig. 1 and the following description show a table as an example of a self-levelling piece of furniture 1. Four legs 3a to 3d, each consisting of a fixed upper part and a movable lower part, are connected to the table top as useful surface 2. In this example, the lower part can be moved up and down by a motor 8 within the upper part via a spindle 9 in accordance with Fig. 2, thereby changing the length of the leg 3 with its foot 4. The motors 8 are controlled by a control 6, which is conveniently arranged in or below the table top and is supplemented by an autonomous power supply 7, so that the table can also be operated in remote locations.

In order to determine whether the tabletop is horizontal, the table also contains at least two inclination sensors 5a and 5b, which are not arranged parallel to each other and are housed in a common housing or chip according to the state of the art.

The task of setting up the table on an uneven or sloping floor in a wobble-free and horizontal manner can be subdivided into two interlocking tasks, i.e. unshaking and levelling.

De-wobbling

If a table or other piece of furniture is placed on the floor, the feet of the legs usually only touch the floor if all legs are exactly the same length and the floor is level. While the first condition is usually met, the floor, for example on lawns or paved surfaces, is not level inside and outside.

In this case, the empty table is first placed on two diagonal feet, e.g. 4a and 4d in Fig. 1. A third foot, e.g. 4c, will more or less touch the floor if the centre of gravity of the table is not exactly on the axis between the feet 4a and 4d. The fourth foot, in this example foot 4b, has a distance to the floor, even if the table top is horizontal. When the table top is moved back and forth, the table wobbles and feet 4b and 4c alternately touch the floor.

To prevent wobbling, first check that all four feet are touching the floor. It is not enough to determine the distance to the ground. Since in practice the floor, especially outdoors, is usually somewhat yielding, even if one foot is at zero distance from the floor, the floor under the foot would be slightly compressed when the table is then loaded. Then the table would shake again. Therefore the table advantageously needs a device with which it can be determined whether each foot presses on the floor with a certain minimum force. It is advisable to set the minimum force as high as possible, but it must be below the weight of the empty table above one foot so that the table is not lifted above the foot. If all four feet with this minimum force and less than the weight of the empty table press on the floor above one foot, the table shall not be lifted above one foot nor shall the table wobble. In addition, as the compression of the floor by the foot usually increases only slightly as the force increases, it can be assumed that by far the largest part of the yielding of the floor has already taken place as a result of the minimum force applied and that a further yielding due to loads on the table no longer causes the table to shake.

Force sensor

In one possible version (Fig. 2), the device for detecting the minimum force described consists of a force sensor 10 on each leg 3 of the table. For example, this is located between leg 3 and foot 4 and measures the force between leg and foot. If the leg 3 previously suspended in the air is extended, the foot 4 will eventually touch the ground and the force between leg 3 and foot 4 will increase. The measured force or the exceeding of a pre-defined force is signalled, for example, via the electrical connections 11 to the control 6. As soon as the set minimum force is reached, control 6 switches off the relevant motors.

In another advantageous version, the force sensor 10 is located, for example, between useful area 2 and leg 3 and or between the upper and lower part of leg 3, in order to better protect it from moisture and impacts.

Current measurement

In another version, where the legs 3 are driven by electric motors 8, force sensors are advantageously not required. To unscramble, each leg 3 is lengthened on a trial basis and the current consumed by the associated motor 8 is measured in control 6. As long as the foot 4 of leg 3 does not touch the ground, this current is small. When it touches the ground, it rises because the motor 8 now starts to work against the weight of the table above the foot 4. If the motor current reaches a value A previously determined by the manufacturer when the minimum force is reached, control 6 stops motor 8, otherwise it would later start lifting the table over foot 4.

If one foot 4 is already firmly on the ground when a leg 3 is extended for a test, the motor current during extension exceeds a second value B previously determined by the manufacturer, which corresponds to the force required to lift the table above the foot. In this case, leg 3 may be shortened again by the amount by which it has been extended beyond the minimum force on a trial basis. This measurement is determined, for example, by the running time of the motor during the test extension.

Inclination measurement

In another advantageous version without force sensors, each leg 3 is also lengthened on a trial basis to determine whether the minimum force of its foot 4 on the ground has been reached. However, it is not the motor current that is measured, but the inclination of the table. The inclination does not change as long as the foot 4 of the leg 3 that is lengthening itself by way of trial is still floating in the air and has not touched the ground, nor as long as the table has not been lifted after the foot 4 has touched the ground and the leg 3 has been lengthened further. Only when the table is lifted above foot 4 does the inclination of the table suddenly change. This is the signal to control 6 that both the minimum force and the force required to lift the table above foot 4 have been reached, and control 6 can shorten the leg again by the same amount as it has lengthened it beyond the start of the tilt change.

Current measurement and inclination measurement can also be advantageously combined to achieve higher reliability on different floors.

These devices also work with more than four table legs, so that even large boards or conference tables can be shaken down.

Levelling

For example, a simple operating procedure for a table or other piece of furniture for combined shaking and leveling consists of the following steps (Fig. 1):

1. Before the table was set up, all legs 3 were brought into a defined starting position, for example they were shortened to the stop.

2. The table is placed on a floor at the intended location.

3. The control 6 checks, for example by means of force sensors, whether at least two diagonally opposite feet 4 are pressing on the floor with the specified minimum force.

4. If this is the case, extend the other two legs 3 until their feet also reach the minimum force on the floor. The table can then no longer shake, but can still stand at an angle.

5. The inclination sensor 5b, which is arranged in the longitudinal direction of the table for example, is used to check whether the table top on the left or right is too low compared to the horizontal or a desired inclination.

6. The legs under the transverse side which is too deep are both extended simultaneously by the same amount until the table is also horizontal in the longitudinal direction.

7. Since the extension of the two legs is not necessarily completely synchronous in practice, the minimum force of all legs is checked during or after step 6 and, if necessary, corrected by adjusting the leg lengths.

8. Now check with the help of the other inclination sensor 5a whether the table top 2 is too low at the front or rear.

9. The legs under the long side that is too low are both extended simultaneously by the same amount until the table is horizontal in the transverse direction.

10. Again, during or after step 9, the minimum force is checked and corrected if necessary.

11. Steps 3 to 10 are repeated until there is no more change in inclination.

12. The control unit is set to standby mode, which only needs to be left if the inclination of the table top is changed.

13. In order that the legs are not only extended until they reach the stop each time the table is set up, and so that the table can be set down on a flat surface after use, they can be shortened to the stop again after each use. This can be done, for example, when the table is completely raised by persons for transport. In this case, the inclination changes when the table is lifted and no leg reaches the minimum force. If these conditions are detected, all legs are moved back to the initial length specified in step 1.

An advantageous acceleration of the levelling process can be achieved by determining the resulting overall inclination and direction of the tabletop after step 4 and then determining and carrying out the necessary extension or shortening of all legs simultaneously in one calculation step.

After the table has been leveled and used, the leg lengths can be readjusted to the initial position by means of a control element, or advantageously after appropriate evaluation of the inclination sensors, by lifting the table on only one side. In the latter case, no separate control elements are required.

Likewise, renewed levelling can be initiated by a control element or advantageously by lifting the table on another side, for example.

Another advantageous design allows the tabletop to be brought into a slightly inclined position by means of control elements or by lifting another side so that, for example, raindrops can run off better before the table is used.

In another advantageous version, the overall height of the table can be adjusted by controls after levelling by shortening or lengthening all legs by the same amount at the same time.

For example, commercially available electric linear drives can be used to change the length of the legs 3 of a piece of furniture in keeping with the invention. As a rule, these are equipped with two switches which interrupt the power supply for the corresponding direction of rotation of the drive motor 8 when the moving part is completely extended and shortened until shortly before the mechanical stop. If, for example, one of the legs 3 of a piece of furniture according to the invention reaches its stop during levelling when shortening and cannot be further shortened, then the remaining legs can be extended instead in order to still achieve horizontal alignment. To do this, the stop must be detected and evaluated.

This is achieved in an advantageous design without additional switches by measuring the motor current while shortening this leg. If it suddenly drops to zero, the internal switch has interrupted the circuit and the leg is at the stop. This information is stored in the control until the leg is extended again in the

opposite direction. Then the motor current is also measured in order to detect a possible stop and, if necessary, to influence the direction of the leg movements.

It is advantageous to steer the legs in such a way that at least one leg is shortened or lengthened as far as it will go during dismantling and levelling. This makes optimum use of the limited length variation of the legs on uneven or sloping ground.

Additional elements

Other versions of the ingenious piece of furniture also contain additional elements, preferably within the control system, with which furniture-related functions can be realised. These are, for example:

- A navigation data receiver that makes it easier to find the piece of furniture and/or can be used as an anti-theft device.

- Sensors that determine and report the location and number of free and occupied table seats and/or chairs.

- Components and software for wireless communication that make it possible,

    - to inventory the piece of furniture from a distance and/or

    - uniquely and/or automatically identify the piece of furniture, in particular a table in a restaurant, to the operating personnel and/or

    - to exchange information, in particular with neighbouring tables grouped into groups, on a useful area height to be jointly set, and/or

    - to provide software applications by means of which guests or customers sitting near tables in particular can communicate with the furniture display unit in order, for example, to place orders; and/or

    - provide Internet access for restaurant guests and/or operators.

- A clock that allows the piece of furniture to be tilted and horizontal at an adjustable time.

- A rain sensor that allows the piece of furniture to be tilted in the event of rain.

- A temperature sensor for outdoor temperature detection and/or reporting.

- Charging sockets for charging mobile devices from an existing autonomous power supply.

- A monitoring and/or signalling unit for the operating status of an existing autonomous energy supply for the piece of furniture in order, for example, to be able to charge an existing accumulator in good time.

A further advantage is that the motorised length adjustment of the legs and the devices for signalling the minimum force on the floor as well as the control are designed as retrofit kits for existing furniture.

Reference sign list

1 piece of furniture

2 Useable area

3 Leg

4 feet

5 Inclination sensor

6 Control

7 Autonomous energy supply

8 Engine

9 Spindle

10 Force sensor

11 Electrical connection

Patent claims

1. Self-levelling piece of furniture (1) having a normally horizontal useful surface (2) and three or more legs (3) connected thereto and with the feet (4) of which the piece of furniture can be placed on a floor, wherein all the legs except for at most one leg are individually motor-adjustable in length and the piece of furniture contains inclination sensors (5) which measure and signal the inclination of the useful surface in at least two non-parallel directions, characterised in that the piece of furniture includes devices which signal the presence of a predeterminable minimum force of each foot on the ground, and includes a control (6) which adjusts the length of the adjustable legs at the location of installation of the piece of furniture so in length, in that all feet exert at least the predeterminable minimum force on the floor and at the same time the inclination sensors signal no or a desired deviation of the usable surface inclination from the horizontal, and as a result the piece of furniture does not wobble even on uneven or inclined floor and its usable surface is horizontal or predeterminably inclined.

2. Self-levelling piece of furniture according to claim 1, characterized in that the device for determining the minimum force of a foot (4) on the ground consists of one force sensor (10) per foot, which is arranged in such a way that it measures the exerted force and/or the exceeding of a threshold value of this force of the foot on the ground and signals this to the control (6).

3. Self-levelling piece of furniture according to Claim 1, characterized in that the device for determining a minimum force of one leg on the floor in the case of legs operated by an electric motor is realized by using the current of the motor (8), which rises when the piece of furniture touches the floor as a result of the incipient lifting of the piece of furniture, as a signal.

4. Self-levelling piece of furniture according to claim 1, characterised in that the device for determining a minimum force of one leg on the ground is realised by the control extending a length-adjustable leg on a trial basis or shortening the remaining length-adjustable legs until the inclination of the useful surface with respect to the state without contact with the ground of this leg changes, and this change is used as a signal for exceeding the minimum force, wherein the trial extension of this leg or the shortening of the remaining legs can subsequently be reversed.

5. Self-levelling piece of furniture according to Claim 1, characterised in that the control includes:

- Sensors which determine and report the location and/or number of occupied table seats, and/or

- components for wireless communication that make it possible,

    - to inventory the piece of furniture from a distance and/or

    - uniquely and/or automatically identify the piece of furniture, in particular a table in a restaurant, to the operating personnel and/or

    - to exchange information, in particular with neighbouring tables grouped into groups, on a useful area height to be jointly set, and/or

    - to provide software applications by means of which guests or customers sitting near tables in particular can communicate with the staff of the furniture display unit and/or

- to provide Internet access for restaurant guests and/or operators, and/or

- A clock enabling the piece of furniture to be inclined and horizontally positioned at an adjustable time, and/or

- a rain sensor, by means of which the piece of furniture can be tilted in the event of rain, and/or

- a temperature sensor for outdoor temperature detection and/or reporting, and/or

- a monitoring and/or signalling unit for the operating state of an existing autonomous energy supply of the piece of furniture.

6. Self-levelling piece of furniture according to one of the preceding requirements, characterised in that the motorised length adjustment of the legs and the devices for signalling the minimum force on the floor, as well as the control, are designed as a retrofit kit for existing furniture.

7. Operating method for a self-levelling piece of furniture (1) having a normally horizontal useful surface (2) and three or more legs (3) connected thereto, with the feet (4) of which the piece of furniture can be placed on a floor, wherein all the legs except for at most one leg are individually motor-adjustable in length and the piece of furniture contains inclination sensors (5) which measure and signal the inclination of the useful surface in at least two non-parallel directions, characterised in that the piece of furniture comprises means for signalling the presence of a predeterminable minimum force of each leg on the floor and a control means (6) by means of which, after the piece of furniture has been set up at the place of setting-up, all the length-adjustable legs for which the minimum force on the floor is not signalled are extended and/or the remaining legs are shortened to such an extent that the minimum force is reached and the piece of furniture does not shake, and alternately, for the purpose of levelling the useful surface, those adjustable legs are extended which leave the useful surface above the leg too low relative to the horizontal or the desired inclination and/or those adjustable legs are shortened which leave the useful surface above the leg too high relative to the horizontal or the desired inclination until both freedom from shake and level are achieved.

8. Operating method for a self-levelling piece of furniture according to claim 7, characterized in that the lifting of the piece of furniture on one of the sides, whereby then on the opposite side only two legs exert their minimum force on the floor and the inclination of the useful surface changes in its direction, is used as a signal to trigger, depending on the selected lifted side, a certain action desired by the user, such as the setting of a defined initial length of the length-adjustable legs, a new levelling or an inclination of the piece of furniture.

9. Operating method for a self-levelling piece of furniture according to claim 7, characterized in that after the piece of furniture has been raised completely, whereby the predetermined minimum force on the floor is then no longer signalled for any leg and the inclination of the useful surface with respect to the state of use changes, all length-adjustable legs are brought to a predeterminable initial length.

Summary

The invention describes a self-levelling piece of furniture with three or more legs, e.g. a table or chair, which stands on uneven and sloping ground with the aid of individually motor-driven extendable and shortenable legs and which additionally brings the usable furniture surface into a horizontal or defined sloping position by means of inclination sensors and a control system.

Fig. 1

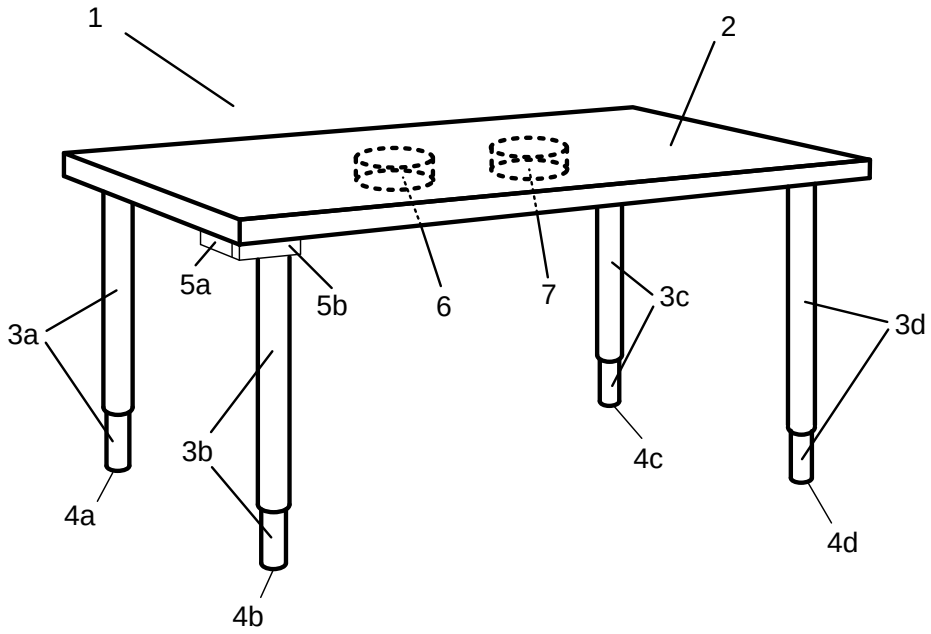

Fig. 2