



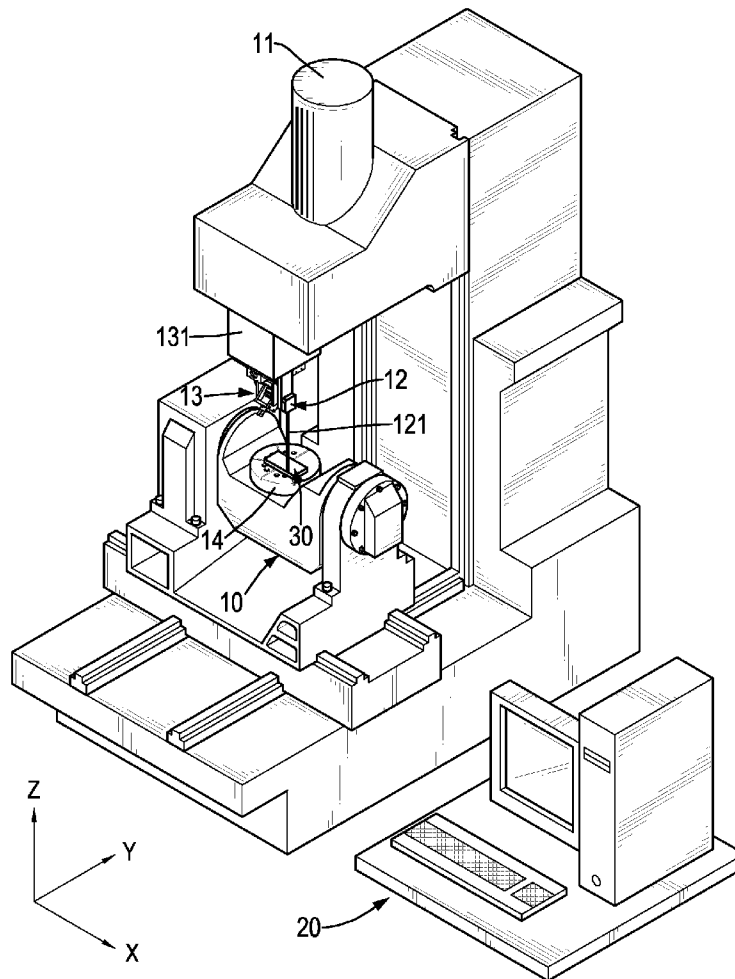
US 20110275280A1

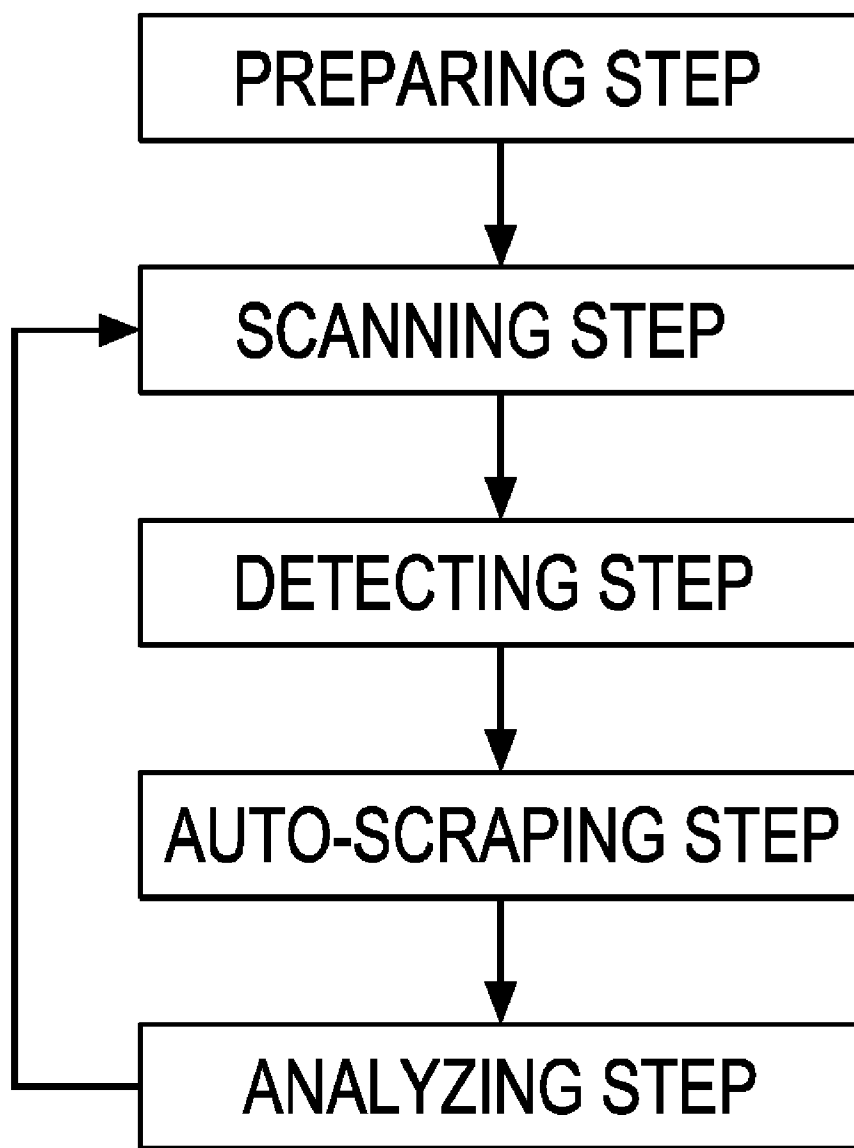
(19) **United States**(12) **Patent Application Publication**
Jywe et al.(10) **Pub. No.: US 2011/0275280 A1**(43) **Pub. Date: Nov. 10, 2011**(54) **METHOD OF AUTO SCANNING AND
SCRAPING A WORK PIECE FOR A HARD
RAIL****Publication Classification**(51) **Int. Cl.**
B24B 51/00

(2006.01)

(52) **U.S. Cl. 451/5**(75) **Inventors:** **Wen-Yuh Jywe**, Yunlin Hsien
(TW); **Ying-Cnien Tsai**, Yunlin
Hsien (TW); **Bor-Jeng Lin**, Yunlin
Hsien (TW); **Meng-Tse Lee**, Yunlin
Hsien (TW); **Hung-Shu Wang**,
Yunlin Hsien (TW); **Tung-Hsing
Hsieh**, Yunlin Hsien (TW); **Bo-Wei
Chen**, Yunlin Hsien (TW);
Ming-Chi Chiang, Yunlin Hsien
(TW); **Jia-Hong Chen**, Yunlin
Hsien (TW); **Chi-Hui Huan**,
Yunlin Hsien (TW)(73) **Assignee:** **National Formosa University**,
Yunlin Hsien (TW)(21) **Appl. No.:** **12/775,857**(22) **Filed:** **May 7, 2010**(57) **ABSTRACT**

A method of auto scanning and scraping a work piece for a hard rail has a preparing step, a scanning step, a detecting step, an auto-scraping step and an analyzing step. The preparing step comprises preparing an auto scanning and scraping apparatus with a multi-axis machine tool, a control computer, an auto-scraping device and a position detector. The scanning step comprises scanning the surface of the work piece to read the roughness value and transporting the data to the control computer. The detecting step comprises forming a 3D-appearance drawing of the work piece and detecting the 3D-appearance drawing with multiple detection steps. The auto-scraping step comprises scraping the surface of the work piece by the auto-scraping device. The analyzing step comprises detecting the 3D-appearance drawing of the work piece that has been scraped with the preceding detection steps and scraping the work piece to meet the preceding detection steps.



**FIG.1**

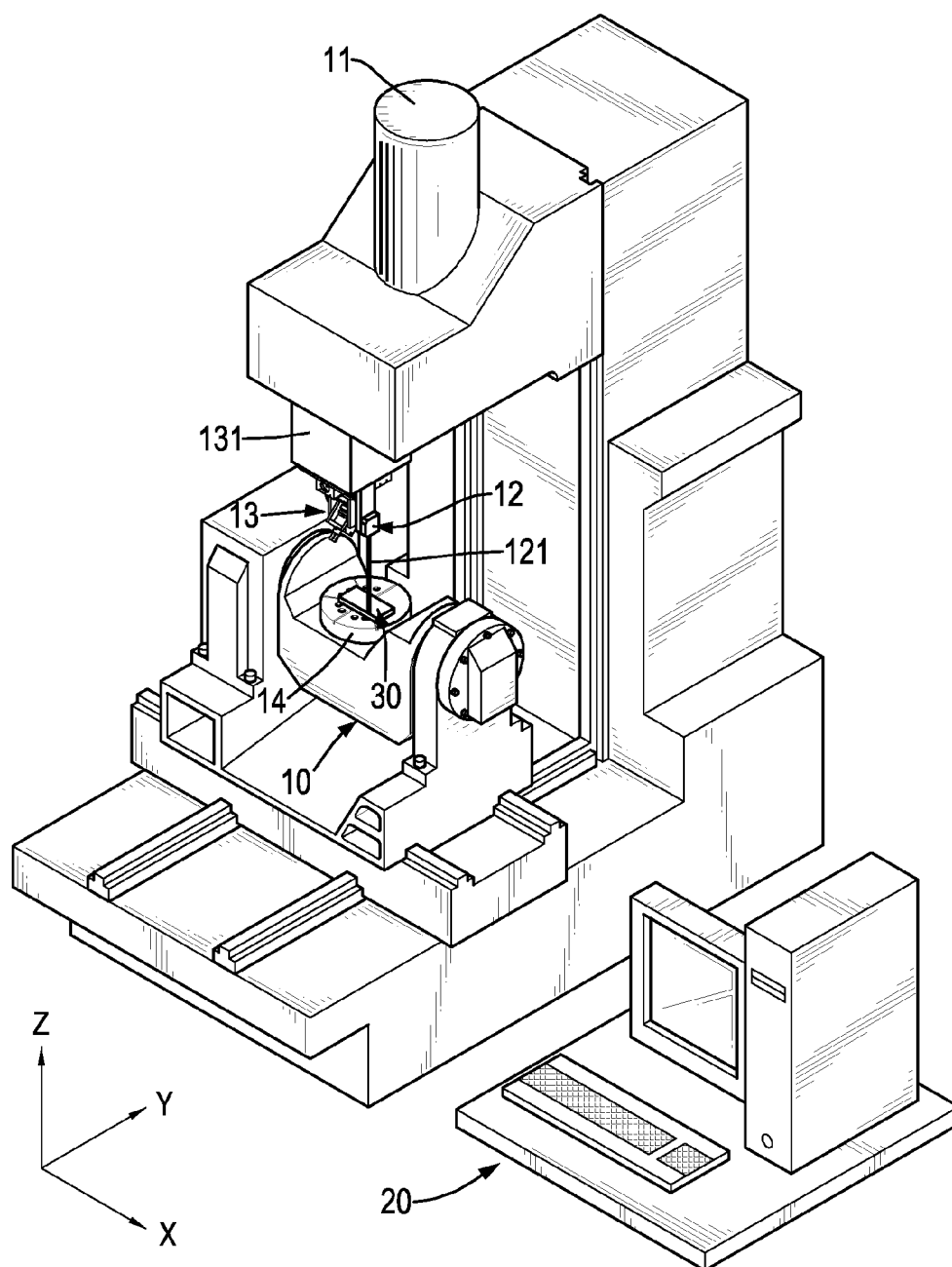


FIG.2

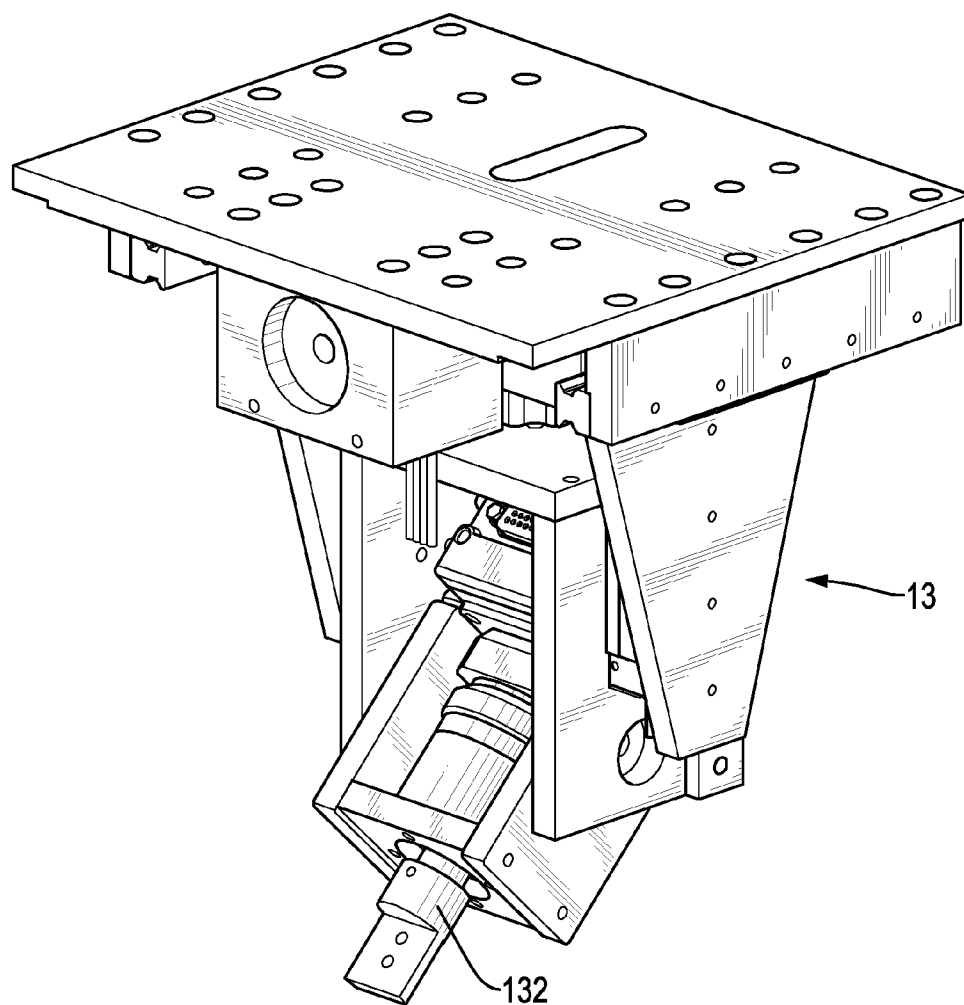


FIG.3

METHOD OF AUTO SCANNING AND SCRAPING A WORK PIECE FOR A HARD RAIL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method of auto scanning and scraping a work piece for a hard rail, and more particularly to a method that can scrape a surface of the work piece quickly and accurately.

[0003] 2. Description of the Prior Arts

[0004] In general, a conventional hard rail for a machine tool needs to be scraped before assembling, a scraping process is used to scrape relative high points of a contacting surface of the conventional hard rail. The scraping process can form multiple recesses on the contacting surfaces of the conventional hard rail. The recesses can be used to store lubricant to lubricate movement of a moving element on the hard rail.

[0005] Detecting a surface roughness of the scraped surface is very important to maintain functions of the conventional hard rail, since the surface roughness may affect mobility of the moving element on the conventional hard rail. A conventional method for determining the surface roughness of the scraped surface comprises the following steps: painting ink on the scraped surface, sliding the moving element on the scraped surface so ink on a higher area will be removed and be found, and measuring a height of the higher area with a measuring tool. In addition, a charge-couple device (CCD) can be used to screen the inked-scraped surface to analyse the surface roughness of the conventional hard rail. However, the detecting result of the described conventional method is not precise since the results of the conventional method are easily affected by human error.

[0006] To overcome the shortcomings, the present invention provides a method of auto scanning and scraping a work piece for a hard rail to mitigate or obviate the aforementioned problems.

SUMMARY OF THE INVENTION

[0007] The main objective of the present invention is to provide a method of auto scanning and scraping a work piece for a hard rail, and more particularly to a method that can scrape a surface of the work piece quickly and accurately.

[0008] The method of auto scanning and scraping a work piece for a hard rail in accordance with the present invention comprises a preparing step, a scanning step, a detecting step, an auto-scraping step and an analyzing step. The preparing step includes, preparing an auto scanning and scraping apparatus with a multi-axis machine tool, a control computer, an auto-scraping device and a position detector. The scanning step includes, scanning the surface of the work piece along a setting route to read the roughness value of the work piece and transporting the data to the control computer. The detecting step includes, forming a 3D-appearance drawing of the work piece by the scanning data in the control computer and detecting the 3D-appearance drawing of the work piece with multiple detection steps. The auto-scraping step includes, scraping the surface of the work piece by the auto-scraping device moved and controlled by the multi-axis machine tool. The analyzing step includes, scanning the surface of the work piece after the auto-scraping step, forming a 3D-appearance drawing using the scanning data in the control computer and

detecting the preceding detection steps of the 3D-appearance drawing of the work piece that has been scraped and scraping the surface of the work piece by the auto-scraping device if the 3D-appearance drawing of the work piece fails to meet the requirement of the preceding detection steps up to meet the requirement of the preceding detection steps.

[0009] Other objectives, advantages and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a block diagram of a method of auto scanning and scraping a work piece for a hard rail in accordance with the present invention;

[0011] FIG. 2 is a perspective view of an auto scanning and scraping apparatus in accordance with the present invention; and

[0012] FIG. 3 is an enlarged perspective view of an auto-scraping device in FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] With reference to FIGS. 1 to 3, a method of auto scanning and scraping a work piece (30) for a hard rail in accordance with the present invention comprises a preparing step, a scanning step, a detecting step, an auto-scraping step and an analyzing step.

[0014] The preparing step comprises preparing an auto scanning and scraping apparatus. The auto scanning and scraping apparatus comprises a multi-axis machine tool, a control computer (20), an auto-scraping device (13) and a position detector (12).

[0015] The multi-axis machine tool has three linear axes (X-, Y- and Z-axes), at least one rotation axis, a spindle (11), a moving mount (10) and a turntable (14). The spindle (11) is defined along the Z-axis of the multi-axis machine tool. The moving mount (10) is defined below the spindle (11), is moved relative to the spindle (11) by the rail devices (not numbered) on the X-axis and the Y-axis of the multi-axis machine tool and has a top. The turntable (14) is rotatably mounted on the top of the moving mount (10) below the spindle (11). A work piece (30) for the hard rail is put on the turntable (14) and has a surface.

[0016] The control computer (20) is electrically connected to the moving mount (10) of the multi-axis machine tool. The auto-scraping device (13) is mounted securely on the spindle (11) above the moving mount (10) and has an extending mount (131) and a scraping tool (132). The extending mount (131) is securely mounted on a bottom of the spindle (11) and has a bottom side. The scraping tool (132) is movably mounted on the bottom side of the extending mount (131) and has a sidewall. The position detector (12) is mounted on the sidewall of the scraping tool (132), is electrically connected to the control computer (20) and has a scanning terminal (121) contacted to scan the surface of the work piece (30). Preferably, the position detector (12) is a triangle-laser position detector.

[0017] After mounting the position detector (12) on the auto-scraping device (13), a height of the spindle (11) is adjusted relative to the turntable (14) to let the valid measurement range of the position detector (12) cover the whole surface of the work piece (30).

[0018] The scanning step comprises moving the turntable (14) relative to the spindle (11) to let the scanning terminal (121) of the position detector (12) move along an S-shaped route to scan the surface of the work piece (30). Preferably, the interval between the adjacent paths of the S-shaped route is a constant value. After scanning the surface of the work piece (30), an initial scan point and a measurement range are set in the control computer (20) and location of position detector (12) in the Z-axis direction is compensated for to eliminate an offset mistake produced by vibration of the turntable (14) in the scanning process. When the offset mistake of the turntable (14) has been corrected by the control computer (20), the surface of the work piece (30) is scanned along the setting route to read the roughness value of the work piece (30) and the data is transferred to the control computer (20).

[0019] The detecting step comprises forming a 3D-appearance drawing of the work piece (30) by the scanning data in the control computer (20). When the 3D-appearance drawing of the work piece (30) has been formed by the control computer (20), the contacting ratio per square inch is detected, including, numbers of the high points per square inch, height distributed mode, straightness of the surface and corner shape of the 3D-appearance drawing of the work piece (30). Coordinates of the 3D-appearance drawing of the work piece (30) that fail to meet requirement of preceding detection steps are transferred and a scraping route planned. The scraping route is translated into a NC (Numerical Control) code and the NC code is transmitted to the multi-axis machine tool to control movement of the multi-axis machine tool.

[0020] The auto-scraping step comprises scraping the surface of the work piece (30) by the auto-scraping device (13) that is moved and controlled by the multi-axis machine tool. Preferably, before scraping the surface of the work piece (30), the surface of the work piece (30) is scraped to confirm with an actual scraping depth of the scraping tool (132) and the scraping process is corrected according to the actual scraping depth of the scraping tool (132).

[0021] The analyzing step comprises scanning the surface of the work piece (30) after the auto-scraping step, forming a 3D-appearance drawing by the scanning data in the control computer (20) and detecting the 3D-appearance drawing of the work piece (30) that has been scraped with the preceding detection steps. If the 3D-appearance drawing of the work piece (30) meets requirements of the preceding detection steps, the auto scanning and scraping procedures is finished. If the 3D-appearance drawing of the work piece (30) fails to meet requirements of the preceding detection steps, the auto-scraping step is repeated to scrape the surface of the work piece (30) by the auto-scraping device (13) to meet the requirement of the preceding detection steps.

[0022] The method of auto scanning and scraping a work piece (30) for a hard rail in accordance with the present invention only needs to put a work piece (30) on the turntable (14) and the position detector (12) can scan the surface of the work piece (30) and a 3D-appearance drawing of the work piece (30) is formed in the control computer (20) by the scanning data, and the auto-scraping device (13) can automatically scrape the work piece (30) that fails to meet the requirement of the preceding detection steps to meet the requirement of the preceding detection steps. Therefore, the method of auto scanning and scraping a work piece (30) for a hard rail in accordance with the present invention can scrape the surface of the work piece (30) quickly and accurately by

the multi-axis machine tool, the control computer (20), the auto-scraping device (13) and the position detector (12) of the auto scanning and scraping apparatus.

[0023] Even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and features of the invention, the disclosure is illustrative only. Changes may be made in the details, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A method of auto scanning and scraping a work piece for a hard rail comprising:

a preparing step comprising:

- preparing an auto scanning and scraping apparatus with a multi-axis machine tool, a control computer, an auto-scraping device and a position detector;
- defining a spindle along the Z-axis of the multi-axis machine tool;
- mounting a moving mount having a top below the spindle moved relative to the spindle by the multi-axis machine tool;
- mounting a turntable rotatably on the top of the moving mount below the spindle;
- putting a work piece with a surface for the hard rail on the turntable;
- connecting the control computer electrically to the moving mount of the multi-axis machine tool;
- mounting an auto-scraping device securely on the spindle above the moving mount with an extending mount and a scraping tool;
- mounting a position detector on a sidewall of the scraping tool and connecting the position detector electrically to the control computer to scan the surface of the work piece; and
- adjusting height of the spindle relative to the turntable to allow valid measurement range of the position detector to cover the a whole surface of the work piece;

a scanning step comprising:

- moving the turntable relative to the spindle to allow the position detector to move along a route to scan the surface of the work piece;
- setting an initial scan point and a measurement range in the control computer and compensating the location of position detector in the Z-axis direction to eliminate an offset mistake produced by vibration of the turntable during the scanning step; and
- scanning the surface of the work piece along the setting route to read roughness value of the work piece and transmitting data to the control computer after correcting offset mistakes of the turntable by the control computer;

a detecting step comprising:

- forming a 3D-appearance drawing of the work piece by the scanning data in the control computer;
- detecting the 3D-appearance drawing of the work piece by multiple detection steps;
- transmitting coordinates of the 3D-appearance drawing of the work piece that fail to meet requirements of the preceding detection steps and planning a scraping route according to the coordinates; and

translating the scraping route into a NC code and transmitting the NC code to the multi-axis machine tool to control movement of the multi-axis machine tool;

an auto-scraping step comprising:

- scraping the surface of the work piece by the auto-scraping device, moved and controlled by the multi-axis machine tool; and
- an analyzing step comprising:
 - scanning the surface of the work piece after the auto-scraping step;
 - forming a 3D-appearance drawing by the scanning data in the control computer and detecting the 3D-appearance drawing of the work piece that has been scraped with the preceding detection steps; and
 - scraping the surface of the work piece by the auto-scraping device if the 3D-appearance drawing of the work piece fails to meet requirements of the preceding detection steps to meet requirements of the preceding detection steps.

2. The method as claimed in claim 1, wherein in the preparing step:

- mounting the extending mount with a bottom side securely mounted on a bottom of the spindle;
- mounting the scraping tool with a sidewall movably on the bottom side of the extending mount;
- mounting the position detector on the sidewall of the scraping tool; and
- contacting a scanning terminal of the position detector with the surface of the work piece to scan the work piece.

3. The method as claimed in claim 2, wherein in the scanning step, the scanning terminal of the position detector is moved along an S-shaped route to scan the surface of the work

piece and the interval between the adjacent paths of the S-shaped route is a constant value.

4. The method as claimed in claim 3, wherein in the detecting step, the preceding detection steps include the contacting ratio per square inch, the numbers of the high points per square inch, the height distributed mode, the straightness of the surface and the corner shape of the 3D-appearance drawing of the work piece.

5. The method as claimed in claim 4, wherein in the scraping step, the surface of the work piece is scraped to confirm the actual scraping depth of the scraping tool before scraping the surface of the work piece and correcting the scraping process according to the actual scraping depth of the scraping tool.

6. The method as claimed in claim 1, wherein in the scraping step, the surface of the work piece is scraped to confirm the actual scraping depth of the scraping tool before scraping the surface of the work piece and correcting the scraping process according to the actual scraping depth of the scraping tool.

7. The method as claimed in claim 2, wherein in the detecting step, the preceding detection steps include contacting ratio per square inch, numbers of the high points per square inch, height distributed mode, straightness of the surface and corner shape of the 3D-appearance drawing of the work piece.

8. The method as claimed in claim 3, wherein in the detecting step, the preceding detection steps include contacting ratio per square inch, numbers of the high points per square inch, height distributed mode, straightness of the surface and corner shape of the 3D-appearance drawing of the work piece.

* * * * *