

SYSTEM AND METHOD FOR ASSEMBLING MOSAIC ARTWORK

TECHNICAL FIELD

The present disclosure generally relates to the assembly of mosaic artwork, and more specifically to system and method for the automated assembly of mosaic artwork.

BACKGROUND

The manual assembly of mosaic artwork using mosaic pieces of different dimensions, such as Lego pieces (8 mm x 8 mm) or Nanoblock pieces (4 mm x 4mm) is labour intensive, time consuming, and prone to errors in placing the mosaic pieces on the mosaic baseplate, or substrate. The mosaic piece building blocks may also be referred to herein as bricks. The placement of each brick in the proper position on the mosaic baseplate may take 5-10 sec in manually assembly. A small-sized Lego portrait may be an array of 50x50 or 2,500 bricks, and may require 3.5 hours to manually assemble, while a normal wedding photo mosaic may include an array of 200x260 or 52,000 bricks and may require 72 hours to manually assemble.

Due to the number of hours needed for manual assembly, the labour costs for the manual assembly workers are very high, and even higher when factoring in worker efficiency, downtime and manual assembly errors. Thus, it may be desirable to have a fully automated end-to-end, robotic apparatus and system for the assembly of mosaic artwork.

SUMMARY

A system for assembling mosaic artwork by placing mosaic pieces on a mosaic baseplate, the apparatus may include at least one vibratory feeder bowl, at least one mosaic piece selector, a robotic arm, a vision sensor and a controller. The at least one vibratory feeder bowl may include a bowl, a feeding track and an actuator. The bowl may include a bottom region for holding a plurality of mosaic pieces of different types for assembly onto studs attached to a mosaic baseplate and arranged in an array. The feeding track may lead from the bottom region to an upper region of the bowl. The actuator may be operatively coupled to the bowl for producing a rotation or vibration of the bowl, so as to cause mosaic pieces from the plurality of mosaic pieces to move along the feeding track from the bottom region to a robotic arm landing pad coupled to the feeding track in the upper region of the

bowl. The at least one mosaic piece selector may be positioned along the feeding track in the upper region of the bowl and may include a top member and a side member. One or more grooves or steps may be formed in the top member or the side member to permit each respective type of mosaic piece moving on the feeding track to selectively pass through the at least one selector to the robotic arm landing pad in a predefined orientation. The robotic arm with a first end and a second end may include an end effector at the first end including a pickup head with a stopper guide for acquiring at least one mosaic piece from said plurality of mosaic pieces from the robotic arm landing pad in the predefined orientation. The vision sensor may be used for acquiring mosaic piece image data from an image of the at least one mosaic piece from said plurality of mosaic pieces. The controller may include robotic arm control circuitry for controlling movement of the robotic arm and the pickup head, and a processor to instruct the robotic arm control circuitry to cause the robotic arm to snap the at least one mosaic piece from said plurality of mosaic pieces in the pickup head in the predefined orientation onto at least one stud at an identified position on the mosaic baseplate.

In some embodiments of the present disclosure, the processor may receive a mosaic assembly instruction data file, which includes a mapping.

In some embodiments of the present disclosure, the pickup head may acquire the at least one mosaic piece in the predefined orientation by picking up the at least one mosaic piece with the hole of the at least one mosaic piece downward.

In some embodiments of the present disclosure, the system may include a robotic arm motorized assembly coupled to the second end of the robotic arm to move the robotic arm and the pickup head.

In some embodiments of the present disclosure, the processor may instruct the robotic arm control circuitry to cause the robotic arm to iteratively acquire and to snap the at least one mosaic piece from said plurality of mosaic pieces in the pickup head in the predefined orientation onto studs on the mosaic baseplate until the mosaic artwork is completed.

In some embodiments of the present disclosure, the plurality of mosaic pieces may be bricks.

In some embodiments of the present disclosure, the plurality of mosaic pieces may be Lego or Nano pieces.

In some embodiments of the present disclosure, the upper region of the bowl of the at least one vibratory feeder bowl may be proximate to a rim of the bowl.

In some embodiments of the present disclosure, the at least one mosaic piece selector may be attached to the rim of the bowl.

In some embodiments of the present disclosure, the vision sensor may acquire the mosaic piece image data when the at least one mosaic piece is in the robotic arm landing pad or held in the pickup head.

In some embodiments of the present disclosure, the vision sensor may be configured to determine a color of the at least one mosaic piece from said plurality of mosaic pieces in the pickup head and to relay the color to the processor.

In some embodiments of the present disclosure, all colors of the plurality of mosaic pieces for the mosaic artwork are loaded into the bottom region of the bowl.

In some embodiments of the present disclosure, the system may include a video recording device to record an assembly process of the mosaic artwork.

In some embodiments of the present disclosure, the at least one mosaic piece from said plurality of mosaic pieces may be held in the pickup head by a vacuum.

In some embodiments of the present disclosure, the one or more grooves or slots of the at least one mosaic piece selector may selectively filter each respective type of mosaic piece by causing mosaic pieces not in the predefined orientation to fall back into the bottom region of the bowl.

In some embodiments of the present disclosure, the feeding track may lead upwardly in a helix around a perimeter of the bowl from the bottom region to the upper region.

In some embodiments of the present disclosure, each side of the stopper guide may include four retractable side guides.

In some embodiments of the present disclosure, each side guide of the four retractable side guides may be capable of retracting upon contacting a previously positioned mosaic piece on studs adjacent to the at least one stud at the identified position.

In some embodiments of the present disclosure, the processor may:

- (a) receive a mapping between said plurality of mosaic pieces and their placement on the array of the studs on the mosaic baseplate onto which said plurality of mosaic pieces will be assembled,

- (b) instruct the robotic arm control circuitry to move the robotic arm so as to acquire the at least one mosaic piece from said plurality of mosaic pieces from the robotic arm landing pad in the predefined orientation in the pickup head,

(c) assess a color of the at least one mosaic piece from said plurality of mosaic pieces from the mosaic piece image data, and

(d) identify the position on the mosaic baseplate of the at least one stud in the array of studs onto which to place the at least one mosaic piece from said plurality of mosaic pieces based on the assessed color and the mapping.

BRIEF DESCRIPTION OF THE DRAWINGS

Some non-limiting exemplary embodiments or features of the disclosed subject matter are illustrated in the following drawings.

In the drawings:

Fig. 1A schematically illustrates a system for the automated assembly of mosaic artwork on a mosaic baseplate, in accordance with some embodiments of the present disclosure;

Fig. 1B is a block diagram of a controller, in accordance with some embodiments of the present disclosure;

Fig. 2 schematically illustrates a first side view of a mosaic artwork assembly system, in accordance with some embodiments of the present disclosure;

Fig. 3A schematically illustrates a top view of a mosaic artwork assembly system, in accordance with some embodiments of the present disclosure;

Fig. 3B schematically illustrates a side view of a mosaic artwork assembly system, in accordance with some embodiments of the present disclosure;

Fig. 4A schematically illustrates an isometric view of two vibratory feeding bowls, in accordance with some embodiments of the present disclosure;

Fig. 4B schematically illustrates a top view of two vibratory feeding bowls, in accordance with some embodiments of the present disclosure;

Fig. 5A schematically illustrates an isometric view of a first embodiment of a selector, in accordance with some embodiments of the present disclosure;

Fig. 5B schematically illustrates a first side view of a first embodiment of a selector, in accordance with some embodiments of the present disclosure;

Fig. 5C schematically illustrates a front view of a first embodiment of a selector, in accordance with some embodiments of the present disclosure;

Fig. 5D schematically illustrates a second side view of a first embodiment of a selector, in accordance with some embodiments of the present disclosure;

Fig. 6A schematically illustrates an isometric view of a second embodiment of a selector, in accordance with some embodiments of the present disclosure;

Fig. 6B schematically illustrates a first side view of a second embodiment of a selector, in accordance with some embodiments of the present disclosure;

Fig. 6C schematically illustrates a front view of a second embodiment of a selector, in accordance with some embodiments of the present disclosure;

Fig. 6D schematically illustrates a second side view of second embodiment of selector 170, in accordance with some embodiments of the present disclosure;

Fig. 7 schematically illustrates acquiring of a square mosaic piece by a pickup head from a robotic arm landing pad, in accordance with some embodiments of the present disclosure;

Fig. 8 schematically illustrates a vision sensor imaging a square mosaic piece in a pickup head, in accordance with some embodiments of the present disclosure;

Fig. 9A schematically illustrates an isometric view of an end effector assembly, in accordance with some embodiments of the present disclosure;

Fig. 9B schematically illustrates a side view of an end effector assembly, in accordance with some embodiments of the present disclosure;

Fig. 9C schematically illustrates a bottom view of an end effector assembly, in accordance with some embodiments of the present disclosure;

Fig. 10A schematically illustrates a cross-sectional view of a stopper guide holding a mosaic piece prior to placement on a mosaic baseplate, in accordance with some embodiments of the present disclosure;

Fig. 10B schematically illustrates a cross-sectional exploded view of a stopper guide placing a mosaic piece and colliding with an adjacent mosaic piece on a mosaic baseplate, in accordance with some embodiments of the present disclosure;

Fig. 11A schematically illustrates a top view of a portion of a mosaic artwork assembly system using one vibratory feeding bowl, in accordance with some embodiments of the present disclosure;

Fig. 11B schematically illustrates a first side view of a portion of a mosaic artwork assembly system using one vibratory feeding bowl, in accordance with some embodiments of the present disclosure; and

Fig. 12 is a flowchart illustrating a method for assembling mosaic artwork by placing mosaic pieces on a mosaic baseplate, in accordance with some embodiments of the present disclosure.

With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the disclosure. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the disclosure may be practiced.

Identical or duplicate or equivalent or similar structures, elements, or parts that appear in one or more drawings are generally labeled with the same reference numeral, optionally with an additional letter or letters to distinguish between similar entities or variants of entities, and may not be repeatedly labeled and/or described. References to previously presented elements are implied without necessarily further citing the drawing or description in which they appear.

Dimensions of components and features shown in the figures are chosen for convenience or clarity of presentation and are not necessarily shown to scale or true perspective. For convenience or clarity, some elements or structures are not shown or shown only partially and/or with different perspective or from different point of views.

DETAILED DESCRIPTION

Some embodiments of the present disclosure may include a system, a method, and/or a computer program product. The computer program product may include a tangible non-transitory computer readable storage medium (or media) having computer readable program instructions thereon for causing a processor to carry out aspects of the present disclosure. Computer readable program instructions for carrying out operations of the present disclosure may be assembler instructions, instruction-set-architecture (ISA) instructions, machine instructions, machine dependent instructions, microcode, firmware instructions, state-setting data, or either source code or object code written in any combination of one or more programming languages, including any object oriented programming language and/or conventional procedural programming languages.

Before explaining at least one embodiment of the disclosure in detail, it is to be understood that the disclosure is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the

following description and/or illustrated in the drawings and/or the Examples. The disclosure is capable of other embodiments or of being practiced or carried out in various ways.

Mosaic artwork described herein may include, for example, a photo or image data of an image, that may be pixelated and converted to a mapping between the different types of mosaic pieces (e.g., size, color and form factor) needed to assemble the mosaic artwork and the position of each mosaic piece on a mosaic baseplate. The embodiments of the present disclosure describe a system, apparatus, and method of a fully automated, end-to-end assembly solution of the mosaic artwork on a mosaic baseplate, or substrate.

Different types of mosaic pieces, in terms of mosaic piece shape, size and color, may be assembled onto studs arranged on the mosaic baseplate in accordance with the mapping. The mosaic pieces may also be referred to herein as bricks. The mosaic pieces may include Lego or Nano pieces, for example, for assembly onto a suitably adapted baseplate for the Lego or Nano pieces. Typically, both Lego and Nano pieces may be 0.5 cm in height with a 0.3 cm base height and a 0.2 cm stud height. The stud diameter may be 0.4 cm for Lego pieces and 0.2 cm for Nano pieces. These dimensions are typical dimensions for Nano and Lego. However, the embodiments of the present invention described herein may be adapted for any suitable mosaic piece (size, type, shape and/or color) for assembly onto any mosaic baseplate configuration. Each mosaic piece is not limited to one stud hole but may include any suitable number of stud holes.

Fig. 1A schematically illustrates a system 10 for the automated assembly of mosaic artwork on a mosaic baseplate 15, in accordance with some embodiments of the present disclosure. System 10 may include an assembly rack 17 which holds mosaic baseplate 15 on an assembly table 16, and vibratory feeder bowls 30 for holding the mosaic pieces. System 10 may include a robotic arm 20 with an end effector 25 connected at a first end 26 and a robotic arm motorized assembly 45 connected to a second end 27. Robotic arm 20 may be configured to pick up a mosaic piece from vibratory feeder bowl 30, to move to a predefined position above mosaic baseplate 15, and to assemble the mosaic piece at the predefined position onto mosaic baseplate 15.

Robotic arm motorized assembly 45 may include a motor controlled by a controller 40 including digital and drive control circuitry so as to move robotic arm 20 along rails 50 and 55 in orthogonal directions (e.g., in the X-Y plane), for example. Robotic arm motorized assembly 45 may also be configured to move end effector 25 at the first end of robotic arm 20 up and down vertically in the z-direction.

In some embodiments of the present disclosure, a video recording device may be used to record the entire assembly process of mosaic artwork in system 10.

Fig. 1B is a block diagram 57 of controller 40, in accordance with some embodiments of the present disclosure. Controller 40 may include a processor 60. Processor 60 may be coupled to vibratory feeder bowl control circuitry 65, a communication module and interface 70, input and output (I/O) devices 75, robotic arm control circuitry 80, a vision sensor 85, and a memory 90. Communication module and interface 70 for providing remote control of controller 40 and may include wired and/or wireless communication circuitry. Robotic arm control circuitry 80 may be used to control robotic arm motorized assembly 45. In some embodiments of the present disclosure, system 10 may include a vision sensor 85 for acquiring mosaic piece image data of a mosaic piece for assembly on mosaic baseplate 15 that may be coupled to processor 60, so as to relay the acquired mosaic piece image data to processor 60.

In some embodiments of the present disclosure, processor 60 may include one or more processing units, e.g. of one or more computers. Processor 60 may be configured to operate in accordance with programmed instructions stored in memory 18. Processor 12 may be capable of executing an application for controlling the automated placement of mosaic pieces on mosaic baseplate 15 for the assembly of the mosaic artwork.

In some embodiments of the present disclosure, processor 60 may communicate with input and output devices 75. For example, the output device may include a computer monitor or screen. Processor 60 may communicate with a screen of the output device to display the assembly information of the mosaic artwork such as part lists of the mosaic pieces, size, color and a mapping of the position of the different mosaic pieces to be assembled on mosaic baseplate 15. In another example, the output device may include a printer, display panel, speaker, or another device capable of producing visible, audible, or tactile output. The input device may include one or more of a keyboard, keypad, or pointing device for enabling a user to inputting data or instructions for operation of processor 60.

In some embodiments of the present disclosure, input and output devices 75 may include a smart tablet. I/O devices 75 may include a touch panel.

In some embodiments of the present disclosure, processor 60 may communicate with memory 90. Memory 90 may include one or more volatile or nonvolatile memory devices. Memory 90 may be utilized to store, for example, programmed instructions for operation of processor 60, data or parameters for use by processor 60 during operation, or results of

operation of processor 60. Memory 90 may include a computer readable medium for storing program instructions for operation of processor 60. In this example, the programmed instructions may take the form of robot assembly program 95 for controlling the automated placement of mosaic pieces on mosaic baseplate 15 for the assembly of the mosaic artwork. Memory 90 may be utilized to store data or parameters for use by processor 60 during operation, or results of operation of processor 60.

In some embodiments of the present invention, a mosaic assembly instruction data (MAID) file 97 may include a mapping of the positions of the different mosaic pieces on mosaic baseplate 15 and may be stored in memory 90, which may be uploaded to robot assembly program module 95 executed by processor 60.

In operation, processor 60 may execute a method for the assembly of the mosaic artwork by controlling the automated placement of mosaic pieces on mosaic baseplate 15.

In some embodiments, assembly table 16 may include sensors and/or brackets so as to detect mosaic baseplate sizes that may be mounted thereon. Processor 60 may report an error if the geometries of mosaic baseplate 15 are not consistent with the MAID file.

Fig. 2 schematically illustrates a first side view 100 of system 10, in accordance with some embodiments of the present disclosure. Mosaic baseplate 15 may be attached to an assembly table 16 held in place within assembly rack 17. Mosaic baseplate 15 may include an array of studs 105 onto which the mosaic pieces may be assembled or snapped onto thereof, as shown in an enlargement inset 107. End effector 25 at a first end 26 of robotic arm 20 may include a pickup head 130 for acquiring, holding, and/or transport a mosaic piece to a stud at predefined position on mosaic baseplate 15 according to the mapping in MAID file 97.

An inset 108 illustrates a round mosaic piece 110 and a square mosaic piece 120. Round mosaic piece 110 may include a top side 117 and a bottom side 116 with a hole 115. Similarly, square mosaic piece 120 may include a top side 127 and a bottom side 126 with a hole 125. The width W_R of round mosaic piece 110 and width W_S is the distance between opposite faces 128 of square mosaic piece 120 as shown in Fig. 2. In some embodiments, the mosaic piece may have a slanted top. However, any suitably shaped mosaic piece may be assembled onto mosaic baseplate 15 using the automated assembly methods described herein.

In some embodiments of the present disclosure, pickup head 130 of robotic arm 20 acquires, or picks up the mosaic piece in a predefined orientation. The term predefined

orientation as used herein is with reference to pickup head 130 acquiring or picking up the mosaic piece with hole 115 or hole 125 downward as shown in Fig. 2, so as to be able to snap into or mate with stud 105. Thus, the hole of the mosaic piece may be snapped directly onto and held by stud 105 on mosaic baseplate 15 without having to rotate the mosaic piece (e.g., round mosaic piece 110 or square mosaic piece 120) before snapping the mosaic piece onto stud 105. Here, downward refers to hole 115 or hole 125 being substantially opposite to end effector 25. In some embodiments of the present disclosure, MAID file 97 may include, for example, the mosaic piece, or brick type, such as Lego or Nano; the brick shape such as round, square, or sloping head; the brick count, the brick colors, the size of mosaic baseplate 15, the stud count, the stud array pitch, and stud layout on mosaic baseplate 15.

The embodiments shown in Fig. 2 are merely for conceptual clarity and not by way of limitation of the embodiments of the present invention. For example, the mosaic pieces are not limited in any way round mosaic piece 110 or square mosaic piece 120, but may include a mosaic piece of any type, shape (flat, square, round, sloping head, etc.), size and/or color.

Mosaic baseplate 15 may include one or more mosaic baseplates mounted on assembly table 16. The one or more mosaic baseplates may be placed on assembly table 16 in any suitable configuration. The one or more baseplates may include a plurality of studs onto which the mosaic pieces may be assembled. The plurality of studs may be of any suitable size and/or shape and/or pitch and arranged in any suitable array. Accordingly, MAID file 97 may be configured to account for the different configurations of multiple mosaic pieces assembled onto the one or more baseplates described herein. In this manner, multiple mosaic artworks may be assembled on multiple mosaic baseplates attached to assembly table 16 during the same assembly run.

Fig. 3A schematically illustrates a top view 150 of system 10, in accordance with some embodiments of the present disclosure.

Fig. 3B schematically illustrates a side view 160 of system 10, in accordance with some embodiments of the present disclosure. First end 26 of robotic arm 20 may be coupled to end effector 25 with pickup head 130. A second end 27 of robotic arm 20 may be coupled to robotic arm motorized assembly 45.

Fig. 4A schematically illustrates an isometric view 165 of two vibratory feeding bowls 30, in accordance with some embodiments of the present disclosure.

Fig. 4B schematically illustrates a top view 250 of two vibratory feeding bowls 30, in accordance with some embodiments of the present disclosure.

Each vibratory feeding bowl 30 may include a bowl 202 with a bottom region 220 for holding the mosaic pieces for assembly onto studs 105 attached to mosaic baseplate 15 as shown in Fig. 2, and a feeding track 210 leading upwardly in a helix around a perimeter of bowl 202 from bottom region 220 to an upper region 200 of bowl 202, the upper region proximate to a rim 201. Each vibratory feeding bowl 30 may include an actuator 230 operatively coupled to bowl 202 for producing a rotation or vibration of bowl 202.

The vibration and/or rotation applied to bowl 202 by actuator 230 may cause mosaic pieces in bottom region 220 to move upward along feeding track 210 from bottom region 220 to robotic arm landing pads 190 and 195 coupled to feeding track 210 in upper region 200 of bowl 202. In some embodiments, actuator 230 may include a motor. Robotic arm landing pads may be also referred to herein as mosaic piece pickup points, or pickup pads.

Each vibratory feeding bowl 30 may include a first selector 170 and a second selector 175 attached to rim 201 via screws placed through screw holes 174 formed in a selector mounting plate 172. Each mosaic piece reaching the top of vibratory feeding bowl 30 passes through selectors 170 and 175. Each mosaic piece not in the predefined orientation, (e.g., where the mosaic piece hole (e.g., hole 115 or hole 125) is downward in contact with feeding track 210), does not pass through selectors 170 and 175. Each of the mosaic pieces not in the predefined orientation are pushed off feeding track 210 by the selectors falling back into bottom region 220 of bowl 202. Each of the mosaic pieces pushed back into bowl 202 eventually start to move back up the feeding track 210. First selector 170 may perform most of the filtering of the pieces in the predefined orientation. Typically, second selector 175 is typically identical to first selector 170. Second selector 175 may be used for redundancy in the case where a mosaic piece not in the predefined orientation is not properly filtered by first selector 170.

Each of the mosaic pieces that are in the predefined orientation pass through selectors 170 and 175 and queue up at robotic arm landing pads 190 and 195 for pickup by pickup head 130. In the embodiments shown in Figs. 4A and 4B, robotic arm landing pads 190 and 195 may respectively accommodate a smaller width round mosaic piece (e.g., W_R of round mosaic piece 110) and a larger width round mosaic piece as shown in Fig. 4B. In some embodiments, narrow robotic arm landing pad 190 and wide robotic arm landing pad 195

may be respectively fed by a narrow feeding track 191 and a wide feeding track 196 located in different vibratory feeding bowls as shown in Fig. 4B.

In some embodiments of the present disclosure, each of two vibratory feeding bowls 30 may be mounted on a vibratory bowl assembly plate 180. Screws may be placed through screw holes 182, so as to mount the baseplate to assembly rack 17. Robotic arm landing pads 190 and 195 may be located in a top portion of landing pad vertical member 185. The bottom portion of landing pad vertical member 185 may be affixed with screws to vibratory bowl assembly plate 180. Assembly plate 180 may also be referred to as an assembly table.

Fig. 5A schematically illustrates an isometric view of a first embodiment of selector 170, in accordance with some embodiments of the present disclosure.

Fig. 5B schematically illustrates a first side view of the first embodiment of selector 170, in accordance with some embodiments of the present disclosure.

Fig. 5C schematically illustrates a front view of the first embodiment of selector 170, in accordance with some embodiments of the present disclosure.

Fig. 5D schematically illustrates a second side view of the first embodiment of selector 170, in accordance with some embodiments of the present disclosure.

The first embodiment of selector 170 may be used to filter round mosaic piece 110, square mosaic piece 120 and a square mosaic piece 270 with a slanted top. Selector 170 may include a side member 260A and a top member 265A which when assembled form an L-shaped jig that defines a cross-sectional region 301 for the mosaic pieces to selectively pass. Region 301 is bounded on the top by top member 265A, on the side by side member 260A, on the bottom by feeding track 210, and open to the side opposite to side member 260A.

Selective filtering of each of the mosaic pieces for allowing mosaic pieces in the predefined orientation to pass through region 301 may be achieved by a series of one or more grooves or steps 300 formed in top member 265A as shown in Figs. 5A-5D. Region 301 is open to the other side. One or more grooves or steps 300 block the mosaic pieces not in the predefined orientation from passing due to a mismatch in the mosaic pieces with the one or more grooves or steps, and to be pushed back and/or fall back into bottom region 220 of bowl 202. A tuning screw 295 may be used to tune the filtering selectivity. Moreover, the dimensions of the one or more grooves or steps may be determined by the dimensions and/or form factor of the mosaic pieces. Stated differently, the one or more grooves or slots of the mosaic piece selectors selectively filter each respective type of mosaic piece by causing

mosaic pieces not in the predefined orientation to fall back into bottom region 220 of bowl 202.

In some embodiments of the present invention as shown in an inset 213 of Fig. 5A, selector 170 may be mounted on a selector baseplate 290, and may be adjusted with tuning screw 295 placed through a tuning screw hole 296. Selector baseplate 290 may form a portion of feeding track 210 in the region of selector 170. Selector baseplate 290 may be part of feeding track 210, integrated into feeding track 210, and/or may be separate unit from feeding track 210. Selector baseplate 290 may include an edge 211 from which the mosaic pieces may be pushed by selector 170 back into the bowl 202. In some embodiments, the selectivity of selector 170 to allow mosaic pieces to pass in the predefined orientation may also be controlled by the shape and/or angles of edge 211 as well as grooves 212 and 214 formed in edge 211. These grooves and/or shape of edge 211 as described for Figs. 5A-5D for controlling the selectivity are equally applicable to the next embodiment of selector 170 shown in the following figures.

Fig. 6A schematically illustrates an isometric view of a second embodiment of selector 170, in accordance with some embodiments of the present disclosure.

Fig. 6B schematically illustrates a first side view of the second embodiment of selector 170, in accordance with some embodiments of the present disclosure.

Fig. 6C schematically illustrates a front view of the second embodiment of selector 170, in accordance with some embodiments of the present disclosure.

Fig. 6D schematically illustrates a second side view of second embodiment of selector 170, in accordance with some embodiments of the present disclosure.

The second embodiment of selector 170 may be used to filter a round mosaic piece 310 with a lip 330, a square mosaic piece 122 and a square mosaic piece 272 with a slanted top. Selector 170 may include a side member 260B and a top member 256B which when assembled form an L-shaped jig that defines a cross-sectional region 302 for the mosaic pieces to selectively pass. Region 302 is bounded on the top by top member 265B, on the side by side member 260B, on the bottom by feeding track 210, and open to the side opposite to side member 260B. Selective filtering of each of the mosaic pieces for allowing mosaic pieces in the predefined orientation to pass through region 302 may be achieved by a series of one or more grooves or steps 300 formed in top member 265B as in Figs. 5A-5D. However in Figs. 6A-6D, one or more grooves or steps, such as a groove 320, may be formed in side

member 265B, so as to allow lip 330 of round mosaic piece 310 to pass if round mosaic piece 310 is in the predefined orientation.

Fig. 7 schematically illustrates acquiring of a square mosaic piece 310 by pickup head 130 from robotic arm landing pad 195, in accordance with some embodiments of the present disclosure. Square mosaic piece 310 in the left vibratory feeding bowl of Fig. 7 may be moved from bottom region 220 along feeding track 210 through selectors 170 and 175 in the predefined orientation to robotic arm landing pad 195. Pickup head 130 in end effector 25 of robotic arm 20 picks up square mosaic piece 310. A smaller square piece 305 in robotic arm landing pad 190 is shown in Fig. 7 in the right vibratory feeding bowl waiting for pickup by pickup head 130.

Fig. 8 schematically illustrates vision sensor 85 imaging square mosaic piece 310 in pickup head 130, in accordance with some embodiments of the present disclosure. Vision sensor 85 may be used to acquiring mosaic piece image data from an image of square mosaic piece 310 held in pickup head 130 and to relay the mosaic piece image data to processor 60 of controller 40. Processor 60 may be used to assess the color, form factor, size of each mosaic piece acquired by pickup head 130 during the assembly of the mosaic artwork. In some embodiments, vision sensor 85 may be configured to directly determine the color of mosaic piece held in the pickup head and to relay the color to the processor.

The embodiments shown in the previous figures illustrating two vibratory feeding bowls 30, and are merely for conceptual clarity and not by way of limitation of the embodiments of the present disclosure. At least one vibratory feeding bowl 30 may be used in the automated assembly of the mosaic artwork. One parameter for determining the number of vibratory feeding bowls to be used may be the relative width (e.g., W_R or W_S) of the mosaic pieces.

In some embodiments of the present disclosure, if the mosaic artwork is to be assembled from the same size mosaic pieces (e.g., round, square, slanted, Lego, or Nano) but different colors mixed together, one vibratory feeding bowl may be used. However, during assembly of the mosaic artwork on mosaic baseplate 15, in order for controller 40 to assess onto which stud 105 to place each mosaic piece in accordance with the MAID data file and the mapping, processor 60 may be used to assess the color of each mosaic piece from the acquired mosaic piece image data from vision sensor 85.

In some embodiments of the present disclosure, if the width W_R for round mosaic piece 110 is substantially the same as width W_S for square mosaic piece 120 (e.g., $W_R=W_S$),

the the same robotic landing pad and a single vibratory feeding bowl may be used. The one or more grooves or slots 300 in selectors 170 may be chosen accordingly to filter the different form factors of the mosaic pieces. However, if different robotic landing pad sizes are needed, then multiple vibratory feeding bowl may be needed to accommodate the different sized mosaic pieces.

In some embodiments of the present disclosure, if one vibratory feeding bowl is used, vision sensor 85 may acquire the mosaic piece image data from an image of each mosaic piece in the robotic arm landing pad before pickup or after pickup while held in pickup head 130. If multiple vibratory feeding bowls are used, then vision sensor 85 with an imaging axis 350 may image the mosaic piece in pickup head 130 after robotic arm 20 moves the mosaic piece in pickup head 130 into the field of view of vision sensor 85 after pickup as shown in Fig. 8. Processor 60 may then assess onto which stud 105 to snap the acquired mosaic piece.

The terms type, or different type, of mosaic pieces as used herein refer to mosaic pieces of different shapes and colors, but of substantially the same size, such that the same vibratory feeding bowl and the same robotic arm landing pad may be used. The selector used may be appropriately chosen to selectively filter the predetermined orientation of each mosaic piece for each of the different or respective types of mosaic pieces.

Fig. 9A schematically illustrates an isometric view of an end effector assembly 360, in accordance with some embodiments of the present disclosure.

Fig. 9B schematically illustrates a side view of end effector assembly 360, in accordance with some embodiments of the present disclosure.

Fig. 9C schematically illustrates a bottom view of end effector assembly 360, in accordance with some embodiments of the present disclosure.

End effector assembly 360 may include a mounting plate 375 for mounting end effector assembly 360 to first end 26 of robotic arm 20. End effector 25 may be coupled to mounting plate 375 with four springs 380 and attached thereon with four bolts 385. Pickup head 130 may be mounted to end effector 25. Pickup head 130 may include a stopper guide 135 formed on each side with four retractable side guides 367, which are arranged opposite to one another as shown in Fig. 9A. Each retractable side guide is denoted 367A, 367B, 367C, and 367D where side guides 367A and 367B as well as side guides 367C and 367D are opposite to one another. The bottom of pickup head 130 may include a vacuum hole 370. The bottom end of stopper guide 135 may be shaped to interchangeably receive and hold

different types of mosaic pieces 400 in the predefined orientation with the mosaic piece hole held downward.

In some embodiments of the present disclosure, mosaic piece 400 that is acquired by pickup head 130 may be held in pickup head 130 by a vacuum applied through vacuum hole 370 (e.g., by an external vacuum pump coupled to vacuum hole 370).

In some embodiments of the present disclosure, four springs 380 may be compressed during the placement of mosaic piece 400 so to reduce the rigidity of pickup head 130 when contacting mosaic baseplate 15. This may minimize the possibility of breakage of mosaic baseplate 15.

The embodiments shown in Figs. 9A-9C are merely for conceptual clarity and not by way of limitation of the embodiments of the present invention. End effector assembly 360 may be suitably adapted to pick up mosaic pieces of any type, shape (flat, square, round, sloping head, etc), size and/or color with any number of stud holes for assembly onto any number of mosaic baseplates on assembly table 16.

Fig. 10A schematically illustrates a cross-sectional view of stopper guide 135 holding mosaic piece 400 prior to placement on mosaic baseplate 15, in accordance with some embodiments of the present disclosure.

Fig. 10B schematically illustrates a cross-sectional exploded view of stopper guide 135 placing mosaic piece 400 and colliding with an adjacent mosaic piece 425 on mosaic baseplate 15, in accordance with some embodiments of the present disclosure.

When mosaic piece 400 is placed on stud 105A in the stud array which is already populated by an adjacent mosaic piece 425 previously placed on stud 105B adjacent to stud 105A, pickup head 130 may contact or collide with already-placed mosaic piece 425 on adjacent stud 105B. Generally, mosaic piece 400 in pickup head 130 may attempt to pivot if held rigidly in pickup head 130 when colliding with one or more already-placed mosaic pieces on adjacent studs.

In some embodiments of the present invention, stopper guide 135 in pickup head 130 may include four retractable side guides 367A and 367B which are shown in the cross-sectional views opposite to one another in Figs. 10A and 10B (referring to Fig. 9A). Each of four retractable side guides 367 may be internally spring loaded, coupled respectively to four side guide springs 410, which hold each of the four retractable side guides (367A and 367B) downward around a central member 412 holding the top portion of mosaic piece in place (e.g., by a vacuum, for example) as shown in Fig. 10A.

In Fig. 10B, stopper guide 135 of pickup head 130 may be lowered over an identified stud 105A for assembly placement where adjacent mosaic piece 425 has been previously assembled on adjacent stud 105B. When a downward force applied by end effector 25 on pickup head 130, retractable side guide 367B upon colliding with previously placed adjacent mosaic piece 425 may retract upward, while the downward force by end effector 25 on central member 412 pushes mosaic piece 400 to snap onto stud 105A. Retractable side guide 367A remains rigidly extended and holds mosaic piece with hole 420 downward in the predefined orientation during assembly. Without the use of retractable side guide 367B as shown here, but using a rigid side guide (not shown), pickup head 130 may tilt sideways. This would subsequently tilt hole 420 at the bottom of mosaic piece 400 away from the downward predefined orientation complicating the assembly of mosaic piece 400 on stud 105A.

The embodiments in Figs. 10A and 10B are shown merely for visual and conceptual clarity, and not by way of limitation of the embodiments disclosed herein. For example, if there are four adjacent previously-assembled mosaic pieces 425 surrounding stud 105A, all four retractable side guides 367A, 367B, 367C, and 367D are configured to retract in the same manner as shown in Fig. 10B during the assembly of mosaic piece 400 onto stud 105A (e.g., snapping hole 420 onto stud 105A). Pickup head 130 may be suitably adapted to place mosaic pieces of any type, shape (flat, square, round, sloping head, etc), size and/or color with any number of stud holes for assembly onto any number of mosaic baseplates on assembly table 16 with any suitable stud pitch and/or array.

Fig. 11A schematically illustrates a top view of a portion 450 of mosaic artwork assembly system 10 using one vibratory feeding bowl 30, in accordance with some embodiments of the present disclosure.

Fig. 11B schematically illustrates a first side view of a portion 450 of mosaic artwork assembly system 10 using one vibratory feeding bowl 30, in accordance with some embodiments of the present disclosure.

In the case where one vibratory feeding bowl 30 may be used, vision sensor 85 may be configured to image the mosaic piece 305 while still placed in robotic arm landing pad 190 waiting for pickup as shown by imaging axis 350 imaging the region of robotic arm landing pad 190. In this manner, the assembly of the mosaic artwork may be substantially faster since the pickup head 130 does not have to first acquire the mosaic piece, move and

hover within the field of view of vision sensor 85 as shown in Fig. 8 as in the case for more than one vibratory feeding bowl 30.

In some embodiments, if the assembly of the mosaic artwork is partially completed and all that remains to complete the artwork is the placement of mosaic pieces of the same one color, the same mosaic pieces loaded into one vibratory feeding bowl 30. The assembly process may then continue without the need to image the mosaic piece in robotic arm landing pad 190 (e.g., with the vision system turned off), so as to shorten the assembly time.

In either way of imaging the mosaic piece for assessing the color of the mosaic piece, the use of one vibratory feeding bowl 30 allows the use of different colored mosaic pieces of different shapes, but same substantially size to be assembled in one end-to-end assembly run. A mosaic artwork may be assembled using many different colors (e.g., 15 or more mosaic colored pieces) so the use of the methods taught herein using one vibratory feeding bowl 30 eliminates the need to setup the system with multiple mosaic piece feeders for each of the different colored pieces, or to manually setup up an assembly run for each mosaic piece color.

Thus, the methods taught herein significantly simplifies mosaic artwork assembly system 10 in that one pickup head may be configured to pick up different shaped mosaic pieces of substantially the same size. The different shaped mosaic pieces may queue up using one robotic arm landing pad in the predefined orientation, filtered by one selector to accommodate the different mosaic pieces in one vibratory feeding bowl 30. Thus, the exact quantities of each color (e.g., part count) of the mosaic pieces to assemble the mosaic artwork may be loaded into a single vibratory feeding bowl.

Fig. 12 is a flowchart illustrating a method 500 for assembling mosaic artwork by placing mosaic pieces on a mosaic baseplate, in accordance with some embodiments of the present disclosure. Method 500 may be performed by controller 40 in system 10.

Method 500 may include receiving 510 a mapping between mosaic pieces and their placement on an array of studs on a mosaic baseplate.

Method 500 may include moving 520 robotic arm to pick up a mosaic piece from the robotic arm landing pad in a predefined orientation in a pickup head coupled to the robotic arm.

Method 500 may include assessing 530 a color of the mosaic piece using a vision sensor.

Method 500 may include identifying 540 a position of a stud in the stud array onto which to place the mosaic piece based on the assessed color and the mapping.

Method 500 may include moving 550 robotic arm with the mosaic piece held in the pickup head to the identified position.

Method 500 may include snapping 560 the mosaic piece held in the predefined orientation in the pickup head onto the stud at the identified position on the mosaic baseplate.

Method 500 may include a decision step 570 where processor 60 may assess whether the studs on the mosaic baseplate have been populated with assembled mosaic pieces in accordance with the mapping. If yes, the mosaic artwork is finished in step 580. If not, the robotic arm may be moved in step 520 to pick up another mosaic piece so as to continue assembling the mosaic artwork.

In some embodiments of the present disclosure, the assembly process may be started on a touch panel (e.g., I/O devices 75). Robot assembly program 95 may identify the mosaic piece type and count, and verify that MAID data file 97 is uploaded to processor 60 with the mapping between the different colored mosaic pieces and the respective stud assembly positions on the mosaic baseplate. The end effector 25 fitted for the specific mosaic pieces including different shaped mosaic pieces to be assembled may be chosen for the specific brick type, and mounted on robotic arm 20. End effector 25 may be fitted to accommodate slope-shaped bricks (e.g., mosaic piece 270, for example in Fig. 5D). Furthermore, feeding tracks 210 of vibratory feeding bowls 30 may accommodate the different shape of mosaic pieces or bricks, and to move each of them from bottom region 220 of bowl 202 to the robotic arm landing pad when motor 230 causes bowl 202 to jiggle under vibration or rotation.

During the assembly process, pickup head 130 acquires a mosaic piece from the robotic arm landing pad, and vision sensor 85 assesses the color of the piece. Robot assembly program 95 may then reference the MAID file, so as to determine onto which stud on the mosaic baseplate to place the mosaic piece with the assessed color. In this manner, all colors of the mosaic pieces to be assembled may be placed in one vibratory feeding bowl in some embodiments.

In some embodiments of the present disclosure, a system for assembling mosaic artwork by placing mosaic pieces on a mosaic baseplate may include at least one vibratory feeder bowl, at least one mosaic piece selector, a robotic arm, a vision sensor, and a controller.

The at least one vibratory feeder bowl may include:

a bowl with a bottom region for holding a plurality of mosaic pieces of different types for assembly onto studs attached to a mosaic baseplate and arranged in an array;

a feeding track leading (e.g., upwardly in a helix around a perimeter of the bowl) from the bottom region to an upper region of the bowl; and

an actuator operatively coupled to the bowl for producing a rotation or vibration of the bowl, so as to cause mosaic pieces from the plurality of mosaic pieces to move along the feeding track from the bottom region to a robotic arm landing pad coupled to the feeding track in the upper region of the bowl.

The at least one mosaic piece selector may be positioned along the feeding track in the upper region of the bowl and may include a top member and a side member. One or more grooves or steps may be formed in the top member or the side member, so as to permit each respective type of mosaic piece moving on the feeding track to selectively pass through the at least one selector to the robotic arm landing pad in a predefined orientation.

The robotic arm with a first end and a second end, may include an end effector at the first end including a pickup head with a spring loaded stopper guide for acquiring at least one mosaic piece from said plurality of mosaic pieces from the robotic arm landing pad in the predefined orientation.

The vision sensor may be used to acquire mosaic piece image data from an image of the at least one mosaic piece from said plurality of mosaic pieces.

The controller may include robotic arm control circuitry for controlling movement of the robotic arm and the pickup head, and a processor. The processor may be configured to:

- (a) receive a mapping between said plurality of mosaic pieces and their placement on the array of the studs on the mosaic baseplate onto which said plurality of mosaic pieces will be assembled,
- (b) instruct the robotic arm control circuitry to move the robotic arm so as to acquire the at least one mosaic piece from said plurality of mosaic pieces from the robotic arm landing pad in the predefined orientation in the pickup head,
- (c) assess a color of the at least one mosaic piece from said plurality of mosaic pieces from the mosaic piece image data,

- (d) identify a position of the at least one stud in the array of studs onto which to place the at least one mosaic piece from said plurality of mosaic pieces based on the assessed color and the mapping,
- (e) instruct the robotic arm control circuitry to move the robotic arm with the at least one mosaic piece from said plurality of mosaic pieces in the pickup head to the identified position, and
- (f) instruct the robotic arm control circuitry to cause the robotic arm to snap the at least one mosaic piece from said plurality of mosaic pieces in the pickup head in the predefined orientation onto the at least one stud at the identified position on the mosaic baseplate.

Each side of the stopper guide may include four retractable side guides, each side guide capable of retracting during the snapping of the one mosaic piece from said plurality of mosaic pieces onto the stud at the identified position on the mosaic baseplate upon contacting (e.g., colliding with) a previously positioned mosaic piece on a stud (e.g., on another stud) adjacent to the stud at the identified position.

In some embodiments of the present disclosure, the pickup head may acquire at least one or more mosaic pieces to be snapped onto respective one or more studs on the mosaic baseplate and is not limited to handling one mosaic piece one at a time.

In the context of some embodiments of the present disclosure, by way of example and without limiting, terms such as 'operating' or 'executing' imply also capabilities, such as 'operable' or 'executable', respectively.

Conjugated terms such as, by way of example, 'a thing property' implies a property of the thing, unless otherwise clearly evident from the context thereof.

The terms 'processor' or 'computer', or system thereof, are used herein as ordinary context of the art, such as a general purpose processor, or a portable device such as a smart phone or a tablet computer, or a micro-processor, or a RISC processor, or a DSP, possibly comprising additional elements such as memory or communication ports. Optionally or additionally, the terms 'processor' or 'computer' or derivatives thereof denote an apparatus that is capable of carrying out a provided or an incorporated program and/or is capable of controlling and/or accessing data storage apparatus and/or other apparatus such as input and output ports. The terms 'processor' or 'computer' denote also a plurality of processors or computers connected, and/or linked and/or otherwise communicating, possibly sharing one or more other resources such as a memory.

The terms 'software', 'program', 'software procedure' or 'procedure' or 'software code' or 'code' or 'application' may be used interchangeably according to the context thereof, and denote one or more instructions or directives or electronic circuitry for performing a sequence of operations that generally represent an algorithm and/or other process or method. The program is stored in or on a medium such as RAM, ROM, or disk, or embedded in a circuitry accessible and executable by an apparatus such as a processor or other circuitry. The processor and program may constitute the same apparatus, at least partially, such as an array of electronic gates, such as FPGA or ASIC, designed to perform a programmed sequence of operations, optionally comprising or linked with a processor or other circuitry. The term 'configuring' and/or 'adapting' for an objective, or a variation thereof, implies using at least a software and/or electronic circuit and/or auxiliary apparatus designed and/or implemented and/or operable or operative to achieve the objective.

A device storing and/or comprising a program and/or data constitutes an article of manufacture. Unless otherwise specified, the program and/or data are stored in or on a non-transitory medium.

In case electrical or electronic equipment is disclosed it is assumed that an appropriate power supply is used for the operation thereof.

The flowchart and block diagrams illustrate architecture, functionality or an operation of possible implementations of systems, methods and computer program products according to various embodiments of the present disclosed subject matter. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of program code, which comprises one or more executable instructions for implementing the specified logical function(s). It should also be noted that, in some alternative implementations, illustrated or described operations may occur in a different order or in combination or as concurrent operations instead of sequential operations to achieve the same or equivalent effect.

The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprising", "including" and/or "having" and other conjugations of these terms, when used in this specification, specify the presence of stated features,

integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

The terminology used herein should not be understood as limiting, unless otherwise specified, and is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosed subject matter. While certain embodiments of the disclosed subject matter have been illustrated and described, it will be clear that the disclosure is not limited to the embodiments described herein. Numerous modifications, changes, variations, substitutions and equivalents are not precluded.

CLAIMS

1. A system for assembling mosaic artwork by placing mosaic pieces on a mosaic baseplate, the apparatus comprising:

at least one vibratory feeder bowl comprising:

a bowl with a bottom region for holding a plurality of mosaic pieces of different types for assembly onto studs attached to a mosaic baseplate and arranged in an array;

a feeding track leading from the bottom region to an upper region of the bowl; and

an actuator operatively coupled to the bowl for producing a rotation or vibration of the bowl, so as to cause mosaic pieces from the plurality of mosaic pieces to move along the feeding track from the bottom region to a robotic arm landing pad coupled to the feeding track in the upper region of the bowl;

at least one mosaic piece selector positioned along the feeding track in the upper region of the bowl, comprising a top member and a side member, wherein one or more grooves or steps formed in the top member or the side member permit each respective type of mosaic piece moving on the feeding track to selectively pass through the at least one selector to the robotic arm landing pad in a predefined orientation;

a robotic arm with a first end and a second end, comprising an end effector at the first end including a pickup head with a stopper guide for acquiring at least one mosaic piece from said plurality of mosaic pieces from the robotic arm landing pad in the predefined orientation;

a vision sensor for acquiring mosaic piece image data from an image of the at least one mosaic piece from said plurality of mosaic pieces; and

a controller comprising robotic arm control circuitry for controlling movement of the robotic arm and the pickup head, and a processor to instruct the robotic arm control circuitry to cause the robotic arm to snap the at least one mosaic piece from said plurality of mosaic pieces in the pickup head in the predefined orientation onto at least one stud at an identified position on the mosaic baseplate.

2. The system according to claim 1, wherein the processor receives a mosaic assembly instruction data file, which includes a mapping.

3. The system according to claim 1, wherein the pickup head acquires the at least one mosaic piece in the predefined orientation by picking up the at least one mosaic piece with the hole of the at least one mosaic piece downward.
4. The system according to claim 1, further comprising a robotic arm motorized assembly coupled to the second end of the robotic arm to move the robotic arm and the pickup head.
5. The system according to claim 1, wherein the processor instructs the robotic arm control circuitry to cause the robotic arm to iteratively acquire and to snap the at least one mosaic piece from said plurality of mosaic pieces in the pickup head in the predefined orientation onto studs on the mosaic baseplate until the mosaic artwork is completed.
6. The system according to claim 1, wherein the plurality of mosaic pieces are bricks.
7. The system according to claim 1, wherein the plurality of mosaic pieces are Lego or Nano pieces.
8. The system according to claim 1, wherein the upper region of the bowl of the at least one vibratory feeder bowl is proximate to a rim of the bowl.
9. The system according to claim 8, wherein the at least one mosaic piece selector is attached to the rim of the bowl.
10. The system according to claim 1, wherein the vision sensor acquires the mosaic piece image data when the at least one mosaic piece is in the robotic arm landing pad or held in the pickup head.
11. The system according to claim 1, wherein the vision sensor is configured to determine a color of the at least one mosaic piece from said plurality of mosaic pieces in the pickup head and to relay the color to the processor.

12. The system according to claim 1, wherein all colors of the plurality of mosaic pieces for the mosaic artwork are loaded into the bottom region of the bowl.
13. The system according to claim 1, further comprising a video recording device to record an assembly process of the mosaic artwork.
14. The system according to claim 1, wherein the at least one mosaic piece from said plurality of mosaic pieces is held in the pickup head by a vacuum.
15. The system according to claim 1, wherein the one or more grooves or slots of the at least one mosaic piece selector selectively filter each respective type of mosaic piece by causing mosaic pieces not in the predefined orientation to fall back into the bottom region of the bowl.
16. The system according to claim 1, wherein the feeding track is leading upwardly in a helix around a perimeter of the bowl from the bottom region to the upper region.
17. The system according to claim 1, wherein each side of the stopper guide comprises four retractable side guides.
18. The system according to claim 17, wherein each side guide of the four retractable side guides is capable of retracting upon contacting a previously positioned mosaic piece on studs adjacent to the at least one stud at the identified position.
19. The system according to claim 1, wherein the processor:
 - (a) receives a mapping between said plurality of mosaic pieces and their placement on the array of the studs on the mosaic baseplate onto which said plurality of mosaic pieces will be assembled,
 - (b) instructs the robotic arm control circuitry to move the robotic arm so as to acquire the at least one mosaic piece from said plurality of mosaic pieces from the robotic arm landing pad in the predefined orientation in the pickup head,

- (c) assesses a color of the at least one mosaic piece from said plurality of mosaic pieces from the mosaic piece image data, and
- (d) identifies the position on the mosaic baseplate of the at least one stud in the array of studs onto which to place the at least one mosaic piece from said plurality of mosaic pieces based on the assessed color and the mapping.