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THEORETICAL AND DIMENSIONAL CONSIDERATIONS ON THE REALIZATION OF A LASER-BEAM ENGRAVING DEVICE FROM RECYCLABLE MATERIALS OPERATED BY BELT TRANSMISSION

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ABSTRACT: The creation of a functional model for the processing of materials from recyclable materials is a modern challenge even for industrial industry. At present they are made traditionally from metallic materials and in some cases of recyclable materials as can be seen only at the level of fastening or assembling parts. As a consequence, the present work is intended to replace several items with a single element satisfying the condition imposed and at the same time allow the achievement of positioning or movement movements at the same level as that of machinery conventional but with much reduced costs.
KEYWORDS: 3D printing; fabrication parts; dimension parts, FDM printing;

1. INTRODUCTION

The work has emerged as a necessity to establish an experimental stand to demonstrate both the way in which the parts of such a stand can be made of recyclable and/or biodegradable materials, but at the same time to it is possible to determine the mode of operation and behaviour of component elements to mechanical and dynamic requests in the process of processing with unconventional processing technologies.

For the achievement of complex parts with a fitting or cinematic role, they were required to be in accordance with the first hypothesis by making additive processing [1]. Based on these assumptions it was chosen for the process of generation by the FDM method, and as materials can be chosen for reasons of mechanical resistance in order of their characteristics are nylon [2], PLA [3], PETG [4] and ABS [5] respectively [6, 8].

From a constructive point of view there are solutions that use recyclable components in the structure [7]. For guiding the movement most installations have secured the movement through two cylindrical rods arranged on the sides of the X axis and parallel to the Y-axis. On these bars, bushings the ball that ensures, by the movement of rotation and translation booth, Reducing friction forces and at the same time better energy efficiency on the translation. For positioning the guiding axis, a structure of 3D printed parts is used to ensure a more precise positioning of mechanical constructive elements but also to take over applications generated by much better advance systems than in the variants previously presented.

Designing a model for experimental testing is an important step in investigating a process or experimental model. Such concepts are generated by the qualitative or quantitative problems of the processing process, those related to the cost of processors or those due to the technological processes of their realization. 3D part generation technologies allow for complex and complete assemblies in the form of a single element.

2. PRESENTATION OF THE CONSTRUCTIVE SOLUTION

The most common constructive solutions are those that have the transmission type through synchronous belt, metric screw, trapezoidal screw or ball screw. The constructive solution chosen to be projected is the one at which the transmission is through the synchronous belt.

From a constructive point of view the experimental stand is carried out on a cartesian coordinate solution with a gears belt system. In the vertical direction Z can achieve the positioning movement. Moving the motion on the plane axis is carried out with step-by-step motors.

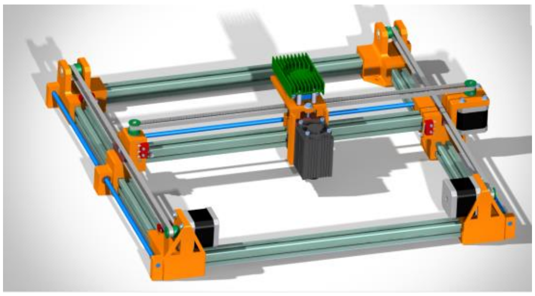

Figure 1. A constructive solution with a guiding profile of extruded aluminium and 3d print supports

The corner supports, the supports of the cross-bar and the laser stand are made by 3d printing which conduct, on the one hand, to the lowering of the manufacturing cost and on the other hand to the decrease in the weight of the mass to be moved [9, 10].

It can be seen in (Figure 1) for the realization of the structure a frame obtained from 20x20 mm extruded aluminium profiles was used. They were preferred because they have high rigidity and at the same time it is a low mass material, which It is an advantage because the misplaced weights are not high. There were chosen bars for the base frame with length of 400 mm. Following constructive design resulted in a cross-bar length of 416 mm.

Since we have a very good surface quality of these aluminium teachers we can make guidance on them by getting the advantage of a small friction because the coefficient of friction between plastic and aluminium is very small.

The fixing of the extruded aluminium bars at the base is done using four corner supports, on each corner being mounting and other elements such as step-by-step motors, or free synchronous belt wheel.

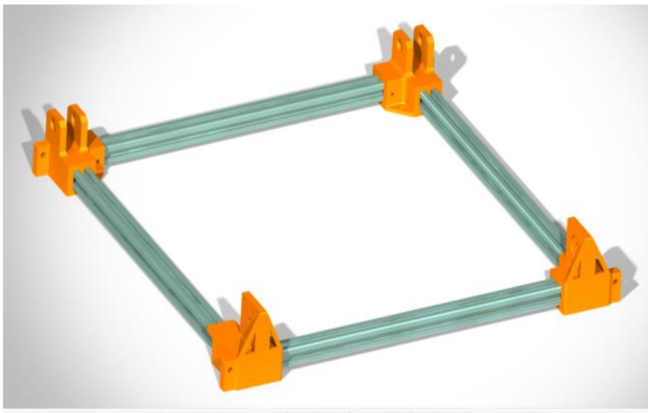

Figure 2. Fixing extruded bars

For position fixation use special elements generated with parts 3d printed type T nut.

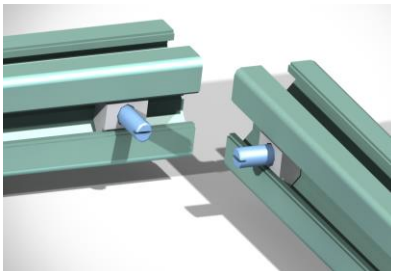

Figure 3. Fasteners for corner elements mounted on bars

The cross-bar is mounted in two supports that have two channels like those from the base frame channels (Figure 4).

The rotation movement is transmitted to the synchronous belt wheel (4) at the opposite end. By fixing a branch of the synchronous strap by means of a fastening plate (5) of the cross-bar holder (6) It is possible to see that the move of the bar on the y direction to the engine control step by step (Figure 5).

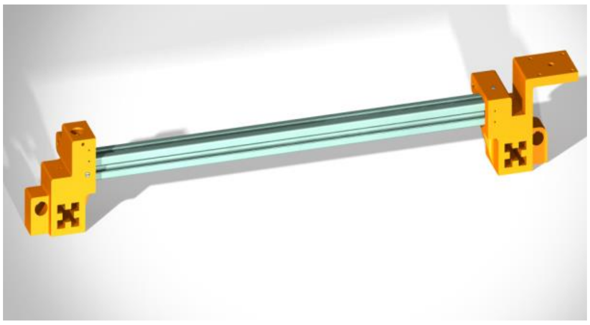

Figure 4. Transverse bar mounted in supports

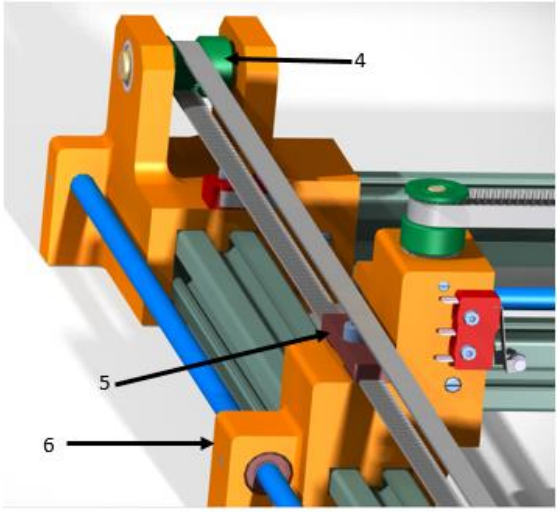

Figure 5. Positioning of the free belt wheel and fixing the extremities of the synchronous strap

Making movement by the X axis of the laser (1) is done by a synchronous belt system (2), the shifting command being performed by a step-by-step motor (3) positioned at the end of the cross-sectional bar with the rotor shaft parallel to direction Z (Figure 6.).

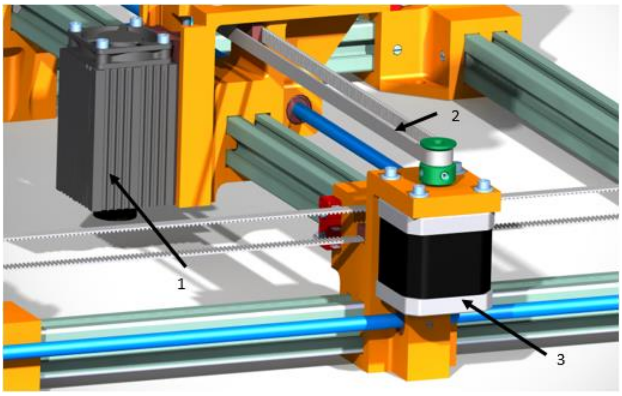

Figure 6. Laser moving on X

The movement is transmitted from the motor axis step by step (4) by means of the belt wheel (5) attached to the axis, which engage with the synchronous belt, to the free belt wheel (6) at the opposite end of the aluminum bar (Figure 7.).

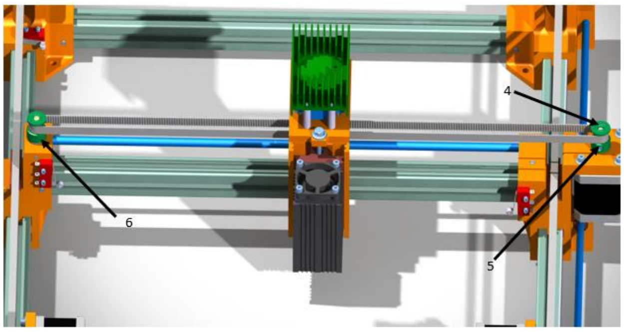

Figure 7. Components with which the rotation movement is made in transversal axis

The weight of the mass to be moved is quite small because we have the 3d printed plastic support that is easy, and the weight of the laser and the control plate is small, where it results that the entire table is supported by the aluminum extruded bar because it has a high rigidity, the cylindrical bar providing only better guidance and eliminating the possibility of rotating the bracket after the x-axis.

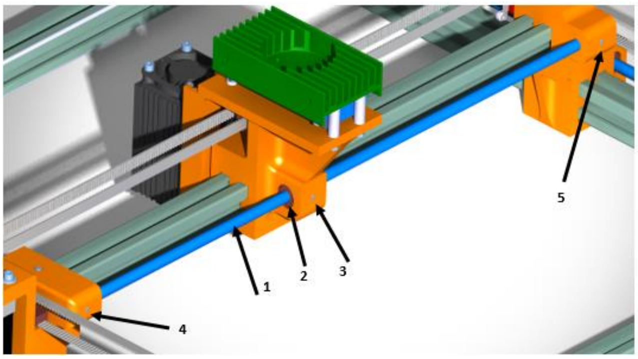

Figure 8. Positioning of the cylindrical bar and balls bushing

Moving on the z direction of the laser (1), for focusing on the surface, is done with a mechanical element. Acting Screw (2) We can adjust the laser to the desired focus position. To adjust the automatic focusing distance you can mount a step-by-step motor that will perform the laser translation movements on this direction (Figure 9).

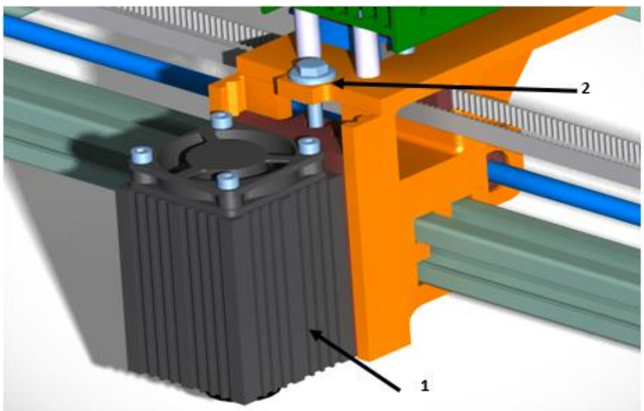

Figure 9. Orifice for alimentation of the orifices for mixing chamber core made form plastic [3]

3. 3D GENERATED AND TECHNOLOGY OF GENERATION OF THE PARTS

As can be seen from the constructive solution chosen we have the following parts which are recommended to be made from recyclable materials which for the case presented was chosen PLA given the mechanical strength of the compression which is close to that of aluminum material. A printer was used to achieve these parts which was specially equipped with additional elements of type TEVO TARANTULA (Figure 10).

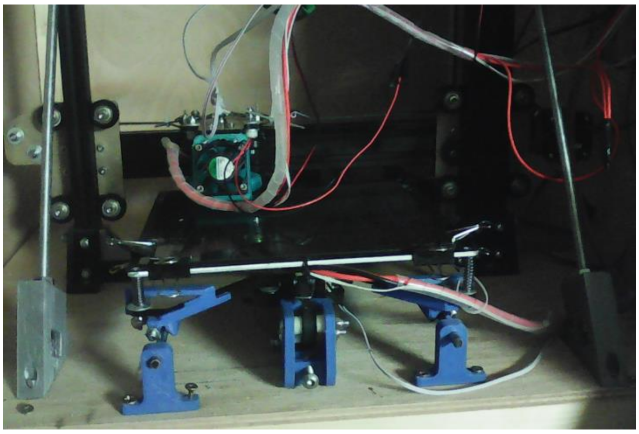

Figure 10. Tevo Tarantula printer modified

The components obtained through this technological process are:

- Left and right support of the roll fixed,
- Left and right support of the stepper motor,
- Fixing support motor element that work after the y-axis,
- Fixing element for roll of synchronous belt after y axis,
- Fixing and moving laser head after Z axis,
- Sleigh head laser after Z axis.

The left bracket for free roll fixed is shown in the two situations after 3d printing, observing the specific elements of support of orifice structures that do not encounter other structures in the plane parallel to the print surface and the part after the removal of their supports and its installation with the aluminum extruded bar that they come into contact (Figure 11.). The same structure has the right support which is why we will not represent it anymore.

The printing parameters [11] are:

- Material: PLA Standard (color: brown);
- Material density: 1.25 [g]/[cm];
- Wire length: 130841 [mm];

- Number of layers: 335;
- Total lines: 21150;
- Wire Diameter: 1.75 [mm];
- First layer thickness deposed: 0.1 [mm];
- Thickness of the layer deposed: 0.2 [mm];
- Material density of the workpiece: 25%;
- Type of line form: infill linear (form of layer interlaced at 45 degrees);
- Type of the support generation: Linear;
- Weight with support generation automatic: 66 grams;
- Weight without support generation automatic: 62 grams;
- Print Speed: 50 [mm]/[s];
- Perimeter printing speed: 40 [mm]/[s];

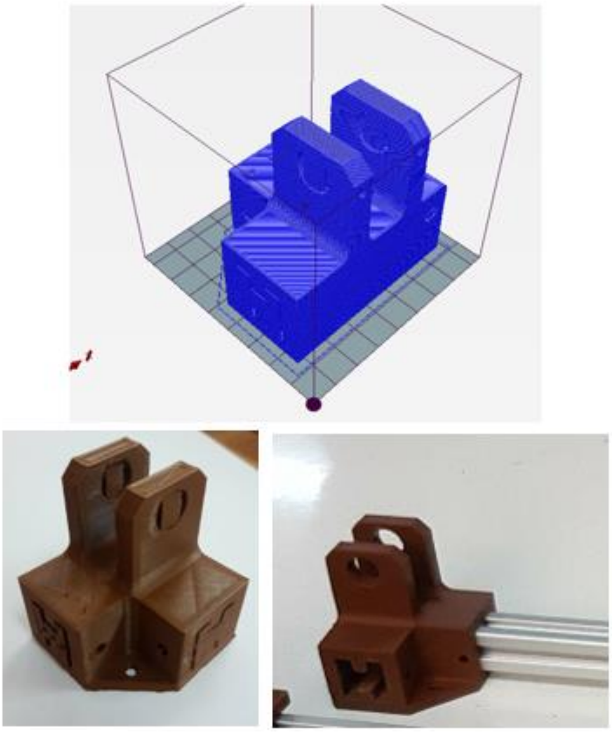

Figure 11. Left support

The left-by-step motor mounting bracket is shown in the two situations after 3d printing (Figure 12.), observing the specific elements of support of orifice structures that do not encounter other structures in the plane parallel to the print surface and the mark after the removal of their supports and its installation with the extruded aluminium bar that they encounter this. Also, to better observe how the structure is generated at the top, the rigid layer of material has not been created. The purpose is purely didactic, it normally generates such a layer.

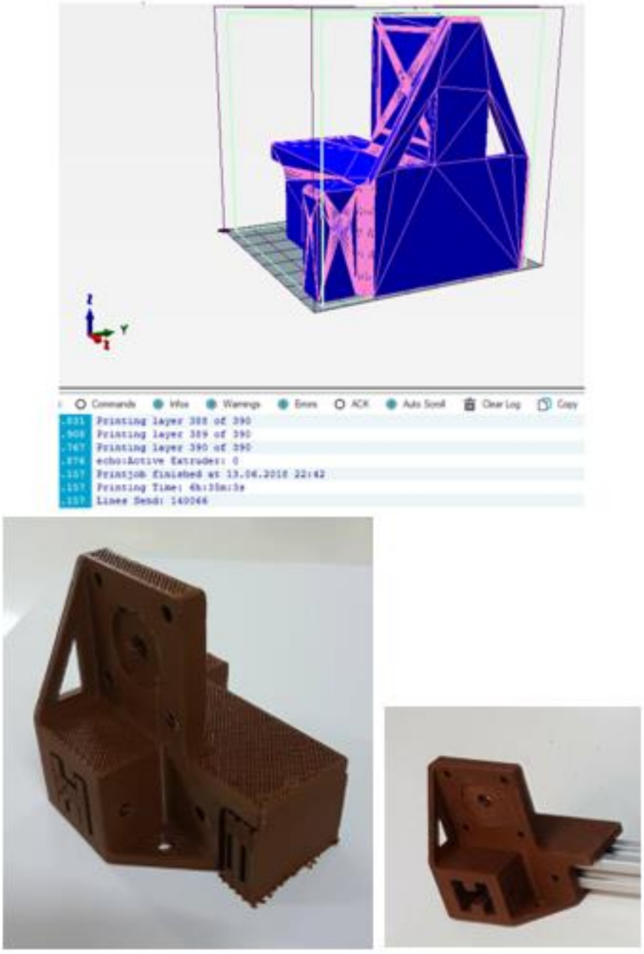

Figure 12. Left bracket for step-by-step motor

The important print parameters are:

- Wire length: 22706 [mm];
- Number of layers: 390;
- Total lines: 143012;
- Weight without pegs: 62 grams;
- Estimated print time: 3 hours and 55 minutes;
- Actual print time: 6 hours and 35 minutes

The first important element for the construction of the structure it is the structure which the clamping of the synchronous belt X and it slides. This element it is shown in the three situations. First it is the positioning of the element on the printing bed of the 3D printer. The second is after the 3d printing, observing the specific elements of the support of orifice structures that it is not into contact with other structures in the plane parallel to the surface and the last it is after the removal of their supports and its installation with the aluminium extruded bar which they come into contact (Figure 13.). Also, to better notice how to generate the structure at the bottom with woven fabric adhesion layer.

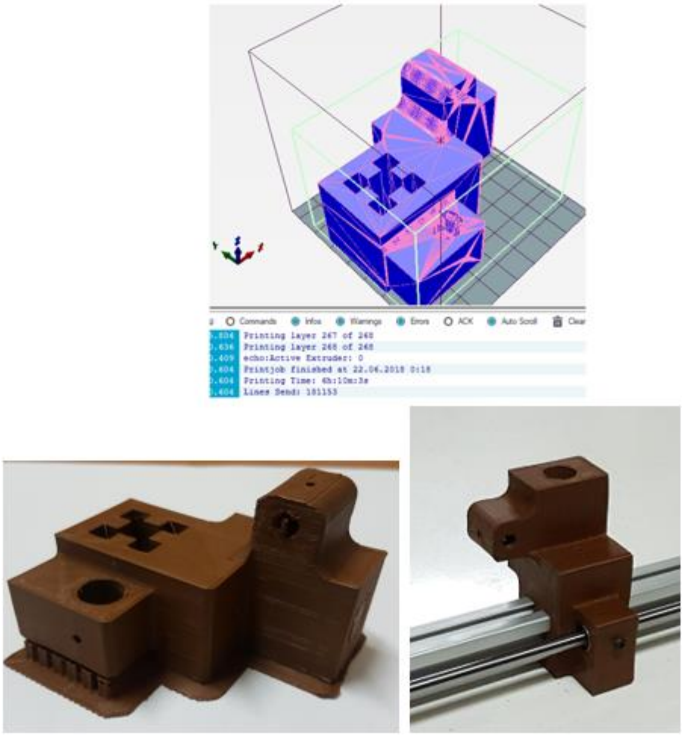

Figure 13. Item that it sliced from aluminium profile the clamping of synchronous strap X

The important printing parameters are:

- Number of layers generated 268;
- Wire length: 19,451 [mm];
- Total number of lines 182658;
- Material density of the workpiece: 35%;
- Weight without pegs: 66 [grams];
- Estimated print time: 3 hours and 58 minutes;
- Actual print time: 6 hours and 10 minutes.

The structure for the X-axis mounted is presented in (Figure 14) observing the good positioning of the elements and a smooth and precise movement of the central element in relation to the lateral fastening pegs.

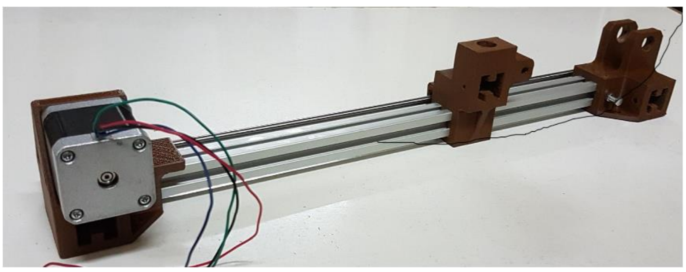

Figure 14. The structure for the X-axis mounted

4. ELECTRONIC CONTROL SYSTEM

Due to the constructive solution for the installation command, an ARDUINO UNO control system with the shape of (Figure 15) will be used. The binding and command of the stepper motor shall be carried out with L298-shaped control interfaces (Figure 16) and ensure that the current is amplified from the microcontroller level to the level required for the engine control, which is maximum 2 A.

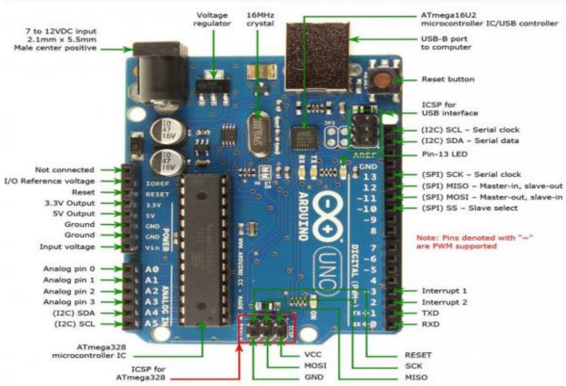

Figure 15. ARDUINO Uno motherboard [12]

Figure 16. L298 module for drive stepper motor [13]

The control system has been designed in this open loop variant that consists of engine control without checking whether the travel movement has been carried out. It should be noted that the engines after the X-axis are ordered in parallel, the same signal being transmitted simultaneously to both stepper motors. To better synchronize the motion after the X-axis can be provided to the capers of untrained belt synchronous wheels a rigid mechanical shaft that connects them.

The command program can be one which it is made by the students based on the step-by-step engine libraries, or one that is already made by type Pronterface (Figure 17.).

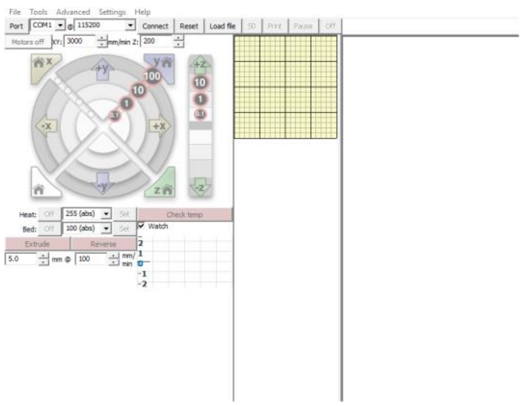

Figure 17. Pronterface interface [14]

As can be seen from the presentation of the program can perform the command of the stepper motors by the coordinate axes or based on commands entered line by line or by uploading the program generated previously and running the program through the interface command. This variant was chosen and because it is free and can be modified or adapted to the needs of the laboratory works.

5. CONCLUSION

In conclusion it is possible to seen that such a structure can be achieved with good results for a laser engraving installation for the laboratory working made with 3d printing components, with reduced manufacturing costs approx. 941 the cost of the components, with an accuracy of positioning one and with precise linear movements.

6. ACKNOWLEDGEMENTS

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