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(54) **MULTI-AXIS AUTOMATIC SHOE SOLE PROCESSING APPARATUS AND METHOD OF THE SAME**

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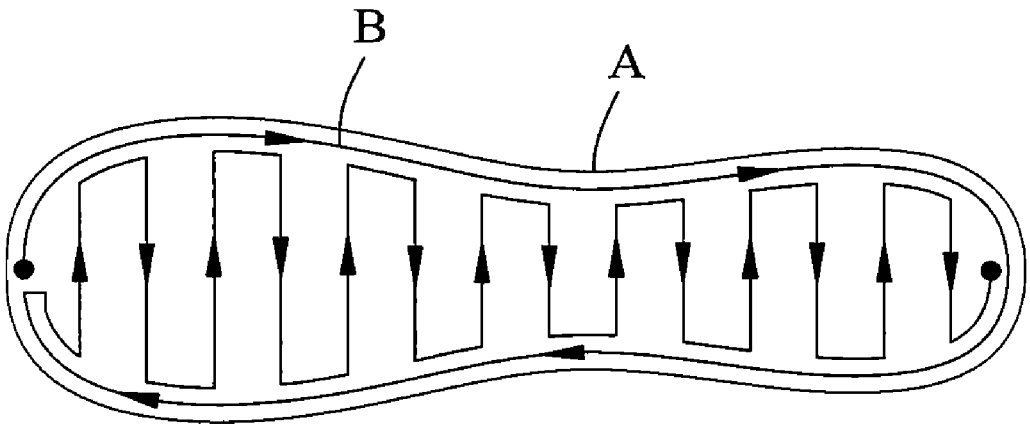
(57) **ABSTRACT**

A multi-axis automatic shoe sole processing apparatus includes a body, a multi-axis mechanical arm, a plasma processing module, and a control module, wherein the multi-axis mechanical arm, the plasma processing module, and the control module are respectively disposed at the body; the multi-axis mechanical arm and the plasma processing module are both electrically connected to the control module, the plasma processing module has a plasma nozzle disposed at the free end of the multi-axis mechanical arm, the control module drives the multi-axis mechanical arm to dislocate the free end according to a shoe data, and drives the plasma processing module to spray plasma from the plasma nozzle for processing the ii surface of a shoe sole with plasma.



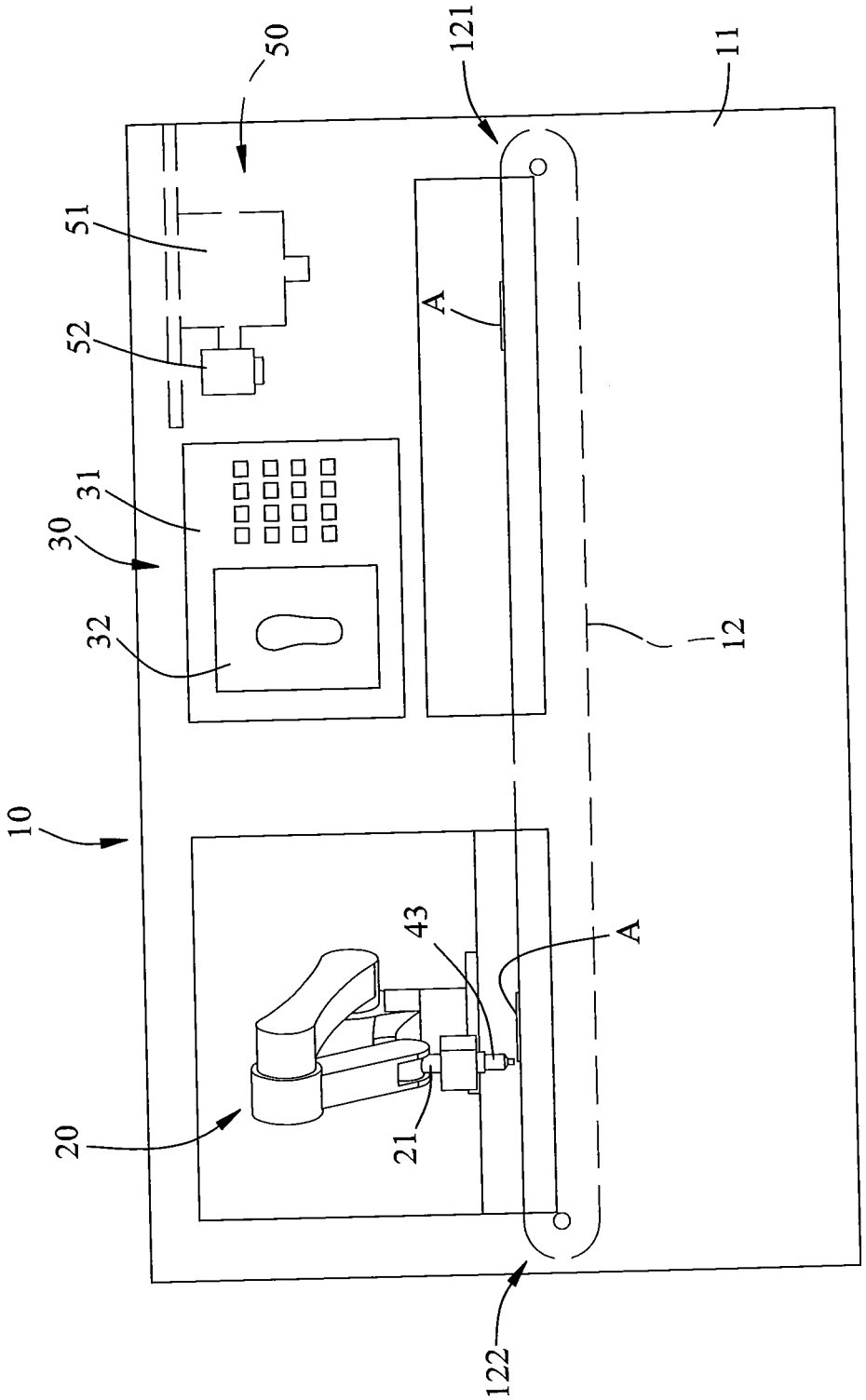


Fig. 1

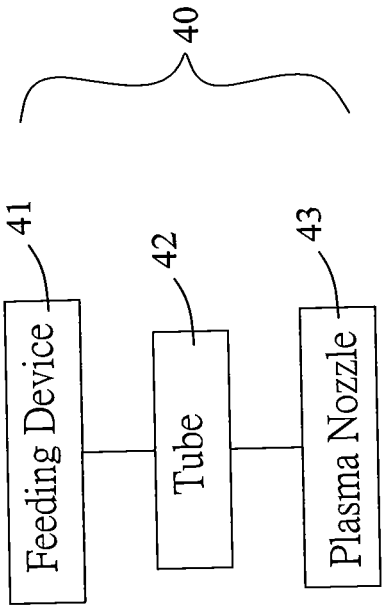


Fig. 2

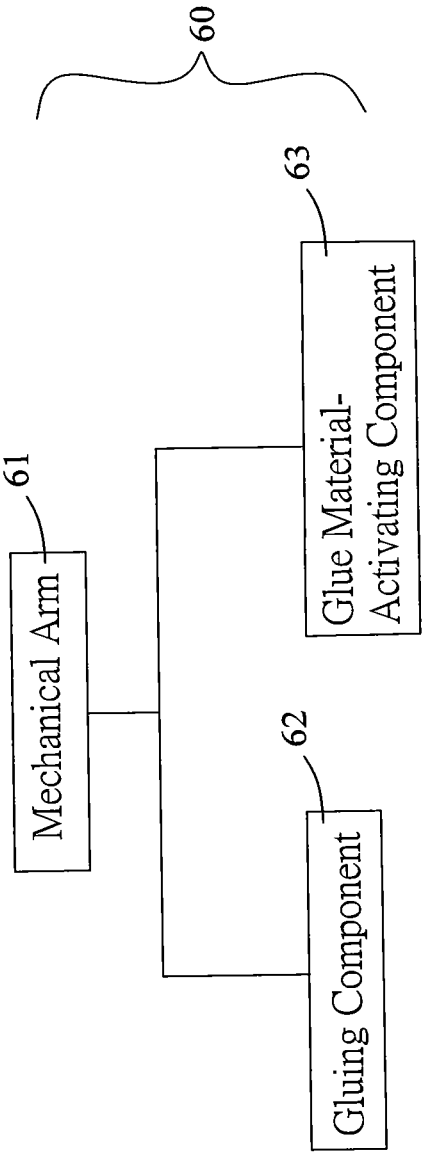

60
61
Mechanical Arm
62
Gluing Component
63
Glue Material-Activating Component

Fig. 3

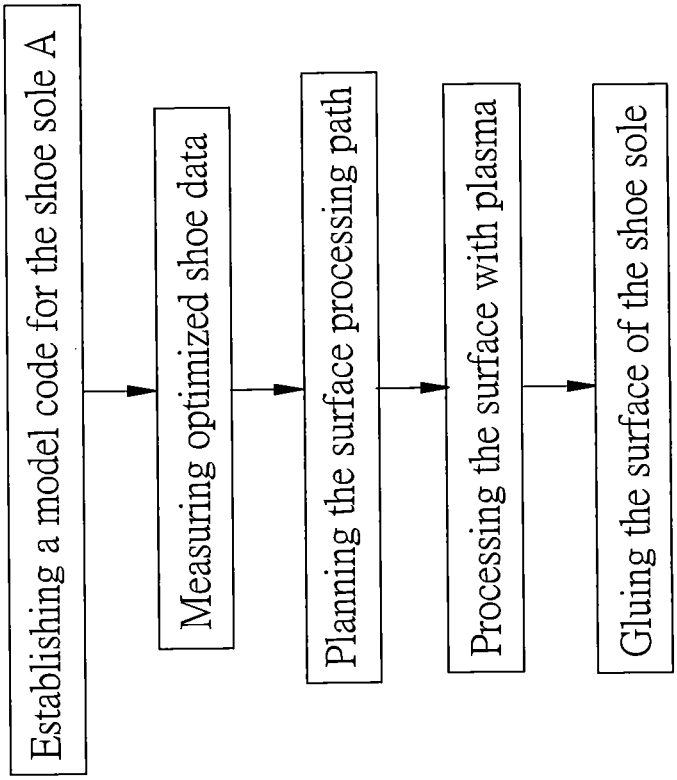

Establishing a model code for the shoe sole A
Measuring optimized shoe data
Planning the surface processing path
Processing the surface with plasma
Gluing the surface of the shoe sole

Fig. 4

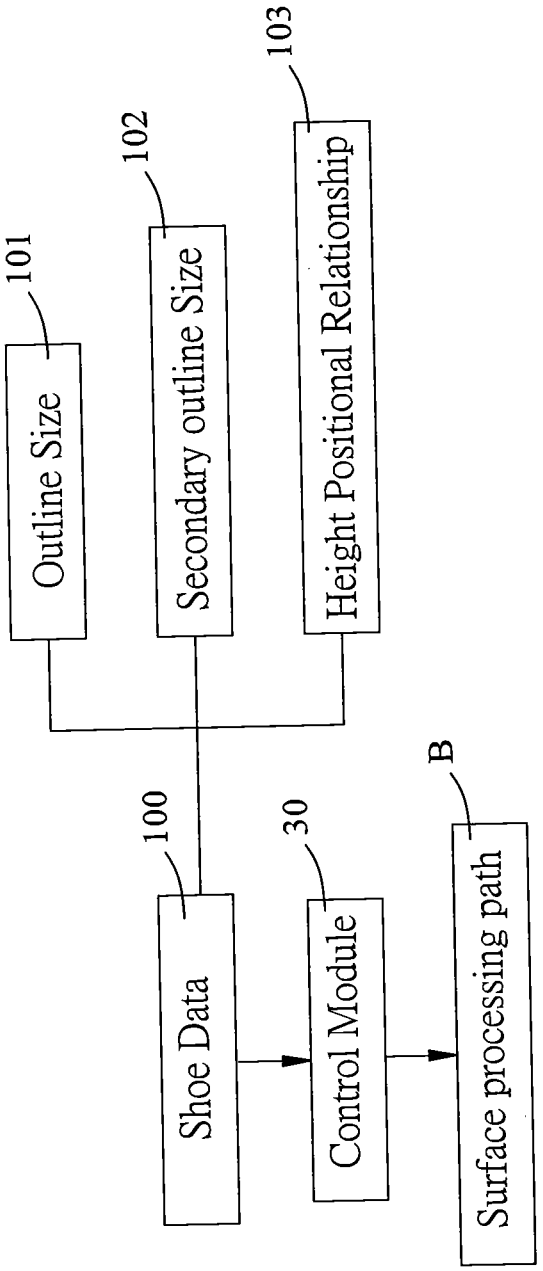

101
Outline Size
102
Secondary outline Size
103
Height Positional Relationship
100
Shoe Data
30
Control Module
B
Surface processing path

Fig. 5

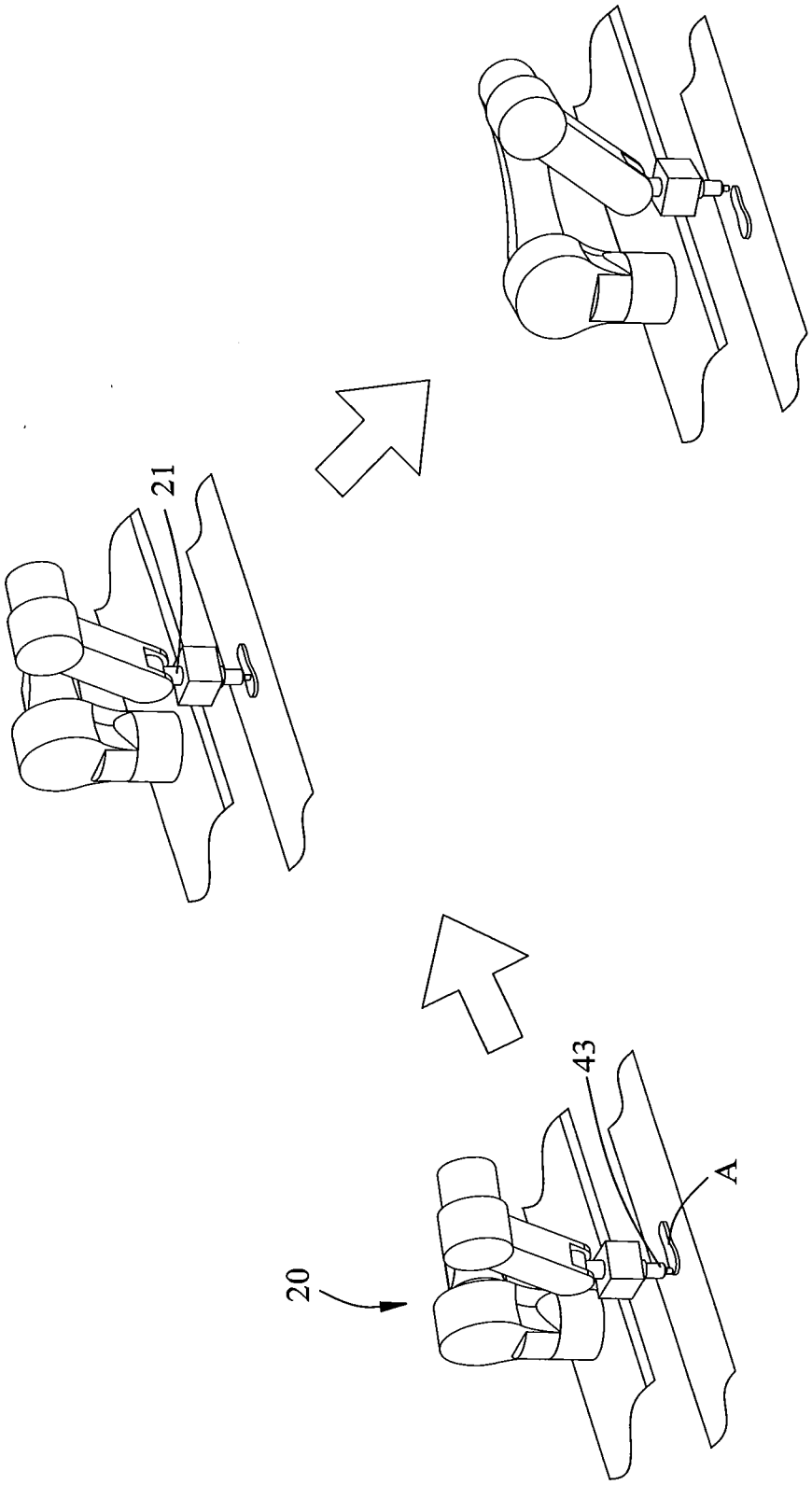


Fig. 6

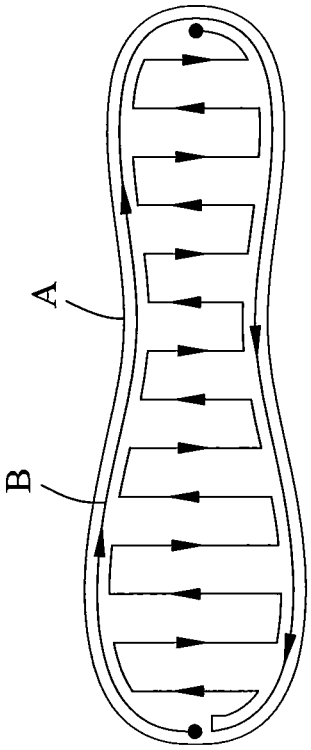


Fig. 7

MULTI-AXIS AUTOMATIC SHOE SOLE PROCESSING APPARATUS AND METHOD OF THE SAME

FIELD OF THE INVENTION

[0001] The present invention relates to a means for processing a surface of shoe sole, and more particularly to a multi-axis automatic shoe sole processing apparatus and method of the same.

BACKGROUND OF THE INVENTION

[0002] Typically, a shoe sole structure contains various shoe soles such as insole, midsole, and outsole. While integrating these shoe soles together, or combining the shoe sole structure with an upper in order to form a shoe, glue is usually used for adhesion between the shoe soles or the entire shoe sole structure to the upper.

[0003] While gluing surfaces between articles, the adhesion force depends on the surface activity of the articles, the higher the surface activity is, the stronger the adhesion force formed between those surfaces will be. Hence, to strengthen the adhesion force between shoe soles in order to prevent them from falling apart, the surfaces of the shoe soles including the insole, midsole, and outsole will be processed with chemical reagents for breaking the bonding of the surface molecules in order to enhance the surface activities of them.

[0004] Utilizing the chemical reagents to treat the surfaces of shoe soles is able to enhance the adhesion force between the shoe soles. However, following cleaning processes for those chemical reagents need to be operated by workers. Those chemical reagents may cause illness of the workers or serious environmental problems. Storage and management of usage of the chemical reagents need to be strictly controlled. The industrial safety is concerned while using the chemical reagents. Thus, a better processing method should be pursued.

SUMMARY OF THE INVENTION

[0005] In order to solve the conventional ways of processing surfaces of shoe soles cause environmental pollution, a more eco-friendly way with less industrial safety concerns to process shoe soles surfaces without chemical reagents needed is provided by the present disclosure. In the present disclosure uses a control module to control a multi-axis mechanical arm that provides plasma and to automatically process the surfaces of shoe soles.

[0006] The present invention provides a multi-axis automatic shoe sole processing apparatus, including a body, a multi-axis mechanical arm, a plasma processing module and a control module, wherein the multi-axis mechanical arm, the plasma processing module and the control module are respectively disposed at the body; the multi-axis mechanical arm and the plasma processing module are both electrically connected to the control module; the plasma processing module has a plasma nozzle disposed at the free end of the multi-axis mechanical arm; the control module drives the multi-axis mechanical arm to dislocate the free end according to a shoe data, and drives the plasma processing module to spray plasma from the plasma nozzle for processing the surface of a shoe sole with plasma, the shoe data at least comprises an outline size of the shoe sole.

[0007] Another aspect of the present disclosure is to provide a multi-axis automatic shoe sole processing method which includes: receiving and processing a shoe data, wherein the shoe data is corresponding to a model code and is comprising at least an outline size; planning a surface processing path for processing of a surface of the shoe sole according to the shoe data; and driving the multi-axis mechanical arm to bring a plasma nozzle along the surface processing path for spraying plasma on the surface of the shoe sole.

[0008] While practicing the present inventions, at least one model code is established for each of the types of the shoe sole. Each model code is corresponding with an outline size of the shoe sole, and each shoe sole has a shoe data, which at least includes the outline size.

[0009] The control module drives the multi-axis mechanical arm to move the plasma nozzle according to the shoe data received and processed by the control module, so as to spray the plasma out from the plasma nozzle for coating the entire surface of the shoe sole and processing the surface of the shoe sole with plasma, thereby enhancing the adhesion of the shoe sole while gluing the shoe sole together with other shoe components.

[0010] Because that the surface of the shoe sole can be activated by processing with plasma without using any other kind of chemicals, the activation process of the surface of the shoe sole can be more eco-friendly, and the overall manufacturing process of shoes can be more safe. Besides, the control module controls the operation of the multi-axis mechanical arm by referring to the shoe data of different type of shoes, therefore, while processing different type of shoe soles, the processing path can be rapidly adjusted to apply to different production lines of various types of shoes.

[0011] The apparatus of the present invention further includes an outline measurement module. By measuring the shoe sole physically, the type of shoe data to be provided to the control module can be variable, and the precision of the actual shoe data can be significantly enhanced. Therefore, while the control module controls the multi-axis mechanical arm for plasma processing according to the shoe data, the operation can be more fine-tuned, the processing path of the multi-axis mechanical arm can be more precise, and the activation of the surface of each shoe sole can be more efficient.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is a schematic diagram illustrating a multi-axis automatic shoe sole processing apparatus according to a preferred embodiment of the present invention.

[0013] FIG. **2** is a block diagram illustrating a plasma processing module according to a preferred embodiment of the present invention.

[0014] FIG. **3** is a block diagram illustrating a gluing device according to a preferred embodiment of the present invention.

[0015] FIG. **4** is a flowchart illustrating a multi-axis automatic shoe sole processing method according to a preferred embodiment of the present invention.

[0016] FIG. **5** is a block diagram illustrating a control module and a shoe data provided to the control module according to a preferred embodiment of the present invention.

[0017] FIG. **6** is a schematic diagram illustrating the movement of the multi-axis mechanical arm driven by the control module according to a preferred embodiment of the present invention.

[0018] FIG. **7** is a schematic diagram illustrating a processing path on the surface of a shoe sole according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] The structure and technical features of the present invention will now be described in considerable detail with reference to some embodiments and the accompanying drawings thereof, so that the present invention can be easily understood.

[0020] Referring to the FIG. **1** and FIG. **2**, a multi-axis automatic shoe sole processing apparatus includes a machine **10**, a multi-axis mechanical arm **20**, a control module **30**, a plasma processing module **40**, and an outline measurement module **50**. The machine **10** includes a body **11** with a conveyer **12**. The conveyer **12** is a linear conveyer and horizontally deposited on the body **11**. The conveyer **12** has an entrance end **121** and an exit end **122**. A shoe sole A is inputted to the entrance end **121** of the conveyer **12** and outputted from the exit end **122**.

[0021] The multi-axis mechanical arm **20** is installed at the body **11**, and is located at a side close to the exit end **122** of the conveyer **12**. The multi-axis mechanical arm **20** includes a free end **21**.

[0022] The control module **30** is an embedded computer system having functions of receiving various shoes data, processing data, displaying data, transmitting control signal, and receiving control signal feedbacks. The control module **30** is installed at the body **11** and includes a control panel **31** being disposed at one side of the body **11**. A display **32** is disposed on the control panel **31**. The multi-axis mechanical arm **20** is electrically connected to the control module **30**. The control module **30** receives and processes the shoe data to generate a processing path on a surface of the shoe sole A, and controls the free end **21** of the multi-axis mechanical arm **20** being moved along that processing path. Aforementioned shoe data includes an outline size of the shoe sole A.

[0023] The plasma processing module **40** is able to generate plasma. The plasma processing module **40** has a feeding device **41** being disposed at the body **11**. The feeding device **41** is connected to a tube **42**. The tube **42** is connected to a plasma nozzle **43**. The plasma nozzle **43** is installed at the free end **21** of the multi-axis mechanical arm **20**, and able to spray plasma downwardly when the feeding device **41** provides gas and electric power toward the plasma nozzle **43** via the tube **42**. The feeding device **41** of the plasma processing module **40** is electrically connected with the control module **30**, so that the control module **30** is able to control the plasma nozzle **43** to spray plasma and also controls output intensity of the spray plasma.

[0024] The outline measurement module **50** is disposed at the body **11** and located above a side of the conveyer **12** close to the entrance end **121**. The outline measurement module **50** includes an image capturing unit **51** and a height measurement unit **52**. Preferred embodiments of aforementioned image capturing unit **51** and the height measurement unit **52** may be a CCD camera and a laser rangefinder. The image capturing unit **51** captures images of the shoe sole A being transferred along the conveyer **12** and obtains an auxiliary outline size of the shoe sole A through a image recognition (not shown in figures). The height measurement unit **52** measures the height differences between different portions of the shoe sole A being transferred along the conveyer **12**. The measured portions of the shoe sole A include the middle portion and the peripheral welt surrounding the periphery of the shoe sole A. While the height differences have been obtained, the auxiliary outline size and the height differences can all be gathered to be included in the aforesaid shoe data, and that these shoe data can then be received and processed by the control module **30**.

[0025] Referring to FIG. **1** and FIG. **3**, according to the preferred embodiment of the present invention mentioned above, a gluing device **60** may be further disposed at the body **11**. The gluing device **60** is electrically connected with and controlled by the control module **30**. The gluing device **60** is disposed beside the conveyer **12** and located closer to the exit end **122** than the multi-axis mechanical arm **20**. The gluing device **60** includes a mechanical arm **61**, a gluing component **62** and a glue material-activating component **63**, wherein the gluing component **62** and the glue material-activating component **63** are combined with the mechanical arm **61**. The glue material-activating component **63** may be a heater or a plasma-processing module. The gluing component **62** is being moved toward the shoe sole A that is being transferred on the conveyer **12** for gluing by the mechanical arm **61**. The glue glued on the shoe sole A is then being activated by the glue material-activating component **62**.

[0026] According to the preferred embodiment of the present invention, the outline measurement module **50** is not limited to be disposed on the body **11**, but may also be installed at the free end **21** on the multi-axis mechanical arm **20** in order to be movable. Furthermore, the gluing component **62** and the glue material-activating component **63** of the gluing device **60** is able to be disposed on the body **11** by combined with the mechanical arm **61**, or by installed at the free end **21** on the multi-axis mechanical arm **20**, in which the surface of the shoe sole A is still able to be glued and activated by either ways.

[0027] Furthermore, while practicing the preferred embodiment, if the shoe data are precise enough, the processing path generated by the control module **30** according to the shoe data will be sufficient for processing the surface of the shoe sole A. The process of measuring additional outline sizes and heights by the outline measurement module **50** may not be needed. Processing the surface of the shoe sole A can solely be completed by controlling the multi-axis mechanical arm **20** to be operated along the processing path which is generated by the control module **30** according to the shoe data received and processed initially.

[0028] As referring to FIG. **1** to FIG. **3**, while practicing the preferred embodiment of the multi-axis automatic shoe sole processing apparatus, the shoe sole A to be processed with plasma is sent to the conveyer **12** from the entrance end **12**, and then a multi-axis automatic shoe sole processing method will be performed. Referring to FIG. **4**, preferring processing steps of present invention are as stated followings.

[0029] A. Receiving and processing the shoe data: referring to FIG. **5** and FIG. **6**, different types of shoe soles A have different outline sizes. At least one model code is established for each type of the shoe sole A. Each model code is corresponded to an outline size **101** of the shoe sole

A, and each shoe sole A has a shoe data **100**. The shoe data includes the outline size **101** and the control module **30** receiving and processing the outline size **101** of the shoe data **100**.

[0030] B. Optimizing the shoe data: referring to FIG. **1** and FIG. **5**, the outline measurement module **50** captures the image of the shoe sole A by the image capturing unit **51** and processes image recognition, thereby obtaining an auxiliary outline size **102** of the shoe sole A. The height measurement unit **52**, like aforementioned laser rangefinder, of the outline measurement module **50** scans and measures the height difference between the middle portion and peripheral welt of the shoe sole A (the surface of the peripheral welt is an inclined surface). By doing so, an interrelation of height **103** of the portions of the shoe sole A may be obtained. The shoe data **100** is able to be optimized by physically measuring the shoe sole A to have the auxiliary outline size **102** and the interrelation of height **103**. The control module **30** receives and processes the auxiliary outline size **102** and the interrelation of height **103** of shoe data **100**. The abovementioned step of optimizing the shoe data means that the image capturing unit **51** recognizes a physical position of the shoe sole A on the conveyer **12** to generate the auxiliary outline size **102**. The control module **30** further adjusts an initial position of the multi-axis mechanical arm **20** according to the auxiliary out line size **102**.

[0031] C. Planning the surface processing path: referring to FIG. **5** to FIG. **7**, after reading the shoe data **100** by the control module **30**, the control module **30** will then start to process and generate a surface processing path B on the surface of the shoe sole A. The surface processing path B starts from circling around the periphery of the shoe sole A, and then twists and turns from one end of the shoe sole A to the other end, and ends there.

[0032] D. Processing the surface with plasma: referring to FIG. **5** to FIG. **7**, the multi-axis mechanical arm **20** is controlled by the control module **30** to be moved along the surface processing path B. The plasma nozzle **43** is able to be brought along the surface processing path B by moving the free end **21** of the multi-axis mechanical arm **20**. Meanwhile, the plasma nozzle **43** is also driven by the control module **30** to spray plasma, so that the plasma can be sprayed along the surface processing path B and be end-up fully coating the entire surface of the shoe sole A. Additionally, if the peripheral welt surrounding the shoe sole part A is also needed to be coated with plasma by the plasma nozzle **43**, the operation angle of the plasma nozzle **43** may be further adjusted by operating the multi-axis mechanical arm **20**, so as to spray plasma at an angle to the inclined surface of the peripheral welt. By applying surface plasma processing to the surface of the shoe sole A, the surface of the shoe sole A is able to be activated and enhanced the adhesion strength with glue.

[0033] The gluing device **60** executes following step after the surface plasma processing set forth above:

[0034] E. Gluing the surface of the shoe sole A: referring to FIG. **3** and FIG. **6**, the control module **30** drives the mechanical arm **61** to bring the gluing component **62** to glue the surface of the shoe sole A, which is previously coated with plasma. Then, the glue glued on the surface of the shoe sole A will be activated by the glue material-activating component **63**, that is, the aforementioned heater or plasma-processing module.

[0035] As shown in FIG. **1**, after executing the multi-axis automatic shoe sole processing method, the processed shoe sole A will be exiting the exit end **122** of the conveyer **12**, and the process of processing the surface of the shoe sole A with plasma is then completed.

[0036] Moreover, in addition to the step of reading shoe data of the aforesaid method, if the data related to the sizes or the outline of the shoe sole A such as the auxiliary outline size **102** and the interrelation of height **103** were measured in advance, and were selectively incorporated as a part of the shoe data **100**, the optimization step (step B) can be omitted. The surface processing path B for surface plasma processing can be generated by simply reading that shoe data **100**, in which the control module **30** controls the multi-axis mechanical arm **20** and the plasma processing module **40** to operate along the surface processing path B.

[0037] If the outline measurement module **50** and the gluing component **62** and the glue material-activating component **63** of the gluing device **60** of the aforementioned multi-axis automatic shoe sole processing apparatus are installed at the free end **21** of the multi-axis mechanical arm **20** instead, the control module **30** drives the multi-axis mechanical arm **20** to guide the outline measurement module **50** to measure the shoe sole A. The multi-axis mechanical arm **20** then respectively guides the gluing component **62** and the glue material-activating component **63** to perform gluing and glue material activating process, thereby completing performing the steps of the multi-axis automatic shoe sole processing method.

What is claimed is:

1. A multi-axis automatic shoe sole processing apparatus comprising a body, a multi-axis mechanical arm, a plasma processing module, and a control module, wherein

the multi-axis mechanical arm, a plasma processing module, and a control module are respectively disposed at the body;

the multi-axis mechanical arm and the plasma processing module are both electrically connected to the control module;

the plasma processing module comprises a plasma nozzle being disposed at the free end of the multi-axis mechanical arm; and

the control module drives the multi-axis mechanical arm to dislocate the free end according to a shoe data, and drives the plasma processing module to spray plasma from the plasma nozzle for processing the surface of a shoe sole with plasma.

2. The multi-axis automatic shoe sole processing apparatus according to claim **1**, wherein the shoe data comprises an outline size of the shoe sole.

3. The multi-axis automatic shoe sole processing apparatus according to claim **1**, wherein

the shoe data comprises an auxiliary outline size; and

an outline measurement module is disposed at the body for measuring the shoe sole in order to obtain the auxiliary outline size.

4. The multi-axis automatic shoe sole processing apparatus according to claim **3**, wherein

the outline measurement module comprises a height measurement unit for measuring the portions of the shoe sole in order to obtain an interrelation of height; and

the control module controls the intensity of the spray of plasma ejected from the plasma nozzle, the plasma nozzle is dislocated with the multi-axis mechanical arm

based on the shoe data which comprises the interrelation of height, the outline size, or the auxiliary outline size.

5. The multi-axis automatic shoe sole processing apparatus according to claim **1**, wherein the control module receives and processes the shoe data to generates a surface processing path to control the multi-axis mechanical arm for dislocating the plasma nozzle, so as to eject plasma along the surface processing path from the plasma nozzle in order to control the location coated with plasma.

6. The multi-axis automatic shoe sole processing apparatus according to claim **4**, wherein the height measurement unit is a laser rangefinder, the interrelation of height is measured and obtained by scanning the shoe sole using the laser rangefinder.

7. The multi-axis automatic shoe sole processing apparatus according to claim **6**, wherein the laser rangefinder is installed at the free end of the multi-axis mechanical arm.

8. The multi-axis automatic shoe sole processing apparatus according to claim **1**, wherein the body has a gluing device electrically connected to the control module, the gluing device glues the surface of the shoe sole after the shoe sole has been processed with plasma.

9. The multi-axis automatic shoe sole processing apparatus according to claim **8**, wherein the gluing device is installed at the free end of the multi-axis mechanical arm.

10. The multi-axis automatic shoe sole processing apparatus according to claim **8**, wherein the gluing device comprises a gluing component and a glue material-activating component, the gluing component glues the surface of the shoe sole, and the glue material-activating component activates the glue glued on the surface of the shoe sole.

11. The multi-axis automatic shoe sole processing apparatus according to claim **3**, wherein the body has a conveyer having an entrance at an end and an exit opposing the entrance at the other end, the multi-axis mechanical arm is located close to a side of the conveyer close to the exit, and the outline measurement module is located above a side of the conveyer close to the entrance.

12. A multi-axis automatic shoe sole processing method comprises steps of:

receiving and processing a shoe data, wherein the shoe data is corresponding to a model code and is comprising at least an outline size;

planning the surface processing path for processing of the surface of the shoe sole based on the shoe data; and

driving a multi-axis mechanical arm to bring a plasma nozzle along the surface processing path for spraying plasma on the surface of the shoe sole.

13. The multi-axis automatic shoe sole processing method according to claim **12**, before the step of planning the surface processing path, further comprising a step of optimizing the shoe data, wherein the shoe sole to be processed will be measured to fill in the shoe data in order to proceed on the step of planning the surface processing path.

* * * * *