THE PROBLEMS OF INDUSTRIAL 3D ABS AND PLA PRINTERS IN CERMISO CENTER

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Abstract - Within the CERMISO INCDMTM Bucharest center, the study of drones requires, among other processing equipment, the use of a high-volume industrial plastic 3D printer. This is the reason why the center was equipped with a JCR 1000 Dual printer with a 1000 x 600 x 600 mm printing volume (insulated and heat-controlled), two printheads, closed enclosure and heat-controlled bed. In the period of about two years since the acquisition of this industrial equipment, we have performed tests, trials and research on this model of 3D printer, so we have reached a series of problems that can be solves for a more safe and precise operation. The problems and the related solutions found are presented in this paper.
There are 5 sensitive areas that affect working with this equipment:
a. Calibration of the printing bed in 49 points;
b. ABS and PLA wire aging too fast inside the equipment driving pipes;
c. Loss of reference during printing in case of the appearance of voltage spikes and transients;
d. Problems of total job loss due to power failure;
Given our rich experience with such printers, the paper will present a number of viable solutions to these problems. These proposals are made in such a way as to require a minimum of investment and effort.

Keywords: Printing 3D, ABS & PLA, Industrial printer, Printing 3D problems.

1. Introduction

Industrial 3D printers are a very special type of printer. They usually have advanced technologies, in addition to being considerably larger in size and costing thousands of euros. Industrial printers are designed for use in industry, to quickly and accurately print parts and assemblies. They can be used in sectors such as aeronautics, electronics and semiconductors, pharmaceuticals, vehicles, construction, aerospace, motor sports, etc.

We start from a practical study that we have encountered over time in the use of industrial 3D printer on ABS and PLA from SICNOVA 3D, namely the JCR 1000 Dual model, which has two printheads, closed enclosure and a 1000 x 600 x 600 mm printing volume. In a period of about two years since the acquisition of this industrial equipment, we have performed tests, trials and research on this 3D printer model, so we have reached a series of practical conclusions that we will present in this paper.

These problems we had working with this equipment are generated in 5 areas as follows:

a. Calibration of the printing bed in 49 points (a too complicated procedure);

b. ABS and PLA wire aging too fast inside the equipment driving pipes;

c. Problems of loss of reference during printing, in case of voltage spikes and transients;

d. Problems of total job loss due to power failure;

2. Calibration of Industrial 3D Printers

Problem 1

The calibration of the printing bed is one of the most important procedures in order to obtain high quality 3D printed parts. During this process, the distance between the tip of the extruder and the printing bed must be adjusted using a time-consuming procedure in all its 49 factory present points.

Calibration is done manually using the software in the configuration of the 3D printer. The calibration is made using a sheet of paper (its thickness being the "standard distance" between the tip of the extruder and the printing bed) on 49 points

symmetrical distributed over the entire surface of the printing bed.

Calibration is performed after heating the printing bed to 45 - 50^{0}C.

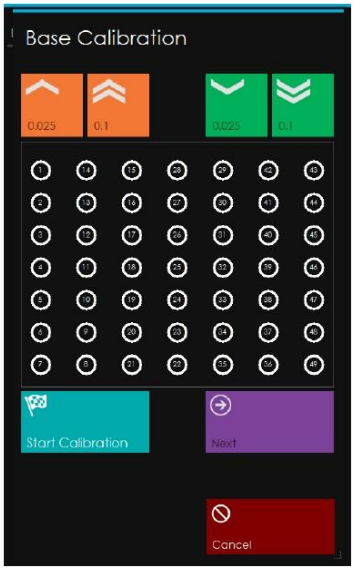

Figure 1 - Base Calibration - 49 print bed calibration points (operator interface)

This calibration requires the use of two operators, namely a person sitting on a ladder next to the machine (the bed is situated at 2 m hight from the ground) in order to be able to manually check with a sheet of paper the distance between the extruder and the printing bed. A second person sitting in front of the display, which controls how far away the printer bed is from the extruder and the transition to the next point to be calibrated.

Please note that the thickness of the sheet changes throughout this calibration due to the pressing of the nozzle as well as the impurities on the nozzle that can influence this standard sheet thickness. The person who is sitting on the ladder has to change the sheet of paper very often in order to obtain the best possible accuracy. This procedure is extremely time consuming.

Solution 1

Given the new advanced technologies, with the help of a clamping system attached in parallel with the extruder, a digital comparator with bluetooth connection can be used, and next to the 3D printer display can be attached a receiving system with a display (Raspberry pi, phone, tablet, etc.). These two devices can be connected together, so a single operator can easily perform the calibration the printing bed. The operator receives in real time the value of the distance between the extruder and the printing bed, being able to adjust the values in real time, so as to reach the optimal distance, with a very precise control, thus increasing the precision of the machine and decreasing the necessary time needed for this operation.

3. ABS and PLA Wire Aging Too Fast Inside the Equipment Driving Pipes

Problem 2

Given the length of the pipes (about 2m long from the wire roller to the extrusion head), a strange aging phenomenon appears so the ABS or PLA wire (1-2 days after the last printing) inside become crispy and cannot be removed using the equipment motors. No one explains and does not take a measure related to this aspect also valid in the case of the industrial printer we own, the SICNOVA JCR1000 Dual.

We have started from 3 important aspects:

- during the printing, the bed can reach a temperature of 45-50^{0}C;
- during the printing the two extruders can reach temperatures of 220 – 240^{0}C;
- all the time, the space enclosure is airtight and closed;

These three aspects mentioned above, lead to the degradation of the ABS or PLA plastic wire if it is on the pipe (inside the enclosure) for more than 1-2 days, due to the fact that the closed enclosure keeps the temperature released both by the extruder and especially of the large surface of the printing bed which is 1000 x 600 mm. So, the temperature is high inside the 3D printer even after a finished job (the inside temperature decreases slowly), and the plastic wire degrades very quickly if it is not removed in time, it breaks (become crispy) and can cause serious blockages, or even block the extruder motors which leads to costly damage, both money and time consuming.

To remove the pieces of plastic wire from the pipes, it is necessary to disconnect the pipe from both the roller starting motor and the extruder motor. Then is needed a strong - hard wire (plastic or metal) with a smaller diameter than the one of the driving pipe. This hard wire will be inserted at one end of the pipe and pushed manually to the other end of the pipe to remove the pieces of aged and broken wire.

Finally, we extract the hard wire that we used as a thread to unclog the pipe, so that the driving pipe is empty inside.

Solution 2

To avoid this rather unpleasant unclog procedure, it is necessary to remove the plastic wire from the pipes back on the rollers after each 3D printing, even if the printer is in Stand By mode or is turned Off.

4. Loss of Reference During Printing in Case of the Appearance of Voltage Spikes and Transients

Figure 2: A piece badly completed due to some voltage spikes and transients in the electric power supply

Problem 3

The ABS and PLA industrial 3D printer from SICNOVA JCR1000, is directly connected to the electrical network of the INCDMTM - Bucharest Institute. Unfortunately, voltage spikes and transients periodically appear during longer 3D print jobs, the machine tends to lose its reference, and the printer continues to deposit layer upon layer but in a different location than the one set according to the 3D drawing, resulting in parts similar to those presented in Figure 2.

After several studies and research, we came to the conclusion that this industrial 3D printer has no built-in electrical protection from the factory against these electrical problems. This important aspect leads to very large losses of material and time, especially during the 3D printing of very large parts, so we need to reprint the same job.

Solution 3

The equipment must be powered thru an original special filter designed and created in INCDMTM, the DF filter (approved in 1999). It's main purpose is to cut off the voltage spikes and transients witch unfortunately pass through normal UPS, internal Power Sources and finish into the mainboards of the equipment sometimes even destroying lot of electronic parts.

The DF filter is composed mainly from the following filter modules:

- L1; L2 coils winded on the same ferrite torus (TRAF 01) being identical as number of windings but opposite directions. The voltage spikes and transients (identical on phase and null) being in anti-phase inducing opposite currents into the torus and become almost zero.
- C001; C004 filters between Phase and Null
- C002; C003; C005; C006 filters between Phase and Ground and Null and Ground mounted before and after the main filter module L1; L2.
- A final module filter R004; R005; C008-C011 between Phase Out and Ground.
- The R001-R003; LED is a visual indicator for quickly determination of the polarization of the equipment when plugged (the equipment must be plugged in the outlet in the correct position i.e. the led is lit). If the LED is off, the plug must me inversed into the outlet. If in both positions of the plug the LED is on, then, for sure, the Ground is missing (in that case the equipment has a separate connector that will be wired with an external wire to another Ground existing in the building).

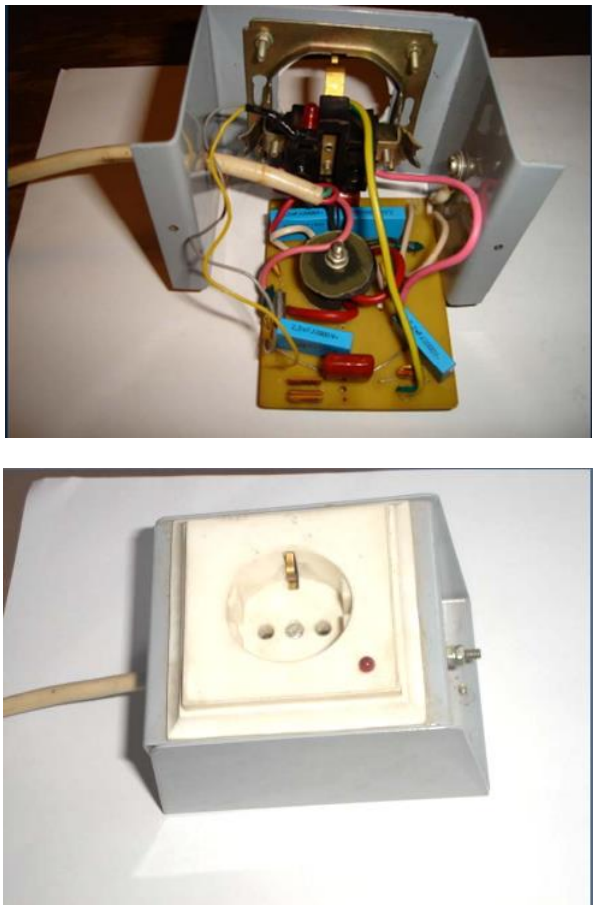

Figure 3: The DF filter

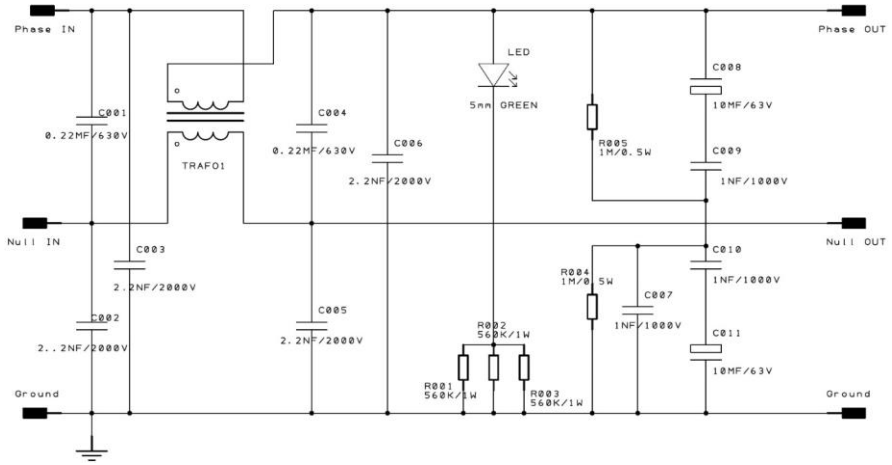

Figure 4: Electric diagram of DF filter

5. Total Job Loss due to Power Failure

Problem 4

When voltage drops occur for longer periods of time, due to the high weight of the printing bed, it falls slowly to the minimum control limit with a very high possibility of rotating it around the axis between the two electric motors. In most cases, the back of the printer bed is higher. Having no control or ability to observe this level difference in the surface of the printing bed, there is a very high possibility that when you start a new 3D printing job, to lose the equipment calibration ("the thickness of the sheet of paper") made in 49 points, and thus the nozzle hits and scratches the glass of the printing bed. These above effects can lead to very large damage to the printing bed by puncturing the glass and scratching it, as can be seen in Figure 5.

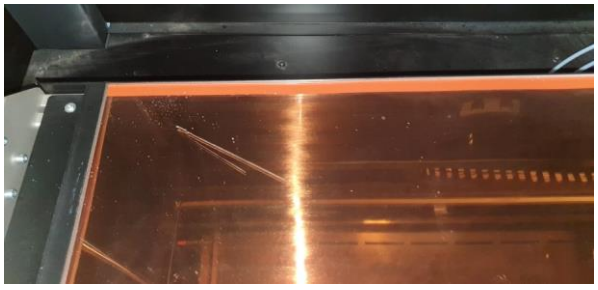

Figure 5: The extruder hits and scratches the print bed

Solution 4

In conclusion, for this problem related to power outages, the manufacturer states in the equipment file that there is an intelligent system for managing the power. This intelligent system is an advanced UPS that offers long life, to continue printing in normal parameters in case of a power failure. After a while, the system shuts down in a controlled manner, saving the printer parameters, announcing the incident, and the operator can then resume the print from where it left off.

The dedicated UPS is able to communicate directly with the printer but unfortunately it is very expensive.

We manage to solve this problem in order to use any intelligent UPS that can provide a power of 2000W. The UPS power both the JCR 1000 equipment and the command-and-control laptop. But this time the smart connection is made between laptop and UPS. And by default, all orders will be given this time from laptop to printer. This avoids the need to buy the original equipment that comes with the printer, which is extremely expensive.

6. Conclusions

INCDMTM specialists have identified a number of problems specific to high volume industrial 3D printers and have found solutions to fix them. Practice has demonstrated the viability and functionality of the proposed solutions. The only unfinished solution is Solution No. 1. Here we are still working on the interface between the Bluetooth digital comparator and the operator interface.

The complete solution of Solution No. 1, being a bit more laborious, will be presented in a future issue of the magazine.

References

[1] „Hod., Lipson (11 February 2013). Fabricated: the new world of 3D printing. Kurman, Melba. Indianapolis, Indiana. ISBN 978-1-118-35063-8. OCLC 806199735".
[2] „Model Repair Service". Modelrepair.azurewebsites.net.
[3] „How to repair a 3D scan for printing". Anamarva.com.
[4] „Model Repair Service". Modelrepair.azurewebsites.net.
[5] Tran, Jasper (2017). Reconstructionism, IP and 3D Printing (Thesis). SSRN 2842345