provide a mechanical or digital representation of the sensed contour or topography of the foot, absent any individualized, restorative adjustment of foot structures (e.g., bones or soft tissues). While functional and accommodative orthotics may temporarily decrease foot pain due to restricting pathologic range of motion and in cushioning the foot, they necessarily cause pathologic gait, and this approach will inevitably cause pain in other joints in the foot, leg, pelvis and/or back as they compensate for this abnormal motion. There remains a need for an apparatus that generates an image or contour of a foot's plantar surface when the foot's structures are adjusted to a restored position, from which a foot orthosis can be constructed that corrects and/or restores the alignment and/or positioning of foot structures.

[006] The foregoing examples of the related art and limitations related therewith are intended to be illustrative and not exclusive. Other limitations of the related art will become apparent to those of skill in the art upon a reading of the specification and a study of the drawings.

BRIEF SUMMARY

[007] The following aspects and embodiments thereof described and illustrated below are meant to be exemplary and illustrative, not limiting in scope.

[008] In a first aspect, an apparatus comprising a plurality of ~~engagement structures~~pins and one or more biasing members is provided. Each pin is independently movable along a longitudinal axis, and the one or more biasing members is configured to exert a force on one or more pins in the plurality of pins, such that a first set of pins in the plurality of pins moves from a first position to a second position independent of a second set of pins in the plurality of pins.

[009] In one embodiment, the one or more biasing members exerts a force to achieve movement of the one or more pins in the plurality of pins. In another embodiment, the one or more biasing members resists a force applied to one or more pins in the plurality of pins.

[010] In one embodiment, pins in the first set of pins are moved prior to movement of pins in the second set of pins. In another embodiment, pins in the first set of pins are moved by a first force applied by a biasing member in the one or more biasing members to the pins in the first set of pins, the first force different from a second force applied by a biasing member in the one or more biasing members to pins in the second set of pins.

[011] In another embodiment, the one or more biasing members comprise at

[020] ~~In another aspect, a~~An apparatus comprised of a plurality of pins and at least one biasing member is ~~provided~~also disclosed, wherein the plurality of pins is supported with a frame or housing, and each pin is independently movable along a longitudinal axis. One or more biasing members is disposed within the frame, where the one or more biasing members is configured for contact with one or more pins in the plurality of pins such that a first set of pins in the plurality of pins is moved along the longitudinal axis of each pin in the first set at a pressure and/or at a time different from movement of a second set of pins in the plurality of pins along the longitudinal axis of each pin in the second set.

[021] ~~In one embodiment~~As disclosed herein, the one or more biasing members comprise a plurality of biasing members. ~~In another embodiment~~As disclosed herein, each biasing member in the plurality of biasing members is dedicated for movement of a single pin in the plurality of pins or of a single set of pins in the plurality of pins.

[022] ~~In another embodiment~~As disclosed herein, a first biasing member is dedicated for urging pins in the first set of pins from a first position to a second position (e.g., from an initial position to an engagement position), and a second biasing member is dedicated for urging pins in the second set of pins from a first position to a second position (e.g., from an initial position to an engagement position).

[023] ~~In another embodiment~~As disclosed herein, the one or more biasing members is configured for direct or indirect contact with sets of pins, and in another embodiment, for direct or indirect contact with a third set of pins in the plurality of pins such that pins in the third set move along their longitudinal axis at a pressure or at a time (e.g, subsequent to) different than pins in the first set of pins and/or the second set of pins.

[024] ~~In another embodiment~~As disclosed herein, the biasing member has an upper surface for contact with the lower surface of the plurality of pins, and wherein the upper surface of the biasing member has a pre-selected contour to contact the first set of pins prior to contact with the second set of pins. ~~In a more specific embodiment~~As disclosed herein, the biasing member is rectangular, and the upper surface has a pyramid-like contour with an apex offset from a center point of the rectangle. ~~In another specific embodiment~~As disclosed herein, the biasing member is rectangular, and the upper surface has a terraced contour with an uppermost terrace offset from a center point of the rectangle. ~~In yet another specific embodiment~~As disclosed herein, the biasing member consists of tens sides, and wherein five of the ten sides are on the upper surface. ~~In yet another specific embodiment~~As disclosed herein, the pre-selected contour of the biasing member is a pyramid-like shape with a flat apex.

[025] ~~In another embodiment~~As disclosed herein, the biasing member is composed of a first

material having a first density and a second material having a second density. ~~In another embodiment~~As disclosed herein, the biasing member or members is/are composed of a fluid, preferably a gas, that can be pressurized to urge pins from first to second positions. ~~In other embodiments~~As disclosed herein, the biasing member or members is/are a force that act directly or indirectly on one or more pins to effect movement of the pin(s) from first to second positions. Exemplary forces include magnetic force, a pneumatic force or pressure, a pressurized fluid force, gravitational force, a mechanical force and the like.

[026] ~~In another embodiment~~As disclosed herein, the biasing member is composed of a first material having a first durometer and a second material having a second durometer. ~~In a specific embodiment~~As disclosed herein, the first material is a viscoelastic foam. ~~In other specific embodiments~~As disclosed herein, the biasing member is composed of a rubber, an elastomer, a plastic, or a foam.

[027] ~~In yet another embodiment~~As disclosed herein, the apparatus further comprises a locking member to secure one or more pins in the plurality of pins.

[028] ~~In still another embodiment~~As disclosed herein, the apparatus further comprises a sensor to determine a position of one or more pins within the plurality of pins. ~~In a specific embodiment~~As disclosed herein, the apparatus comprises a single sensor that determines the position of each pin in the plurality. ~~In another specific embodiment~~As disclosed herein, the apparatus comprises two or more sensors. As disclosed herein~~In various specific embodiments~~, the sensor is a non-contact sensor and exemplary non-contact sensors include a laser, such as a one-dimensional laser, a two-dimensional laser, or a three-dimensional laser, and an optical distance scanner. The apparatus can optionally include a reflective surface positioned to reflect a beam from a laser sensor. ~~In yet another specific embodiment~~As disclosed herein, the sensor comprises a plurality of cameras for obtaining images of the plurality of pins from a plurality of angles.

[029] ~~In another embodiment~~As disclosed herein, each pin in the plurality of pins has a diameter between 0.0624 inches to 0.250 inches.

[030] ~~In still another embodiment~~As disclosed herein, the apparatus further comprises a transducer, such as a hall sensor or capacitive sensor, associated with the one or more biasing members.

[031] ~~In yet another embodiment~~As disclosed herein, the apparatus comprises a sensor to determine relative movement of the one or more biasing members.

[032] ~~In still another embodiment~~As disclosed herein, the plurality of pins and the one or more biasing members are capable of producing a force per pin of between about 0.02-4.0 lb-f, more preferably between about 0.02-5 lb-f.

[033] In another aspect, a method for obtaining a restored bone state in a foot ~~and/or for constructing a foot orthotic~~ is provided. The method comprises placing a plantar surface of a foot on an apparatus as described herein, the plantar surface placed on an upper surface defined by the plurality of pins, wherein said plurality of pins are in an initial position. Movement of pins in the plurality of pins is initiated, via the one or more biasing members, such that a first set of pins adjusts one or more bones in the foot to a restored bone state and a second set of pins engages the foot plantar surface ~~with the foot in its restored bone state~~. A position of each pin in at least the first pin set and the second pin set is determined, to obtain a profile of the foot in its restored bone state ~~from which an orthotic for the foot can be constructed~~.

[034] In one embodiment, the method further comprises transferring positional information of each pin to a computer. In another embodiment, a position of each pin in at least the first pin set and the second pin set is determined, to obtain a profile for construction of a foot orthotic or a series of foot orthotics to be worn sequentially.

[035] In yet another embodiment, the first set of pins adjusts one or more bones in the mid-foot region, or localized mid-foot region, of the foot, and a third set of pins in the plurality of pins moves via the one or more biasing members, such that pins in the third set of pins engage the foot plantar surface at a region other than the mid-foot region.

[036] In yet another aspect, a method is provided, wherein the method comprises placing a plantar surface of a foot an apparatus comprising (i) a plurality of pins, wherein each pin in the plurality of pins is independently movable along a longitudinal axis, and (ii) one or more biasing members configured for contact with one or more pins in the plurality of pins, such that a first set of pins in the plurality of pins is moved along the longitudinal axis of each pin in the first set independent of a second set of pins in the plurality of pins. Movement of the one or more biasing members is effected, such that ~~the first set of pins~~at least some of the pins in the plurality adjusts one or more bones in the foot to an adjusted position; and a position of each pin in at least the first pin set and the second pin set is determined.

[037] In one embodiment, the first set of pins adjusts one or more bones in the foot to a restored bone position. In another embodiment, the first and second sets of pins engage the foot in order to achieve a restored bone position.

[038] In one embodiment, movement of the pins or a biasing member is such that the first set of pins adjusts one or more mid-foot bones to an adjusted position.

[039] In another embodiment, the one or more biasing members is a fluid, and pressurizing the fluid effects movements of one or more pins or sets of pins in the plurality.

[040] In another embodiment, a first biasing member has a first pressure, to achieve movement of the first pin set, and a second biasing member has a second pressure, to achieve movement of the second pin set. The first pressure and the second pressure can be the same or different.

[041] In other embodiments, the position of an end of each pin in at least the first pin set and the second pin set that engages the foot plantar surface are determined, to obtain a positional point of each pin, the positional points collectively defining a surface map.

[042] In one embodiment, the method further comprises after the step of causing, locking the plurality of pins to secure each pin in a final position.

[043] In another embodiment, the step of determining comprises determining by means of the sensor a position of each pin.

[044] In still another embodiment, the method further comprises transferring positional information of each pin to a computer to construct a digital image of the profile.

[045] In another embodiment, the step of determining comprises determining a position of each pin in at least the first pin set and the second pin set to obtain a profile for construction of a series of foot orthotics to be worn sequentially.

[046] ~~In another aspect, a~~There is also disclosed a method comprise~~s~~ing providing an apparatus comprising (i) a plurality of pins, wherein each pin in the plurality of pins is independently movable along a longitudinal axis, and (ii) one or more biasing members configured for contact with one or more pins in said plurality of pins such that a first set of pins in the plurality of pins is moved along the longitudinal axis of each pin in the first set independent (e.g., prior to or at a different pressure) movement of a second set of pins in said plurality of pins along the longitudinal axis of each pin in the second set of pins; placing a plantar surface of a foot on the plurality of pins; causing movement of the one or more biasing members such that some of all of the pins in the first set of pins adjusts one or more bones in the foot to an adjusted position, and the second set of pins engages the foot plantar surface at positions responsive to the one or more bones in the adjusted position; and after the step of causing, determining a position of each pin in at least the first pin set and the second pin set.

[047] ~~In another embodiment~~As disclosed herein, the first set of plurality of pins contacts a foot plantar surface in a pre-determined or pre-selected force, contour or pattern to produce mid-tarsal movement sufficient to produce tension in a dorsal ligament thereby producing an adjusted position of the foot. Second and subsequent sets of pins in the plurality are contact the foot in its adjusted position, the second and subsequent plurality of pins contacting the foot in its adjusted bone position or restored bone state at a time or force different or the same as the first pin set.

[048] In another aspect, a method is provided, wherein the method comprises engaging a center engagement structure against a localized mid-foot region of a plantar surface of a subject's foot to adjust one or more mid-foot bones into a restored bone state; ~~engaging one or more peripheral engagement structures against a region other than the mid-foot region to contact the plantar surface while maintaining the engagement of the center structure; obtaining positional information of the engagement structures; and based on the positional information,~~ determining a surface map ~~or orthotic profile~~of the plantar surface of the foot with the mid-foot bone in its restored bone state.

[049] In addition to the exemplary aspects and embodiments described above, further aspects and embodiments will become apparent by reference to the drawings and by study of the following descriptions.

BRIEF DESCRIPTION OF THE DRAWINGS

[050] FIGS. 1A-1B are views of an individual's right foot, shown as a top plan view (FIG. 1A) and a side view from the right (FIG. 1B);

[051] FIGS. 1C-1E are a top plan views of a right foot, showing the 1st, 2nd, and 5th rays (Fig. 1C), the mid-foot region and the localized mid-foot region (Fig. 1E).

[052] FIGS. 2A-2B is a perspective view (FIG. 2A) and a side view (FIG. 2B) of an embodiment of the apparatus described herein;

[053] FIGS. 3A-3B are simplified illustrations of an embodiment of the apparatus, where a biasing member provides differential movement of pins in a plurality of pins, where the pins in an initial resting position (FIG. 3A) are urged along their longitudinal axes by a contoured biasing member (FIG. 3B);

[054] FIG. 4 is a illustration of another embodiment of a biasing member having a preselected surface contour to provide differential movement of pins in a pin bed array;

[055] FIG. 5 is a top view of a pin bed showing a center band region of pins;

[056] FIGS. 6A-6B are simplified illustrations of another embodiment of the