Project[1] Number: [637081]

Project Acronym: [MAShES]

Project title: [Multimodal spectrAl control of laSer processing with cognitivE abilities]

Periodic Technical Report

Publishable Summary

Period covered by the report: from [01/12/2014] to [30/05/2016]

Periodic report: 1st

[1] The term 'project' used in this template equates to an 'action' in certain other Horizon 2020 documentation

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1. Summary of the context and overall objectives of the project

The purpose of MAShES is to develop a system for RT-control and high speed monitoring that brings into play:

- Reliable monitoring of temperature distribution,
- The 3D seam profile and 2D melt pool geometry,
- The surface texture dynamics, and process speed

in a unified and compact embedded solution. MAShES control will act simultaneously on multiple process variables, including laser power and modulation, process speed, powder and gas flow, and spot size. MAShES will be designed under a modular approach, customizable for different laser processing applications. Scenarios of high added value and impact have been selected for demonstration (e.g. lase metal deposition and laser welding).

Overall, MAShES will develop a breakthrough compact multimodal imaging system for RT closed-loop control of laser processing. It will be built on a novel multispectral optics and multisensor arrangement in the VIS-MWIR spectrum. Temperature, geometry, and speed, will be imaged accurately and reliably. The system will feature embedded RT process control together with the capability of cognitive readjustment and process quality diagnosis. Therefore, MAShES addresses the development of a novel intelligent and self-adaptive system for continuous and autonomous process control.

The use of MAShES system will allow the harmonization of high performance and quality with cost effective productivity, enabling at process level, reconfigurable, adaptive, and evolving factories. End-users would be capable to deal with highly dynamic operations in a productive way.

2. Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

This first period of MAShES project has been devoted to the following main activities:

- A detailed specification of use cases was done in the beginning of the project, describing parts to manufacture, the parameters used in the process, and the most relevant defects that are usually found.
- Laboratory setups have been designed and assembled for process observation at different spectral bands. Different trials have been performed both on welding and LMD processing. Spectral bands were selected, based on results of temperature observation and estimation and a first round of trials on laser process monitoring.
- A ROS based architecture has been specified and developed as middleware to support a smooth integration of sensors and equipment. A first set of data and this software have been released for public access through Zenodo and GitHub.

- The optical system has been designed and is currently under manufacturing. A first approach to fine band filters in the MWIR has been also designed and is also under manufacturing.
- Electronics of MWIR sensors from NIT were redesigned to be integrated -together with the NIR sensor- in the embedded FPGA board in charge of real time embedded processing and control functions. The electronics of the multimodal spectral device was developed and a first version manufactured for implementation of software modules and for laboratory testing purposes.
- Dissemination of the project have been addressed from the beginning, elaborating materials and setting up a web site and specific project channels or groups in social and professional network platforms (i.e. Twitter, Youtube, LinkedIn, GitHub, Zenodo). Dissemination included scientific and industry oriented presentations in fairs, specialized conferences, and workshops.
- The business plan has been updated with further elaboration on sales prospects, based on market analysis performed by integrator companies in the consortium.

3. Progress beyond the state of the art and expected potential impact

A novel open source middleware based on ROS has been developed that aims to facilitate deployment and virtualisation of novel approaches to multimodal monitoring of laser processing by allowing a smooth integration of sensors and equipment in any laser robot cell.

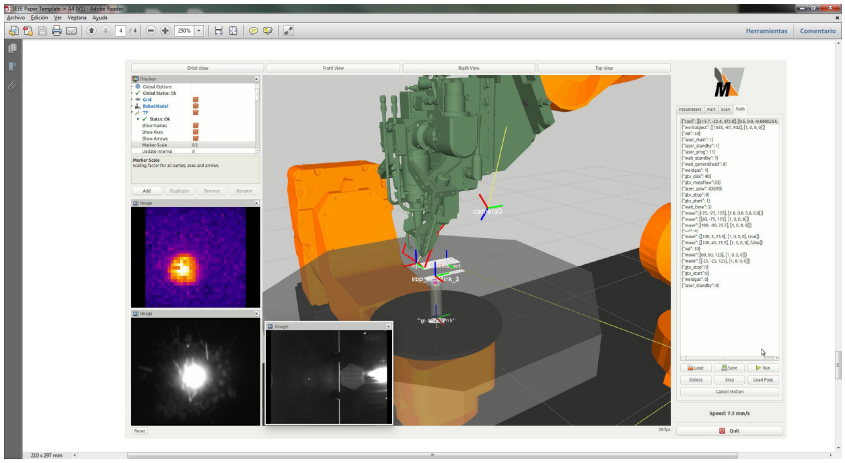

Figure 1 OpenLMD at work

A novel multisensor board has been developed capable to image melt pool at high speed in different spectral bands from visible to middle wavelength infrared (0.4-5 µm wavelenght). This board enables high speed spectral imaging of the melt pool for multimodal monitoring of laser processing.

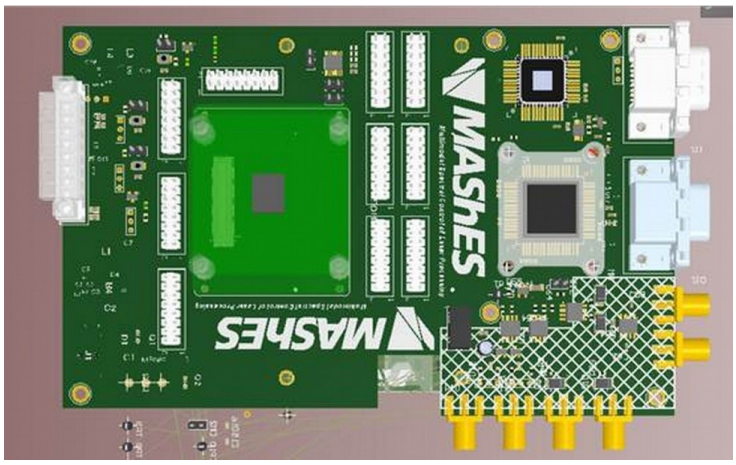

Figure 2 MAShES multisensor board

A novel optics has been designed for coaxial multispectral imaging of melt pool in laser processing applications that can be integrated in existing laser heads.

Overall, this first period of MAShES project has enabled -for the first time- coaxial multispectral imaging of laser processing in a wide spectral range covering from the visible to the MWIR.

3. Project website

www.mashesproject.eu