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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, by means of inclination sensors and a control system, additionally brings the usable furniture surface into a horizontal or defined inclined position. 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 ground changes its inclination, as with ships. In all the cases mentioned, a piece of furniture placed on it can wobble and/or its usable 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 eliminate the wobbling and standing at an angle with beer coasters pushed under the feet or with other underlays. To eliminate the wobbling, a base pushed under one foot is sufficient, as a three-legged piece of furniture, which is always free of wobbles, is supplemented by a fourth leg which fits 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, which have to be pushed under up to three feet.

This procedure is complex, the available underlays 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 are wobble-free standing and levelling for pieces of 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 pair of legs and a pair of movable legs that are supposed to adapt to the floor by manually moving the table back and forth. However, this does not automatically bring the table top into a horizontal position as a useful surface.

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 must be brought manually into three different positions for levelling and the table must be adjusted twice manually and the table top must 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 the problem of levelling the useful surface of furniture (e.g. table top or seat) on uneven or sloping floors without manual action.

The task is essentially solved by the fact that all the legs of the piece of furniture, except for at most one leg, are motorised in length and 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 shall be motor lengthened or the remaining legs 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 how the invention was carried out are explained using the following figures:

Fig. 1: Elements of a self-levelling table

Fig. 2: Multi-part leg with switch as 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 inside the upper part via a spindle 9 of a motor 8 according to 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, in order to be able to operate the table also 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.

Unshaking

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 on lawns or paved surfaces, for example, 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 touch the floor to a greater or lesser extent if the centre of gravity of the table is not exactly on the axis between feet 4a and 4d. The fourth foot, in this example foot 4b, then has a distance to the floor. When the table top is moved back and forth, the table wobbles and feet 4b and 4c alternately touch the floor.

In order to prevent the wiggling, it must first be determined whether all four feet touch the floor. It is not sufficient to determine the distance to the ground. Since in practice the floor, especially outside, is usually somewhat yielding, even at zero distance between one foot and the floor, the floor would be slightly compressed under the foot 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 press on the floor above one foot with this minimum force and less than the weight of the empty table, the table will not be lifted above one foot and the table will not wobble. In addition, since the compression of the floor by the foot generally increases only slightly with increasing force, it can be assumed that by far the largest part of the yielding of the floor has already taken place due to 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 switch as force sensor 15, on each foot 4 of the table. In the simplest case, this consists of a switch housing 10 at the end of leg 3 and a switch button 12, the lower end of which also forms the foot 4 of leg 3. If the leg 3 previously suspended in the air is extended or the remaining legs shortened, the lower end of switch button 12 will eventually touch the ground. The switch button 12 and a contact surface on its upper surface now press against the spring 11 until the two switch contacts 13 are bridged and a signal is generated via the electrical connections 14 to the control 6, which in turn can switch off the corresponding motor 8 via the electrical connections 14. The spring force to be overcome until the switching contacts close must correspond to the described minimum force.

In another advantageous version, the force sensor 15 is implemented without a switching point. This means that the threshold value above which the minimum force is considered to have been reached can be specified in the controller via software.

In another advantageous design, the force sensor 15 is arranged, for example, between the 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 unswig, each leg 3 is lengthened as a trial and the current consumed by the corresponding 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 shall 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. It does not change as long as the foot 4 of the leg 3 that has been extended for testing is still floating in the air and has not touched the ground, or as long as the table has not been lifted after the foot 4 has touched the ground and the leg 3 has been extended 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 shortens the leg 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

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

1. Before the table was set up, all legs 3 were brought into a defined starting position, they were shortened, for example, 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, the other two legs 3 are extended until their feet also reach the minimum force on the floor. The table can then no longer shake, but still stand at an angle.

5. Now check with the help of the inclination sensor 5b, which is arranged, for example, in the longitudinal direction of the table, whether the table top on the left or right is too low in relation 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 both 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 which 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 the inclination.

12. The control is put into a standby mode, which only needs to be left when the inclination of the table top is changed.

13. So that the legs are not always extended until they reach the stop each time the table is set up, and so that the table can continue to be placed on a flat surface after use, it is advisable to shorten them to the stop again after each use. This occurs, for example, when the table is completely raised by persons for transport. In this case, the inclination changes when the table is lifted and the minimum force is no longer reached for any leg. 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 levelled 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 table top to be brought into a slightly inclined position by means of operating elements or by lifting another side, so that raindrops, for example, can run off better before the table is used.

In another advantageous version, the overall height of the table can be adjusted by means of 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 operating personnel.

- 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 recording and/or reporting outside temperatures.

- 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.

Another advantageous design 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 Switch housing

11 Spring

12 Switch button

13 Switching contact

14 Electrical connection

15 Force sensor

Patent claims

1. 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, characterized in that

- all but one leg is individually motorised and adjustable in length, and

- the furniture contains devices indicating the presence of a predeterminable minimum force of each foot on the floor, 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, and

- the piece of furniture contains a control (6) which adjusts the length-adjustable legs at the location of installation of the piece of furniture in such a way that

    - all feet exert their minimum force on the ground and simultaneously

    - 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 sloping ground and its useful surface is horizontal or predeterminably sloping.

2. Self-levelling piece of furniture according to claim 1, characterised in that the minimum force of each leg on the floor is selected so large that the empty piece of furniture stands firmly on the floor with all legs and does not shake, even with slightly deformable material of the piece of furniture and/or with slightly deformable floor.

3. Self-levelling piece of furniture according to claim 1, characterised in that the device for determining the minimum force of a foot (4) on the floor consists of one force sensor (15) 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 floor and signals this to the control (6).

4. 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 upon contact with the floor as a result of the incipient lifting of the piece of furniture, as a signal.

5. Self-levelling piece of furniture according to claim 1, characterized in that the device for determining a minimum force of one leg on the ground is realized by the fact that the control further extends a length-adjustable leg on a trial basis when it touches the ground or shortens the remaining length-adjustable legs until the inclination of the useful surface with respect to the condition without ground contact 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 is subsequently reversed.

6. self-levelling piece of furniture according to claim 1 or 2, characterised in that the leveled useful area is adjustable in its overall height by the same amount by simultaneously shortening or lengthening all length-adjustable legs or is tiltable by shortening or lengthening adjacent length-adjustable legs.

7. self-levelling piece of furniture according to claim 1 or 2, characterised in that reaching a stop of one of the length-adjustable legs when shortening or lengthening using commercially available electric linear drives is detected by measuring the motor current, which in this case is interrupted by switches in the linear drives, and that the information is used to influence the length of the remaining length-adjustable legs.

8. self-levelling piece of furniture according to claim 1, characterised in that the piece of furniture contains an autonomous power supply (7) in order to be able to operate the table also at locations remote from the mains.

9. self-levelling piece of furniture according to claim 1, characterised in that user commands to the control or feedback signals from the control are given via control elements built into the piece of furniture and/or wired or wireless control elements.

10. Self-levelling piece of furniture according to claim 1, characterised in that the control contains:

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

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

- Building blocks for wireless communication that make it possible,

- Inventory the piece of furniture from a distance, and

- 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.

11. Self-levelling piece of furniture according to one of the preceding claims, 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.

12. Operating method for a self-levelling piece of furniture (1) with a normally horizontal usable 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, characterised in that

- All but one leg is individually motorised and adjustable in length, and

- The furniture contains devices indicating the presence of a predeterminable minimum force of each leg on the floor, 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, and

- In that the piece of furniture furthermore contains a control (6) by means of which, after the piece of furniture has been set up at the place of setting up, all legs which can be adjusted in length and 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 legs which can be adjusted in length are extended, which leave the useful surface above the leg too low in relation to the horizontal or the desired inclination, and/or those length-adjustable legs are shortened which leave the useful surface above the leg too high in relation to the horizontal or the desired inclination, until both freedom from shake and levelling are achieved.

13. Operating method for a self-levelling piece of furniture according to claim 12, characterised in that, for the purpose of levelling, the direction and thickness of the existing inclination of the useful surface is first calculated from the sensor data and then the necessary different changes of all leg lengths are carried out simultaneously on the basis of the calculation results.

14. A method of operation for a self-levelling piece of furniture according to claim 12, 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 the direction thereof, 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.

15. Operating method for a self-levelling piece of furniture according to claim 12, characterised in that after complete lifting of the piece of furniture, in which 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 of the invention

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

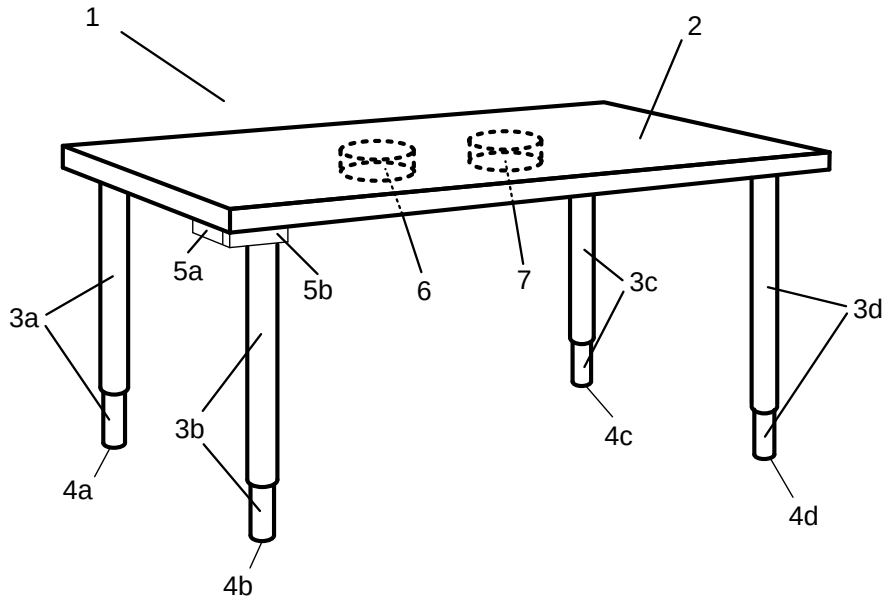

Fig. 2