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# RoboPaint user manual

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## Main page

At the beginning the software appears as shown in the figure below:

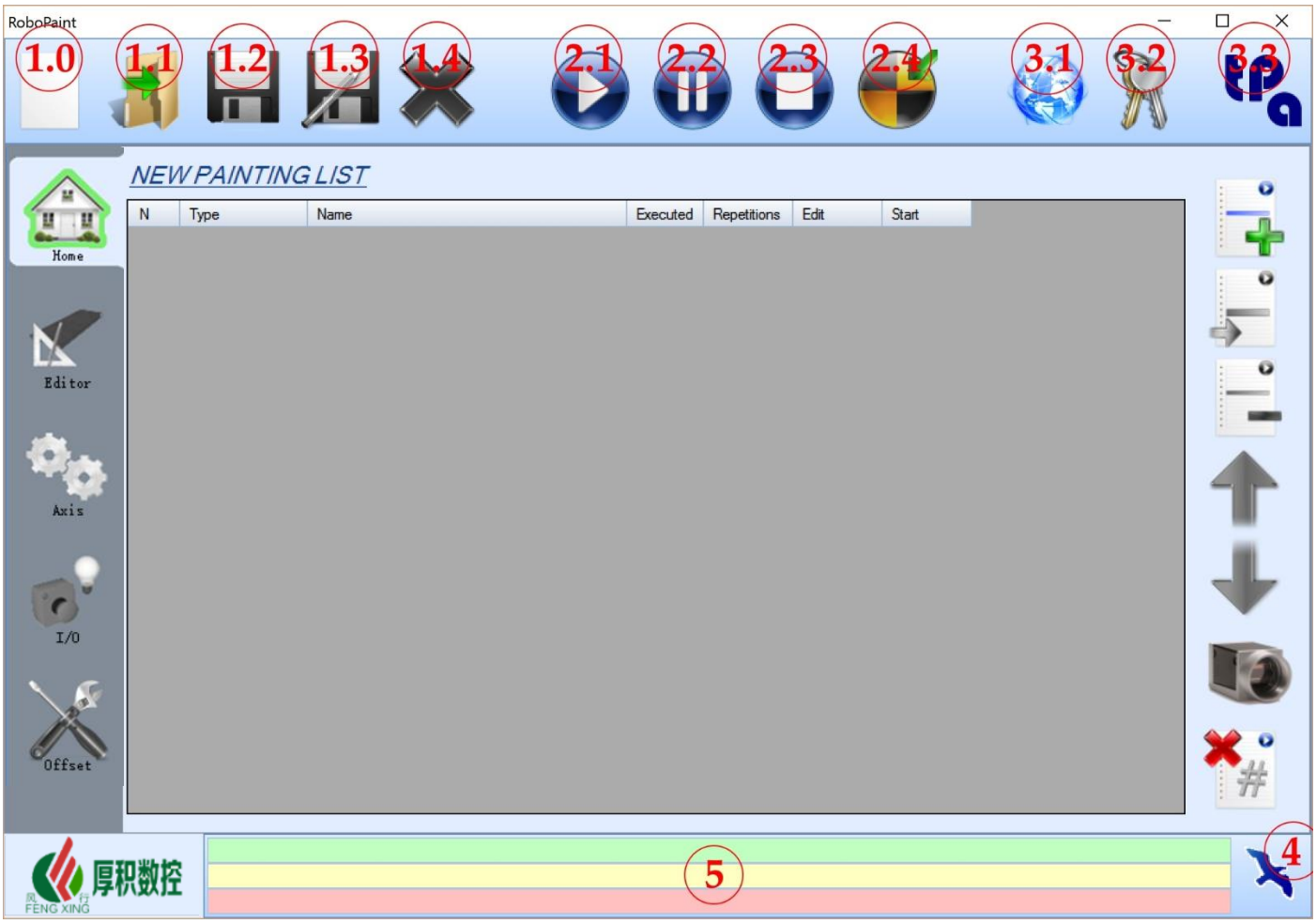


Fig.1

The main commands in each screen of the program are visible at the top of the window.

Below, the meaning of each button with reference to the numbering in the image:

1.0 NEW: used to open a new painting list or a new program.
1.1 OPEN: opens a previously saved painting list or a single program.
1.2 SAVE: saves the currently open painting list or the program.
1.3 SAVE AS: saves the painting list or the program and allows you to change its name.
1.4 CLOSE: closes the painting list currently open.
2.1 START: runs the open painting list and then starts the program running.
2.2 PAUSE: pauses the program running.
2.3 STOP: breaks the program running.
2.4 SETPOINT: machine reset. To be run at each startup or after a system error. (The software automatically signals when you need to run the Setpoint).

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3.1 LANGUAGES: changes the Software language displayed.
3.2 PASSWORD: increases the authorizations by entering a password.
3.3 TPA: displays the version of the software you are using.
4 ALBATROS: The icon "Albatros" allows you to view the master software (in icon view, NOT in full screen view). A second pressure allows you to hide the software again.
5 MESSAGE BARS: Here the messages are displayed as follows: GREEN: cycle messages, YELLOW: cycle messages; RED: system error (severe error).

In the main page on the left, see Fig. 2, there are also the buttons to change the page to the software, so that you can access all the available features.

1. HOME: The home tab gives you access to the list and it is the main operating page.

2. EDITOR: on this screen the execution program is configured; afterwards, these programs can be loaded into the Painting List from the 1 HOME tab.

3. MANUAL MODE: allows the axis devices to be displayed, including their real coordinates and the possibility to move them manually through the control board (Fig. 6). There are also the flags for established operations, such as gun washing, manual activation of the guns, etc...

4. DIAGNOSTICS: shows the INPUT / OUTPUT devices and displays their status, to verify their correct operation.

5. PARAMETERS: Protected by PASSWORD (Fig. 1, 3.2). Here you can modify the various offsets and the unique parameters for each machine.

Fig. 2

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## Home

This section allows you to manage the execution of programs in the machine through the execution list.
You can:

- edit the repetitions of a single program;
- view the performed pieces;
- change or just display how the program was designed and, once a list has been set out, you can launch its actual execution.

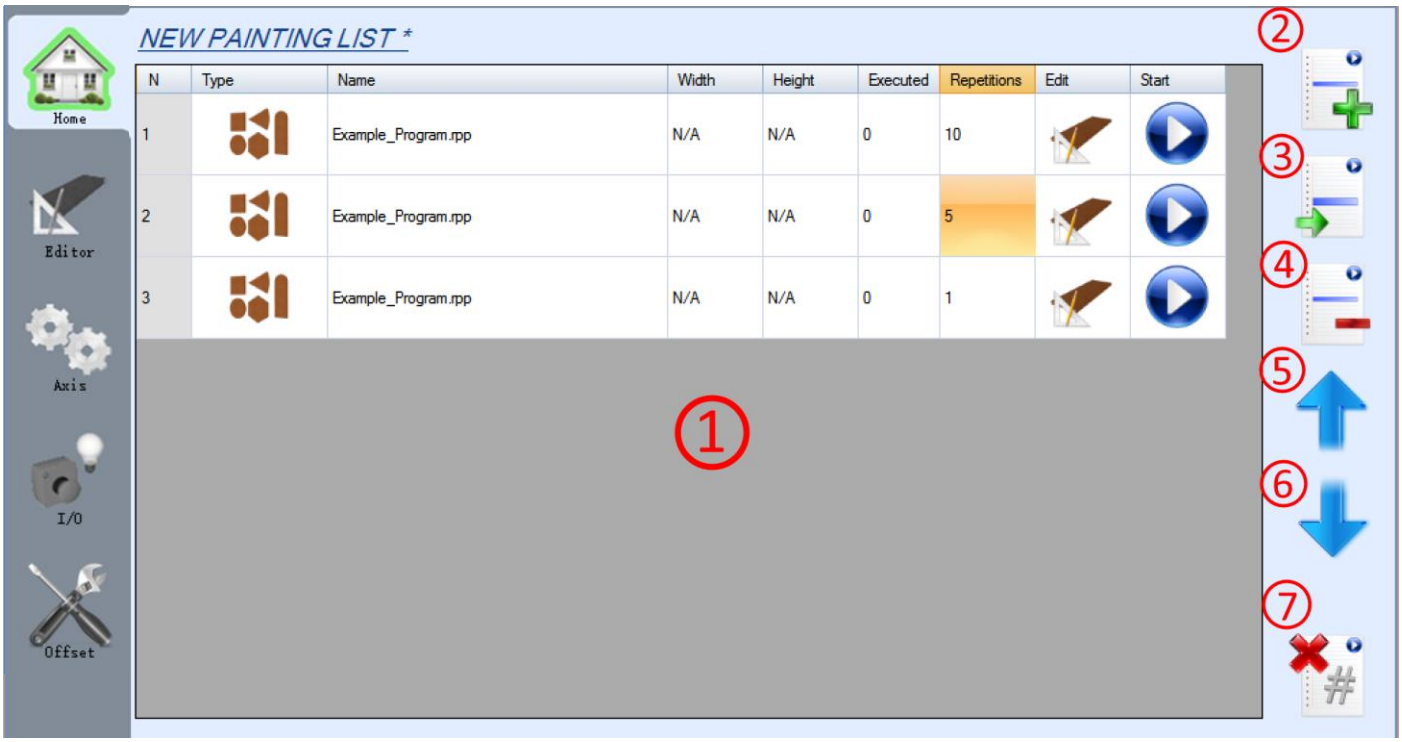


Fig. 3

1. LIST: here the added programs are displayed by pressing the NEW PROGRAM button 2 or the entire loaded list by means of the OPEN command (Fig. 1, 1.1). The programs will be run sequentially according to the values of the first "N" column. In the following columns:
   - Type: shows the icon that identifies the type of the open program.
   - Name: pressing on this column, you can open the folder including all the programs, built through EDITOR Tab 4 (Fig. 2).
   - Width / Height: here you will see the size of the programmed piece. In the case of scanner machine, the sizes appear as automatically calculated by the beams. In the case of machine with rotary table the displayed dimensions are those you have programmed; they can be dynamically changed by pressing the reference column.
   - Executed programs/ Repetitions: By setting the Repetitions column, you will decide how often you want to run the program; the Executed program column shows the actual executions of the program until the Repetitions value is reached. After that, the execution moves to the next line.

- Edit: By pressing the button, you can access the EDITOR Tab 4 (Fig. 2) to modify the program, if needed.
- Start: allows you to run the program for the selected row, without going on in the list to the end of the program execution.

2. ADD ROW: by pressing the button, a window appears (Fig. 4); it allows you to choose the type of program to add to the execution list. Once it has been selected, the folder including the programs previously developed by EDITOR Tab 4, automatically opens (Fig. 2). After choosing the program, this is automatically added to the end of the execution list.

Fig. 4

3. COPY ROW: allows you to copy the previous row and to add it to the end of the execution list.
4. DELETE ROW: deletes the selected row.

5-6. UP / DOWN: scrolls up or down the selection of the programs in the execution list.

7. RESET EXECUTED: resets the value of the column *Executed* in all the programs available in the execution list.

Once the required execution list has been created, you just need to press START (Fig. 1, 2.1) to start its real execution in the machine.

In the case of camera painting machine, the home page has some new commands and parameters in addition to what has been shown in this chapter. Please see Camera system for a detailed explanation.

## Manual mode

In this section you can view the positions of the axes and how to enable their manual handling. There are also specific buttons of each application to perform routine activities such as gun washing or the placement of the axes in a parking position.

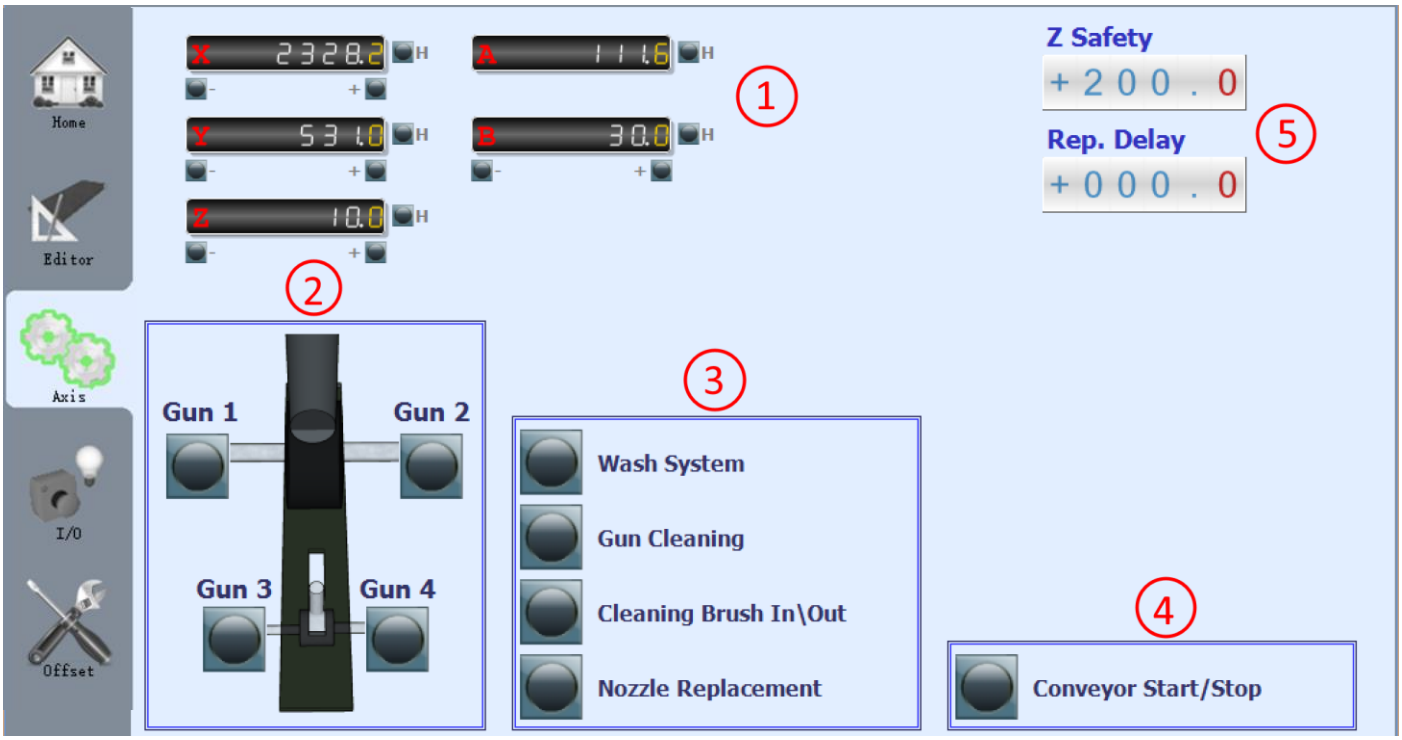


Fig. 5

1. MANUAL HANDLING: in this area there are the axis coordinates; by clicking on them, you can open the manual handling board control:

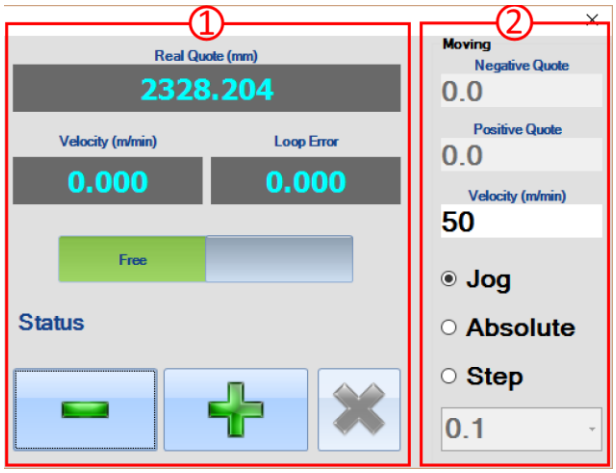


Fig. 6

In the window for the manual handling there are two areas, whose contents are described as follows:

1. DISPLAY AREA
   - Three cells which display the axis Real Position [mm], its speed [m/min] and the Loop Error or tracking error.
   - Two selection buttons which indicate the axis status (Free = open loop, for example because of a system error, Normal = closed loop, corresponding to normal position control status). It is also possible to set the status by using these buttons.
   - Two buttons to select negative or positive direction axis movement.
   - The button to Stop axis movement at any time, during movement in ABSOLUTE or STEP mode.

   1.2 MOVEMENT AREA (Fig.6)
   - Two cells to set a Negative Position and a Positive Position, which will be used in ABSOLUTE mode.
   - One cell to set the Speed set up on the axis during manual movements.
   - Three selection buttons to choose what kind of movement to apply: JOG, ABSOLUTE position or STEP.
   - One cell to set the Step value to use in STEP mode.

   In **JOG** mode the axis will keep on moving as long as the + or - button is kept pressed.

   In **STEP** mode, the axis will move as far as indicated in the "Step" cell each time the + or - button is pressed.

   In **ABSOLUTE** mode, the axis directly reaches the position shown in the Positive position or Negative position cell.

2. GUN ACTIVATION AREA: here, you can activate the guns manually, by pressing the corresponding buttons.

3. SUPPORT PROCEDURE AREA: in this area there are the commands of machine support, such as:
   - WASH SYSTEM: performs the washing cycle set out in the instructions;
   - GUN CLEANING: performs the cleaning procedure of the guns, as described in the instructions;
   - CLEANING BRUSH IN\OUT: allows the enablement or the disablement of the washing system;
   - NOZZLE REPLACEMENT: moves the axes to the position set.

4. CONVEYOR: enables or stops the conveyor belt.

5. PARAMETERS: Here there are some configurable parameters, in this case:
   - Z SAFETY: Z axis safety position; before executing any working, the axis always moves beyond this safety position.
   - REP. DELAY: waiting time parametrizable in seconds from the execution of one piece to the next one.

WARNING! The points 2, 3, 4 and 5 may vary from one machine to the next, because they can be configured by the developer.

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## Diagnostics

This section allows you to view the INPUT and OUTPUT devices set out by the developer and configured in the machine; INPUT and OUTPUT devices are divided into two pages.

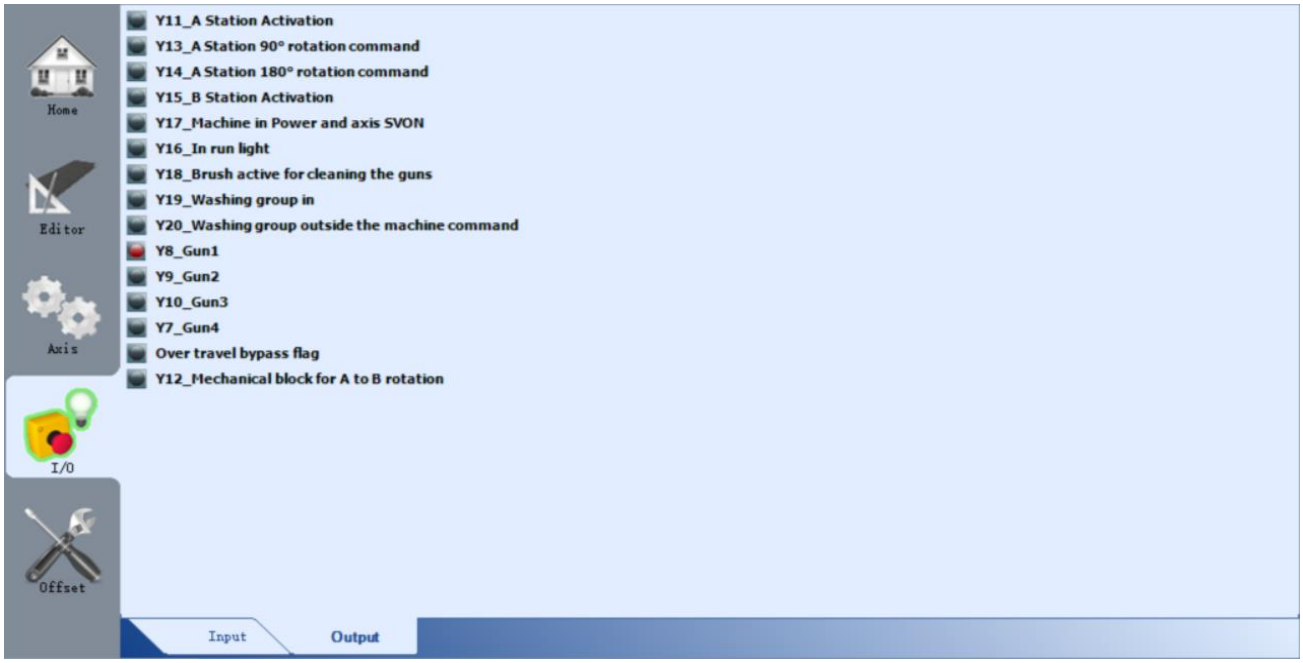


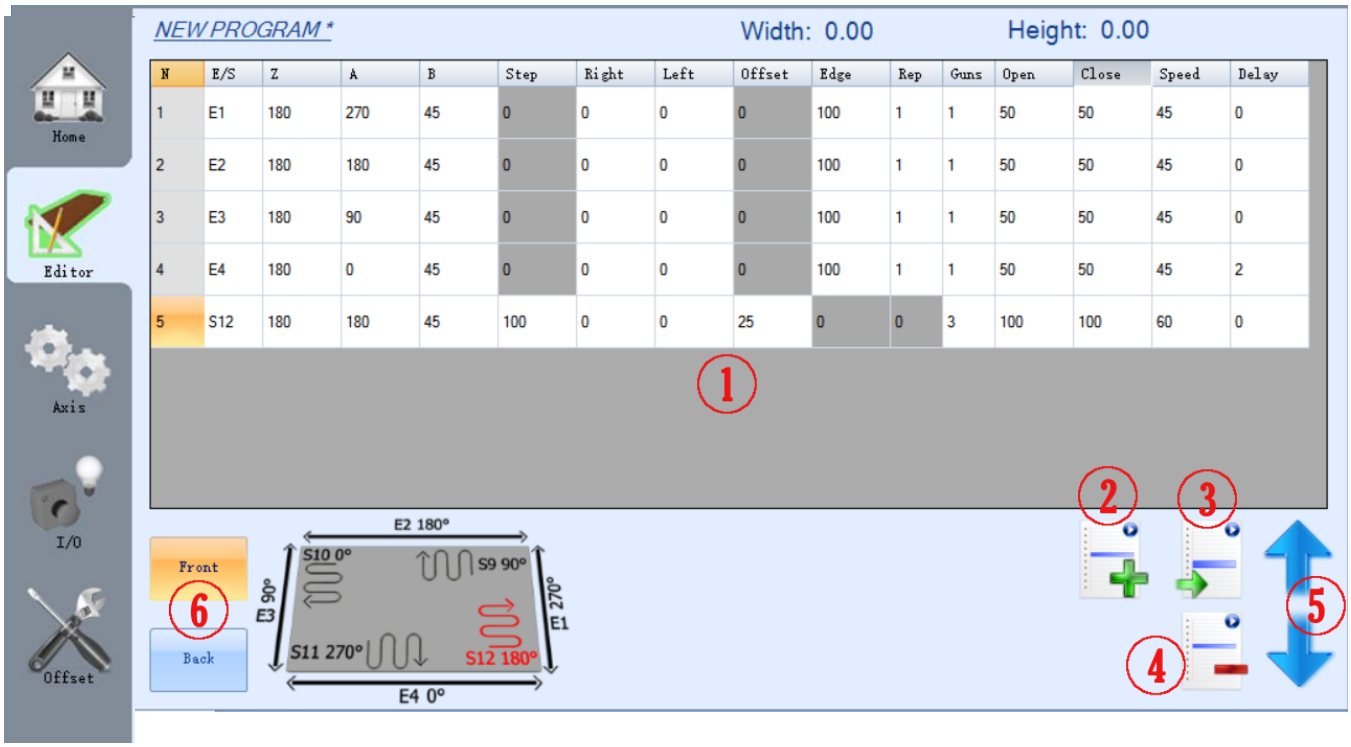

Fig. 7

INPUT devices show the status of each sensor of the machine; when the signal is ON the INPUT device icon is green.

OUTPUT devices show the status of the outputs. Is it possible to enable / disable an output by clicking on its icon? When the OUTPUT device icon is red, the output signal is ON.

## Editor

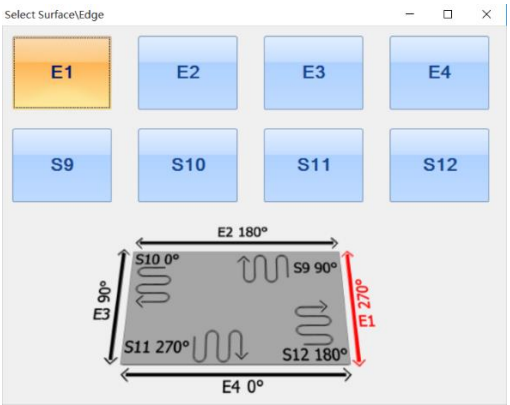
This is a primary section, because here the programs that must be run in the machine are set out and created. Press NEW (Fig. 1, 1.0) to choose the type of the program (Fig. 4) you want to create. On the other hand, the OPEN button (Fig. 1, 1.1) allows you to open and modify a program previously created. The areas of the section are analyzed more specifically, as follows:



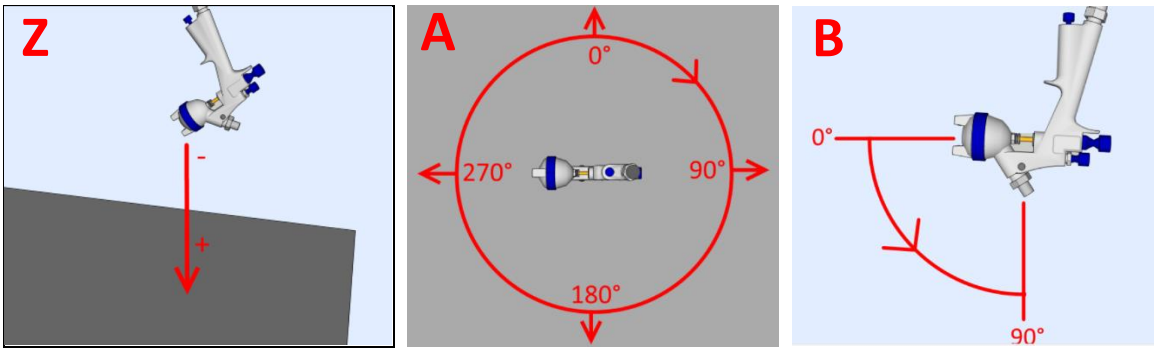

| N | E/S | Z | A | B | Step | Right | Left | Offset | Edge | Rep | Guns | Open | Close | Speed | Delay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | E1 | 180 | 270 | 45 | 0 | 0 | 0 | 0 | 100 | 1 | 1 | 50 | 50 | 45 | 0 |
| 2 | E2 | 180 | 180 | 45 | 0 | 0 | 0 | 0 | 100 | 1 | 1 | 50 | 50 | 45 | 0 |
| 3 | E3 | 180 | 90 | 45 | 0 | 0 | 0 | 0 | 100 | 1 | 1 | 50 | 50 | 45 | 0 |
| 4 | E4 | 180 | 0 | 45 | 0 | 0 | 0 | 0 | 100 | 1 | 1 | 50 | 50 | 45 | 2 |
| 5 | S12 | 180 | 180 | 45 | 100 | 0 | 0 | 25 | 0 | 0 | 3 | 100 | 100 | 60 | 0 |

Fig. 8

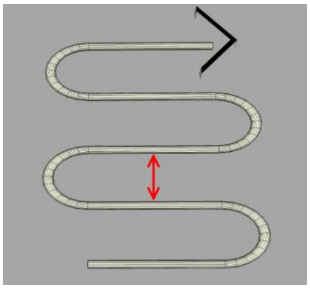
1. PROGRAM AREA: Here you can manage the actual working of the program. On the top of the screen you can see the Width and Height parameters: they respectively set out the total width and height of the piece you want to work (in a machine with a loading conveyor belt system, these parameters are blacked out, because the dimensions are automatically calculated by the scanner). Pressing the button 2 ADD ROW, you can start programming the working through the parameters, divided into columns that can be modified under pressure. In sequence:
   - N: Sequential number, followed by the program execution.
   - E/S: By pressing it, you can select the specific working required, while a small reference image is available at the bottom.



- Z|A|B: Position of the Z|A|B axes during the working.




- Step: [SURFACES ONLY] Step performed by the working between two passes, while the surfaces are worked (S9, S10, S11, S12).



- Right/Left: You can increase the travel of the axis beyond the dimensions set in the program, in the working of both edges and surfaces. Below, an image shows the effect of the parameter.

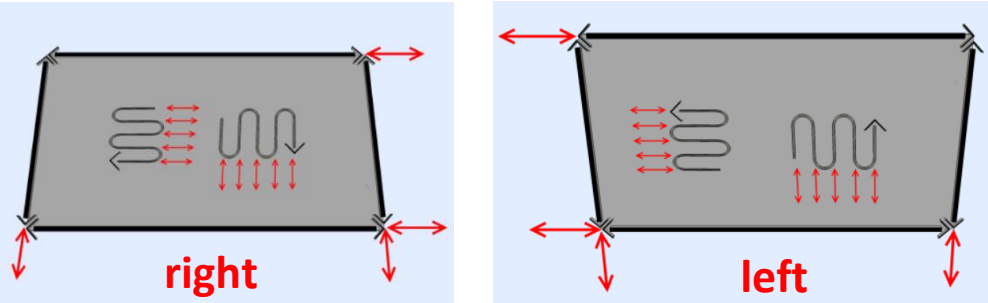
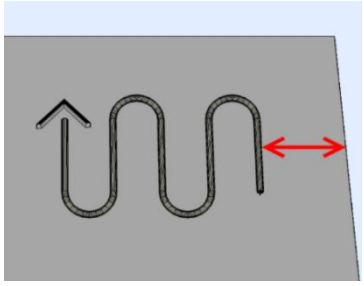
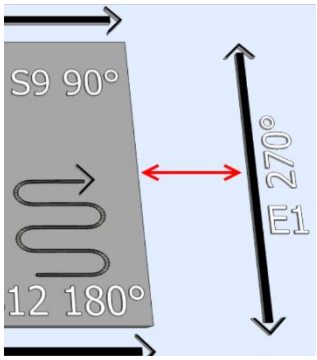


Fig. 10

- Offset: [SURFACES ONLY] allows the working of Surfaces to move the starting position added to this parameter: you can adjust the starting position.



- Edge: [EDGES ONLY] Distance from the selected edge to the execution point of the work.




- Rep: [EDGES ONLY] allows the Edge working to be repeated as many times as the number of this parameter.
- Guns: Allows to choose the guns to be used for the working.
- Open/Close: modifies the enablement or disablement function of the guns. See the image below:

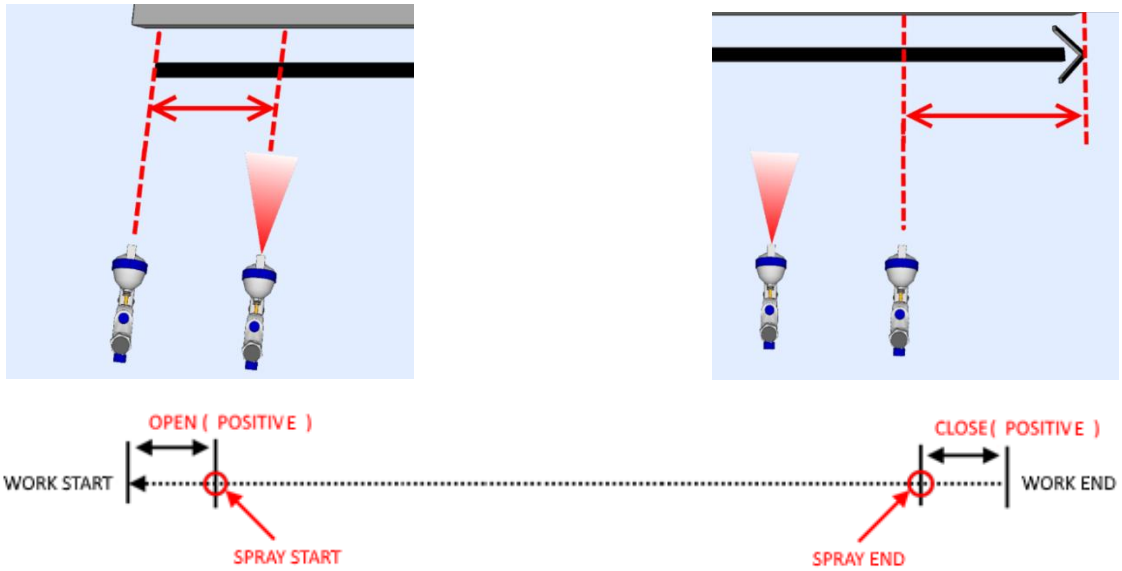



Fig. 11

- Speed: movement speed of the axes during working.

- Delay: delay between a working line and the following one.

2. ADD ROW: adds a row in the program

3. COPY ROW: copies the selected row and adds it to the end of the program.

4. DELETE ROW: deletes the selected row.

5. UP\DOWN: scrolls the selection up or down.

6. FRONT\BACK: In rotary loading machines you can program the working required on both faces of a piece, simply by pressing here the side required. During the execution, the machine automatically rotates a piece after the execution of the first face.

Once the program has been set out, to make the program available to be added to the execution list (Fig.3), press SAVE (Fig. 1, 1.2) or, as an alternative, SAVE AS (Fig.1, 1.3).

## Parameters

The above-mentioned tab can be displayed only by entering a PASSWORD (Fig. 1, 3.2). Here you can modify the various offsets and the unique parameters for each machine. **WARNING!** Only the manufacturer, who holds the password, can edit these *Editing* parameters. An incorrect value can result in malfunction of the machine and make it unusable. The section of parameters has been divided into three pages, all the parameters are described in the following list:

Fig. 12

Page 1:

- X,Y,Z Corrector: Position of the axes at the beginning of the working. For scanner machine type, X axis must be configured with reference to the "Conveyor to X Corrector " parameter.

- X,Y,Z Spare (1, 2, 3): maximum three pieces can be loaded on the bench, this offset refers to the top left position of the three single pieces.
- X Gun ofs (1, 2, 3, 4):
- Y Gun ofs (1, 2, 3, 4):

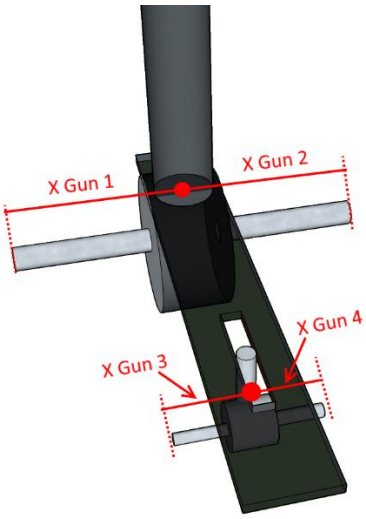



Fig.13

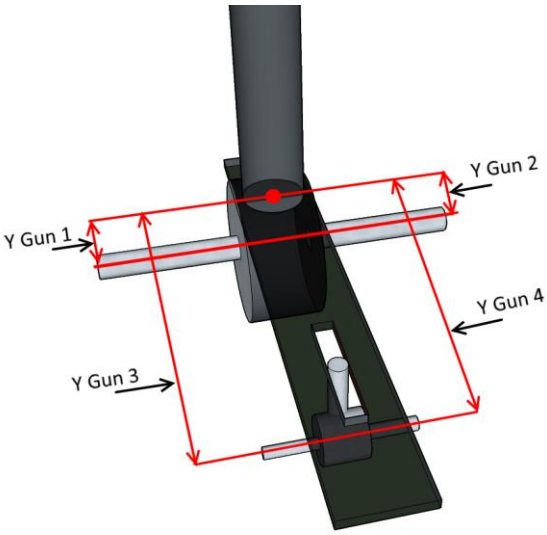



Fig. 14

Page 2:

- Gun Cleaning X,Y,Z,A,B: positions of the axes during the cleaning process of the guns. See GUN CLEANING (Fig.5, 3).
- Wash X,Y,Z,A,B: positions of the axes during the washing process of the guns. See WASH SYSTEM (Fig.5, 3).
- X,Y,Z Nozzle: position of the axes for a visual control of the guns. See NOZZLE REPLACEMENT (Fig.5, 3).
- Y Ref Beam: [scanner painting machine only] position of the Y axis aligned to the first ray of the scanner.
- Conveyor to X Corrector: [scanner painting machine only] movement that the conveyor belt must take on to carry the piece to the position defined in the X Corrector parameter.
- Multi Work: [scanner painting machine only] X distance within which the machine is allowed to work pieces without a loading procedure.
- Nr. Obstr. Beams: [scanner painting machine only] number of the scanner obstructed beams. This value must be close to zero to ensure that this measure is the most effective one.

Page 3:

- X,Y,Z,A,B Pos. (Neg.) Limit: positive (negative) limit of the axes.
- X,Y,Z,A,B Zero Quote: quote assigned to the axes at the end of the setpoint.
- X,Y,Z,A,B Setp End: quote to which the axes move after the setpoint is executed.

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## Options

You can reach the page of the options only after entering the PASSWORD (Fig.1, 3.2), by pressing the button representing the LOGO of the constructor in bottom left of the screen page. **WARNING!** Only the manufacturer, who has the password, can edit these parameters. Editing an incorrect value can result in malfunction of the machine and make it unusable.

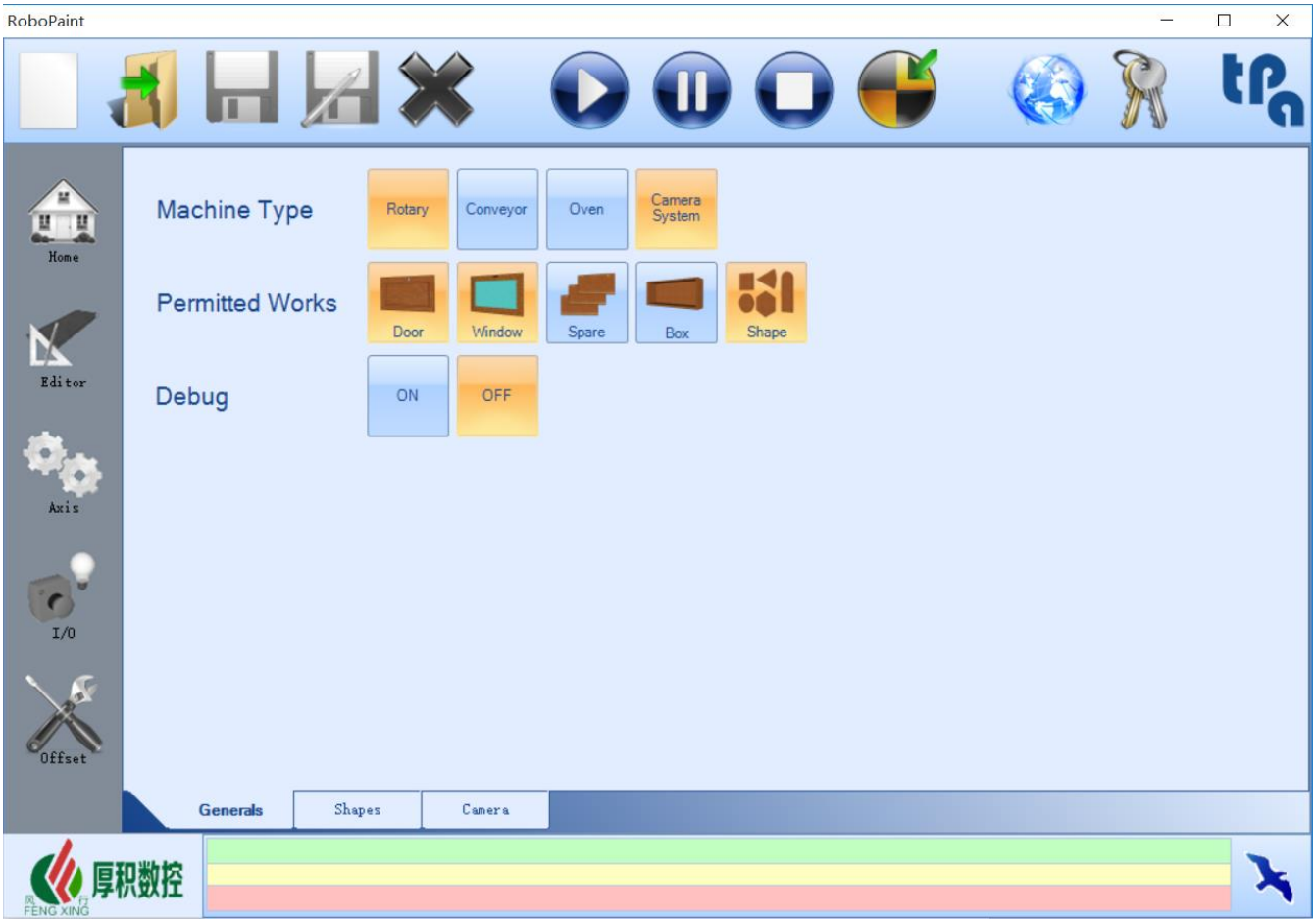


Fig. 15

GENERALS (pg.1): the general settings of the machine can be set in this page. In order:

- Machine Type: the user can select the type of machine from those managed by the software (rotary table, conveyor belt, oven, rotary table camera system machine).
- Permitted Works: allows the user to choose which kind of working can be selected in PROGRAM TYPES (Fig.4).
- Debug: if the machine is equipped with the scanner of the piece, the 2_DEBUG IMAGES are displayed.

SHAPES (pg.2): the following description of the parameters refers to the numbers in Fig.16:

1. Shape angles management: this panel allows the user to set how the machine will move during edge execution in proximity to the profile angles.

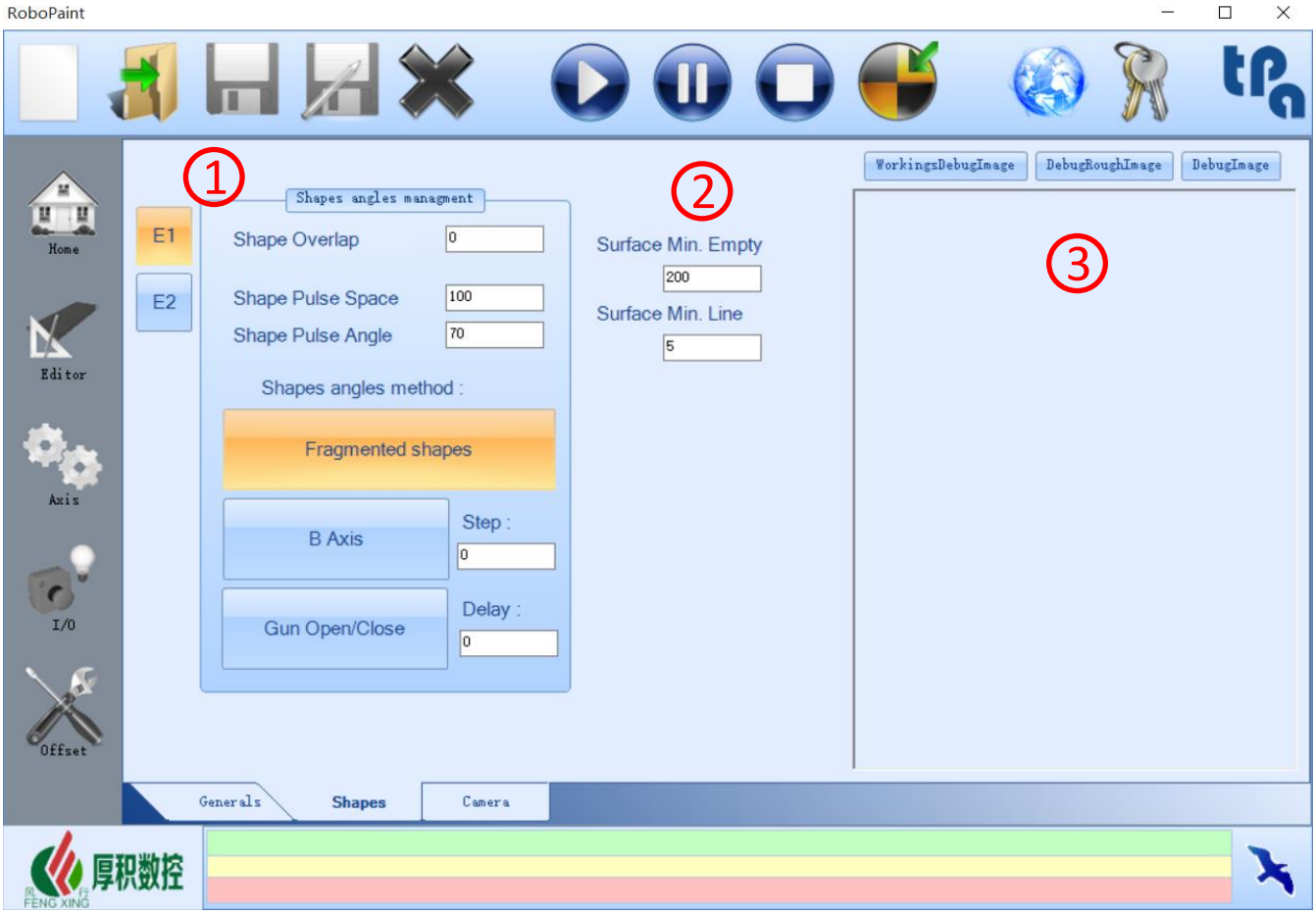


Fig. 16

- E1/E2: by selecting the button E1 or E2, the parameters inside the panel will affect respectively only the external and internal edge painting.
- Shape Overlap: in "Shape" type workings, specifies how much the final point will be moved after the starting point, overlapping the profile onto the final point. It is expressed in millimeters.
- Shape Pulse Space: in the angle management process, it is the length [mm] of profile that the software will consider for the search of the angles.
- Shape Pulse Angle: when the angle is bigger than the value set by the user, the software applies the selected "shape angles method" from the three ones available in the panel.
- Shape angles method: the user can choose how the machine is going to execute the angle of the piece profile. These methods are intended to reduce the excess of paint that is sprayed in the angles, due to the reduction of the machine speed.
  "Fragmented shape": the profile is divided into segments defined in "Shape Pulse space"; when the angle is wider than the one set by the user in "Shape pulse angle", the painting of the profile will be splitted. The machine doesn't follow the movement of the profile, rotating in proximity to the angles, but will paints the edges connecting the angles.
  "B Axis": during the execution of the angle, the machine moves the B axis of the angle "step" set by the user.
  "Gun Open/Close": this method consists in executing the painting on the angle while opening/closing the gun, to reduce the quantity of the paint. The opening/closing time of the gun is set in the "delay" field.

2. SURFACES EXCLUSION: These parameters describe the minimum portion of piece to be painted. More specifically:
   - "Surface min. empty space": while executing a surface, the software will ignore all the holes or portions of empty space in the piece if their dimension [in mm] is smaller than the value set by the user. For higher values the gun will close the empty space during the execution.
   - "Surface min. line": when executing a surface, the software will ignore portion of piece with dimension smaller than the length [in mm] specified by the user.
3. DEBUG IMAGES: divided into 3 categories, allows the user to view how the shape of the previously scanned shapes program has been interpreted.
   - "WorkingsDebugImage": the area of the piece is green, and the optimized profile is blue.
   - "DebugRoughImage": the area of the piece is green.
   - "DebugImage": the actual workings are plotted.

CAMERA: the following description of the parameters refers to the numbers in Fig.17:

1. FLOOD FILL PARAMETERS: these parameters apply to the FLOOD FILL function described in the next chapter. The panel consists of wo parts, Station A and Station B, each one for a loading station of the machine. The user can specify the dimensions of the grid used by the FLOOD FILL function to process the picture.
   - Shadow management: this function is meant to avoid errors in the process of the photographs due to

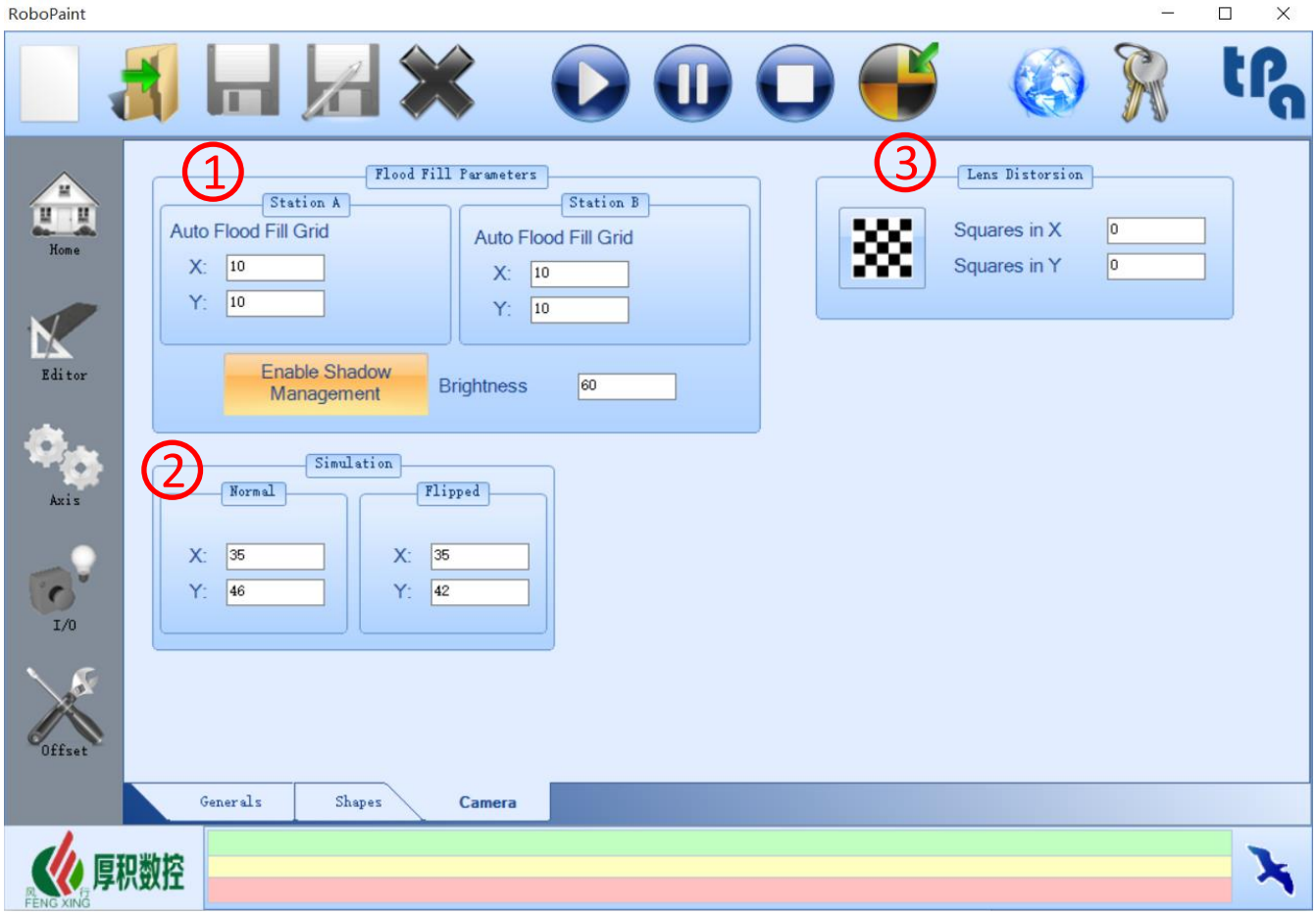


Fig. 17

some unwanted shadows in the picture. The BEFORE picture is modified by changing its brightness of the value set by the user, so that it is easier to recognize the shadows, which are eventually present in the picture and create a more precise profile.

2. SIMULATION: the panel is divided into "normal" and "flipped", as to correct the different position during the rotation of the piece on its axis. The coordinates represent the starting point of the simulation (see next chapter) in the simulation window.
3. LENS DISTORTION: this panel is reserved to the calibration of the camera during the first installation of the rotary camera machine.

## Camera system

When camera system is enabled, the software home page appears as in the figure below:

Fig. 18

The basic home page is still available and can be switched to by pressing the home button on the top left for three seconds.

Compared to the standard version of the software, new commands and parameters have been added to manage the camera system. In sequence:

1. BEFORE/AFTER: these two buttons allow the user to take the picture of the piece loaded on the machine. In detail:
   - BEFORE button should be used to take a picture of the machine unloaded. Basically, the picture should contain only the green tissue on the ground above the loading area;
   - AFTER button is used to take the picture of the piece to be painted. The software will compare this picture with the BEFORE picture to calculate the profile of the piece loaded. To obtain a good result the light and the tissue on the ground should not be different from the previous picture.

2. RESOLUTION / DELTA PIXEL: these two parameters are important for the elaboration of the photo from the software.
   - RESOLUTION [mm/pixel]: the distance of the camera from the loaded piece on the machine is related to the dimension (in pixel) of the piece in the photo. After measuring the real dimension of the piece (mm), for example the length of a door loaded on the machine, the user will compare this value with the number of pixels in the picture corresponding to that length, thus obtaining a mm/pixel ratio. This value is used by the software to calculate the dimension of the profile to be painted inside the machine.
   - DELTA PIXEL: this parameter is the reduction of pixels from image to profile execution.
3. COMPARE: this panel contains three RGB values. After taking the BEFORE and AFTER photos, the software calculates the profile of the piece according to these values, comparing each pixel of the two photos with each other. If the difference of one of the RGB values is bigger than the value previously set by the user, the pixel is considered to represent the piece loaded on the machine, otherwise it will be considered as the background of the photo.
   With a green tissue as background of the picture, the green value in the box should be higher, around 100 or more, depending on the background color and light.
4. FLOOD FILL: after the operation described in point 3, the profile of the piece calculated by the software can be irregular. This function can enhance the precision of the comparison resulting from the analysis of the pixels around a "piece" pixel: if the difference in RGB value is smaller than the one set by the user, the surrounding pixels will be considered as part of the piece as well. The grid used to compare surrounding pixels can be set from the option page as shown in Fig.17.
   Inside the FLOOD FILL panel there are four buttons:
   - "Disabled": if it is selected, the FLOOD FILL function will not be executed,
   - "Automatic": FLOOD FILL function will be automatically executed.
   - "Manual": allows the user to select, by pressing the "Take positions" button, where to execute the FLOOD FILL function. While the "Take positions" button is activated (orange), the user can add points to the picture. To erase all the points, press the "Take positions" button for 3 seconds.
5. ORIGIN POINT: looking at the picture, Y coordinate should be set on the rotation axis of the piece, X coordinate on the side opposed to the axes origin inside the machine. The software uses this point to start calculating the profile of the piece, adding the OFFSET values set in the OFFSET page as in Fig.12.
6. TOP LEFT / BOTTOM RIGHT POINT: the two points show the rectangle in the picture that the software will analyze during the comparing operation described in point 3. Everything out of the rectangle is ignored and will not be processed.
7. SAVE / LOAD: allows the user to save or load a saved set of camera parameters.
8. The home page top bar allows the user to choose what to visualize in the central panel:
   - "Photo Before": shows the picture taken by pressing the BEFORE button (point 1).
   - "Photo After": shows the picture taken by pressing the AFTER button (point 2).
   - "Photo Compared": shows the result of the comparison between the two pictures. The piece to be painted appears on a green background.

- "Simulation": shows the real time movement of the X Y axes of the machine over the piece during the painting process. Simulation parameters can be changed in the camera option page as in Fig.17.
- "Save Photo Program": this button, the last one on the right, is used to save photo type programs. The saved file includes the picture and the painting program designed by the user.

## Camera installation

In the rotary camera machine to ensure the good quality of the photos and, consequently, a good elaboration by the software, the installation of the camera must comply with the following requirements:

- Position of the camera: the camera is already calibrated (correction of lens distortion, etc.), so it is important to install it in the same position as the one used for the calibration. The camera must be centered on the load jig middle point as shown in Fig.19, at around 188 cm from the panel surface. Be sure that the camera is perpendicular to the ground and that its orientation is like shown in the picture below.
- Lights: lighting is provided by two lines of white LED, mounted on the structure over the loading position.

- Green surface: the green surface on the ground is important to create a background that clearly contrasts with the loaded piece, so to obtain a good profile of the piece after the elaboration of the photos.
  Good results are obtained with the color as shown in the figure below (RGB 0,255,0).

Fig. 19

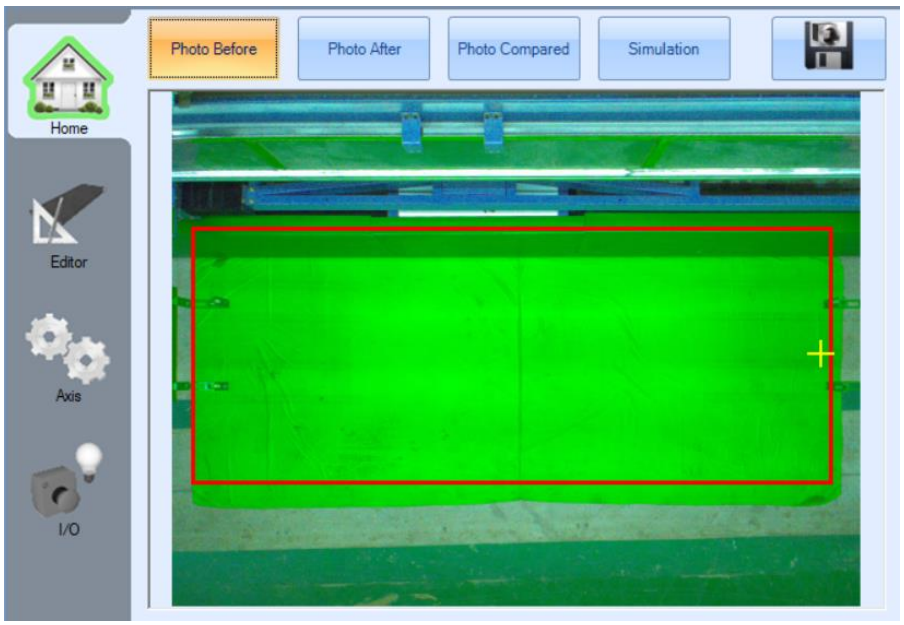


Fig. 20

The photo obtained from the camera must be like the one in Fig.20. In the figure the machine seems arranged horizontally and the structure of the loading jig is aligned on a vertical line on the right (the left part can be moved by the operator). The light is uniform, and no shadows are cast on the green surface on the ground.