Development of a precise positioning system for RFID inductors used in the PalFi standard

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***Abstract*— In this work, a precise positioning system has been designed and implemented allowing to measure the RFID antennas (reader-tag couple) used by the RFID standard PalFi (Passive Low Frequency Interface).**

The effort of this Final Work of Master is focused on developing the minimum number of modifications, which allow to several instruments (signal and network analyzer, oscilloscope, ammeter, among others) to evaluate the features of a low frequency communication system, in particular the its dependency with the orientation and positioning.

The precise positioner was divided into three large blocks: the movement system, the software that controls it and the facilities mandatory wiring for the instruments.

The main work which is object of this documentation focuses on the set of parts that have been designed and manufactured, in order to adapt both the wiring and the instruments to the components that will be positioned with the 3D printer. These pieces have been designed with various computer-aided design (CAD) softwares to later manufacture them with the 3D printer used in this Final Work of Master.

First, a set of replicated parts has been developed that allow build a of chain guide as cable carriers both for feeding and for measuring probes. A guide rail is placed linearly along the vertical axis (Z axis) and the other goes along the transverse axis (X axis). A precise clamping system for the PalFi label is developed without the need for screws. The label holding system is located at the extrusion head. On the other hand, a dual clamping system has been developed for positioning the PalFi Reader (horizontal antenna and at 90º on the X axis), placed in the base of the 3D printer.

Throughout the development of this Final Work of Master a secondary objective has arisen derived of the PLA plastic fabrication, which consists on the vibration study of the structures to be integrated. Therefore, it is necessary to optimize each part of the design in terms of Robustness of the manufacturing.

Finally, the command interface between the 3D printer and the personal computer (G-Code language) have been studied to determine the set of commands necessary to manage the precise positioning.

I. INTRODUCTION

In this Final Master's Project (TFM), it is proposed to develop a precise positioning system for RFID inductors used in the PalFi [1] (Passive Low Frequency Interface) standard.

The PalFi communication standard is designed to transmit not only data, but energy from the reading unit (base of reading / writing, from the English term "reader") to the label (from the English term "tag"). Both the data transfer and energy are performed at low frequency (134.2 KHz). At this frequency, communications are made by magnetic field. Therefore, the antennas are basically inductors.

For practical purposes, this last feature (magnetic coupling) does not allow the use of traditional circuit simulators such as Hspice [2] or Specter [3] among others in normal (not ideal) conditions, being essential to use numerical analysis tools such as Ansys Maxwell [4] or similar.

It is well known that, compared to traditional simulators, numerical analysis tools require large computational resources and memory to solve the different differential equations and obtain a reduced and punctual set of design space solutions under real conditions.

In this Final Master Project, we propose to develop a 3D positioning system (robot), the infrastructure and the minimum software necessary to facilitate the execution of different tests and measurements with various instruments (signal and network analyzer, oscilloscope and ammeter, among others), in order to carry out the characterization of the components of both the reader and the PalFi label.

The developed positioning tool will be validated by checking the values obtained with the numerical simulation tools or the own data offered by the manufacturers in their data sheets.

II. STATE OF ART

A positioning system is a mechanical device whose mission is to locate parts or components in a certain position. In the case in question, this system is used as part of an accurate measuring instrument.

Next, the different systems of micro positioning and the technology that compose them will be listed [12] [13].

- Precision positioning of micropiezas for three-dimensional nanometrology.
- Piezoelectric positioning systems with parallel kinematics.
- Multiaxial positioners.
- Capacitance nanosensors (capacitive sensors).
- Rotating electric motors.
- Guide systems.
- Driver software.

III. TOOLS

In the realization of this Master's Thesis several tools have been used.
Below, each of them is listed and the use that has been given.

1º) FreeCAD: This is a computer-aided design program (Computer Aided Design, CAD), which has been used to design the parts that are part of the positioning system.

2º) Cure: It is the program of lamination and printing that has been used to generate the G-Code of the pieces that make up the positioning system.

3º) Printer: It has been used to print the pieces that have been designed in FreeCAD.

IV. IMPLEMENTATION

The objective of this project is to adapt a 3D printer to perform a function different from the function for which it was created. In this case, this printer will perform the same functions as a positioning system. That is, a 3D printer has been converted into a positioning system.

To achieve this goal, a series of pieces have been designed that have been coupled to the 3D printer. Once these pieces have been designed, they have been printed with the same printer. It has also carried out the study of numerous G codes, with the intention of being able to command the positioning system.

The G codes that have been used to control the positioning system are:

- M104 S25: Allows you to set the temperature at a low value, for example 25 ºC.

- G28: Self-tuning of origin of the printer. (it is located at the left front end of the printing bed).

- G0 X <Number> Y <Number> Z <Number>: Allows to move the head.

In figure 1 you can see some of the pieces that have been designed and manufactured to create the positioning system. In the two images above, you can see the set of pieces that have been designed with the objective of placing the Reader (formed by 3 sections, left image) and the label (formed by 2 sections, second image) of the PalFi system. The design of these pieces aims to allow the positioning of the Reader and its label. Because of this, the printing bed and the extruder of the 3D printer have been chosen as attachment points.

In the two lower images, in this figure 1, you can see the detail of the energy chains that have been designed to contain the Reader's wiring (formed by 35 pieces, left image) and the label (formed by 2 chains of 37 and 29 pieces respectively). The aim of these chains is to allow the proper functioning of the positioning system, ordering the wiring.

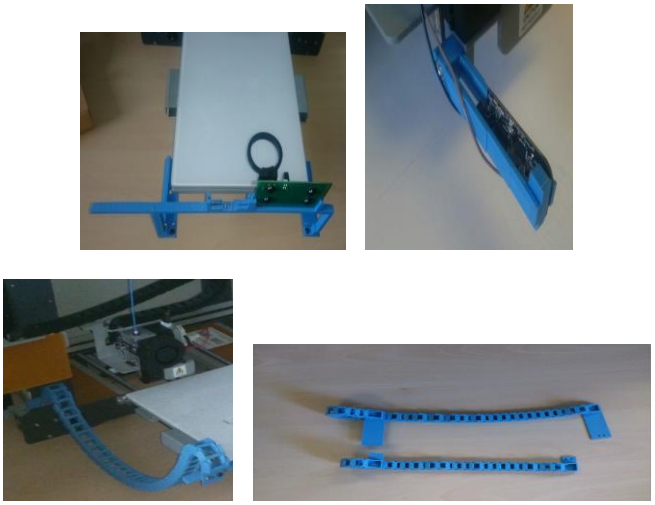

Figure 1. Parts of the positioning system.

Finally, Figure 2 illustrates the final assembly of the positioning system on the 3D printer.

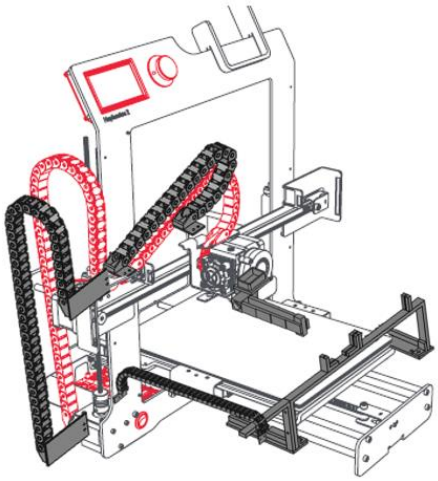

Figure 2. Assembly of the system.

V. CONCLUSIONS

- A 3D printer has been adapted to be able to function as a precise positioning system.
- A thorough study of the printer's infrastructure has been carried out, with the aim of making the positioning system work as efficiently as possible.
- The positioning system has been tested by entering the G-Code command via terminal.

REFERENCES

[1] "PaLFI, Passive Low Frequency Evaluation Kit TMS37157", http://www.ti.com/tool/EZ430-TMS37157, last accessed 08/12/2017

[2] "HSPICE, The Gold Standard for Accurate Circuit Simulation", Synopsys Inc, https://www.synopsys.com/content/dam/synopsys/verification/datasheets/hspice-ds.pdf, last accessed: 08/12/2017

[3] "Spectre. Circuit Simulator Accurate, fast SPICE-level simulation", https://www.cadence.com/content/cadence-www/global/en_US/home/tools/custom-ic-analog-rf-design/circuit-simulation/spectre-circuit-simulator.html, Cadence Design Systems, Inc., last accessed: 08/12/2017

[4] Ansys Maxwell, http://www.ansys.com/products/electronics/ansys-maxwell, last accessed: 08/12/2017

[5] "Hephestos 2", MUNDO READER, S.L. (BQ), https://www.bq.com/es/support/hephestos-2/support-sheet, last accessed: 08/12/2017

[6] http://www.thingiverse.com/, last accessed: 08/12/2017

[7] "Software de Desarrollo de Sistemas NI LabVIEW", National Instruments, http://www.ni.com/labview/esa/, last accessed 08/12/2017

[8] "FreeCAD: An open-source parametric 3D CAD modeler", https://www.freecadweb.org/, last accessed: 08/12/2017

[9] "Cura 3D Printing Slicing Software", Ultimaker B. V., https://ultimaker.com/en/products/cura-software, last accessed: 08/12/2017

[10] Izaro: Tecnologías: Metal: Posicionador de precisión de micropiezas, http://www.izaro.com/contenidos/ver.php?id=es&se=3&su=32&co=1302602048, last accessed: 08/12/2017

[11] PI – Solution for precision motion and positioning, https://www.physikinstrumente.com/en/, last accessed: 08/12/2017

[12] Manual de la impresora 3D Hephestos 2. - Canal del Área de Tecnología Educativa, http://www3.gobiernodecanarias.org/medusa/mediateca/ecoescuela/?attachment_id=4068, last accessed: 08/12/2017

[13] What is g-code? | Ultimaker: 3D Printers, https://ultimaker.com/en/resources/39071-what-is-g-code, last accessed: 08/12/2017

[14] LabVIEW - Wikipedia, la enciclopedia libre, https://es.wikipedia.org/wiki/LabVIEW, last accessed: 08/12/2017

[15] Crear G-Code con Cura para imprimir en 3D - polaridad.es, https://polaridad.es/gcode-cura-imprimir-3d/, last accessed: 08/12/2017

[16] RFID - Radio Frequency Identification and How it Works - RFID, Inc., http://rfidinc.com/rfid-101/, last accessed: 08/12/2017

[17] LF HDX System Parameter Calculation for TMS37157 (PaLFI), http://www.tij.co.jp/jp/lit/an/scba029/scba029.pdf, last accessed: 08/12/2017

[18] PaLFI Range Extender - TI E2E Community, file:///C:/Users/aulas/AppData/Local/Temp/PaLFI_Power_Reader_Rev3.pdf, last accessed: 08/12/2017