SUSTAINABLE PLACES 2025

3D Printing System for Façade Restoration

Overcoming low productivity and integrating BIM technologies

Juan Gabriel Secondo | Technical Managing team | Universitat Politècnica de València

Co-developers

VIAS ita CARTIF UNIVERSITAT POLITÈCNICA DE VALÈNCIA

UNIVERSITAT POLITÈCNICA DE VALÈNCIA IRP INSTITUTO DE RESTAURACIÓN DEL PATRIMONIO INSTITUTO UNIVERSITARIO DE INVESTIGACIÓN inperso

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Presentation Layout

- **Context and previous experiences**
  Work carried out until now
- **INPERSO research scope and actions**
  Research carried out within the Horizon EU Proje
- **Performed tests**
  Positioning system and extrusion tests
- **Conclusions**
  Main remarks and future Works plan

Context

Current situation and technology potential

- Construction faces a big **challenge in adopting new processes and technologies**
- **Industry 4.0 is crucial** for harnessing technologies that **help accelerate processes, improve quality, and increase** on-site **safety**
- Prefabrication already provides a high level of quality and control, but **on-site work can provide flexibility and adaptability.**
- Integrating digital manufacturing systems into construction can **merge industrial precision and speed, with the adaptability of traditional methods**

Traditional mortar application execution

Previous experiences

UPV House
2018

Parametric Desing test
2019

House 2.0
2021

Vertical printing experience

3DCONS

- Initial work led by Vías y Construcciones (ACS Group), it ran from 2015 to 2018 with partners like LafargeHolcim, Saint-Gobain, CYPE, among others, funded by CDTI and FEDER under the CIEN program in Spain

Vertical printing prototype

Horizon Europe. INPERSO Project

Main objectives

- INPERSO EU project (Industrialised and Personalised Renovation for Sustainable Societies) features a **comprehensive deep renovation program.**
- Consists of a **renovation model featuring digitalisation** and **new technologies** requiring TRL level-up.
- Focuses mainly on residential buildings with heritage value.
- Technologies are being installed in **three demonstration cases**, subject to a three-year monitoring for the pre, during, and post retrofit stages.

DC#1. Public rental housing, Spain

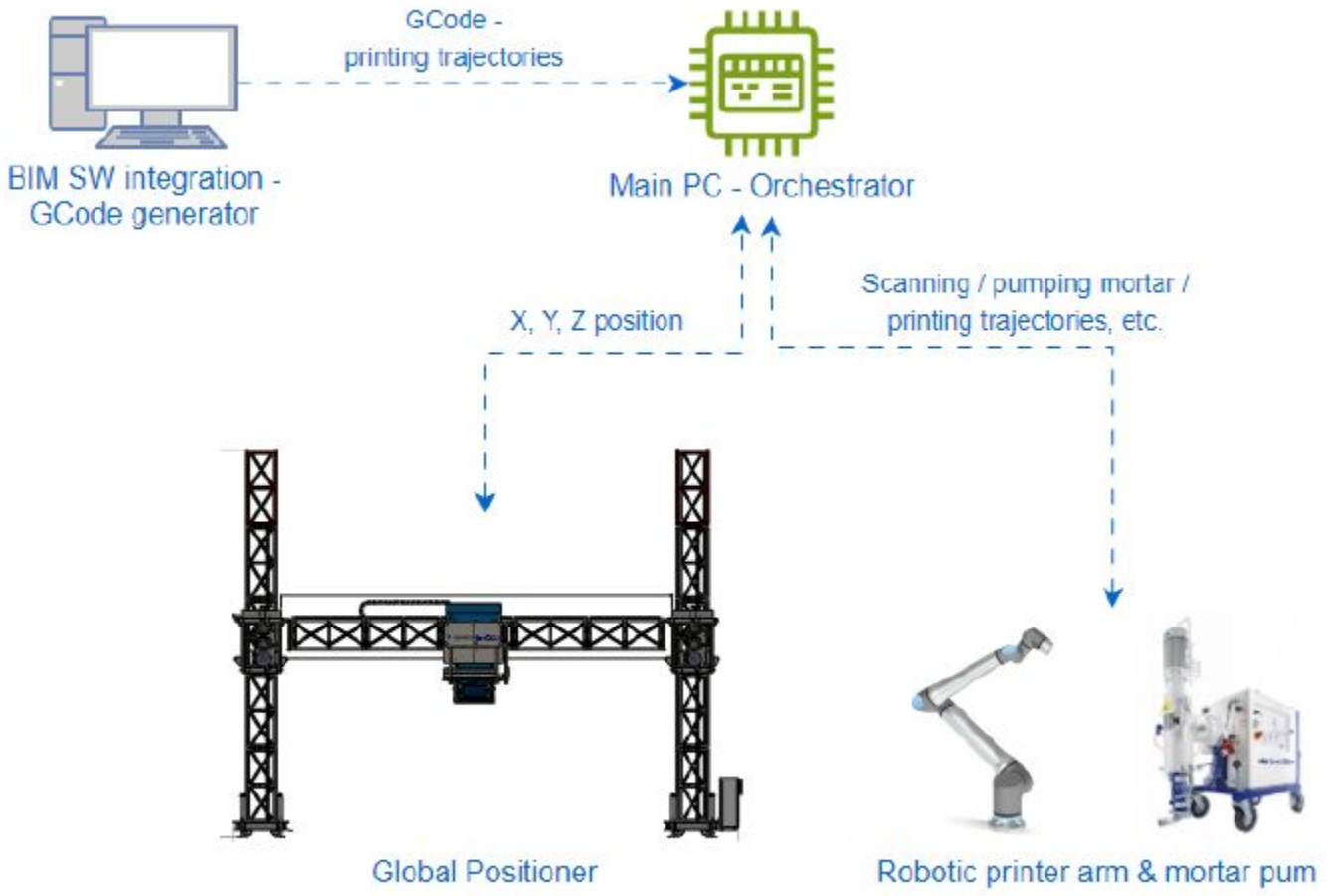
DC#2. Social shelter, The Netherlands

DC#3. Social shelter, Greece

3D printing objectives within INPERSO

Robotic, vertical façade 3D printer integration

- Define system requirements and conceptual design
- Develop and detail the prototype design
- Manufacture, test, and integrate subsystems
- Commission and validate the integrated system

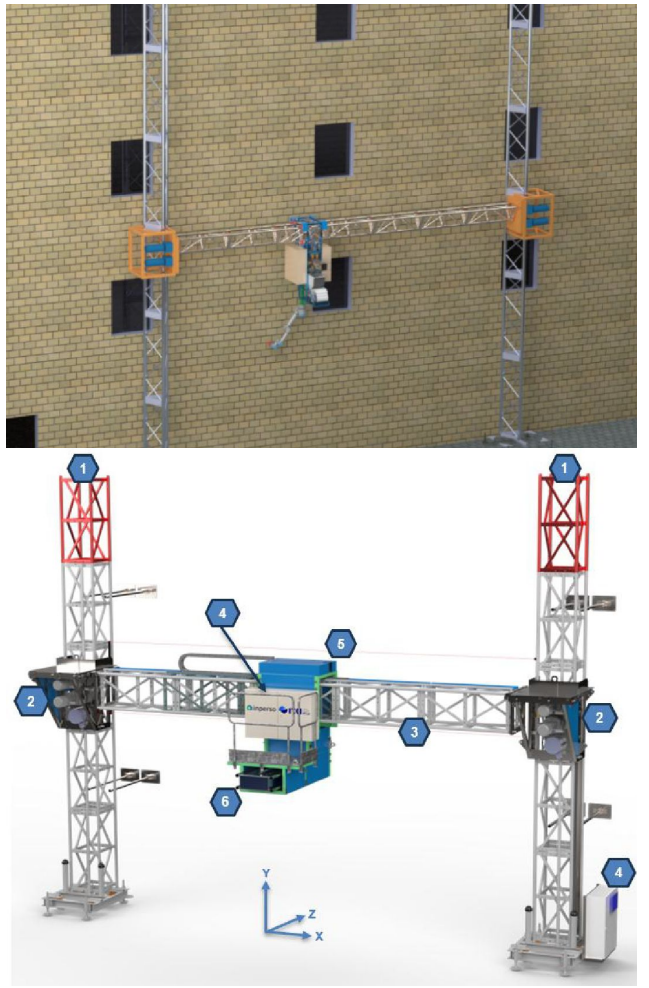


3D Printer Subsystems

Work carried out

Global positioner

- The Global Positioner moves the Robotic Printer Arm along the X, Y, and Z axes using three motorised trolleys with rack-and-pinion mechanisms for precise façade positioning
- Stability and precision were achieved through a robust displacement system inspired by mast climbing work platforms
- Iterative FEM analyses ensured structural stiffness and evaluated system scalability, particularly along the X axis



Positioner Subsystem

Work carried out

Robotic printer & printable materials

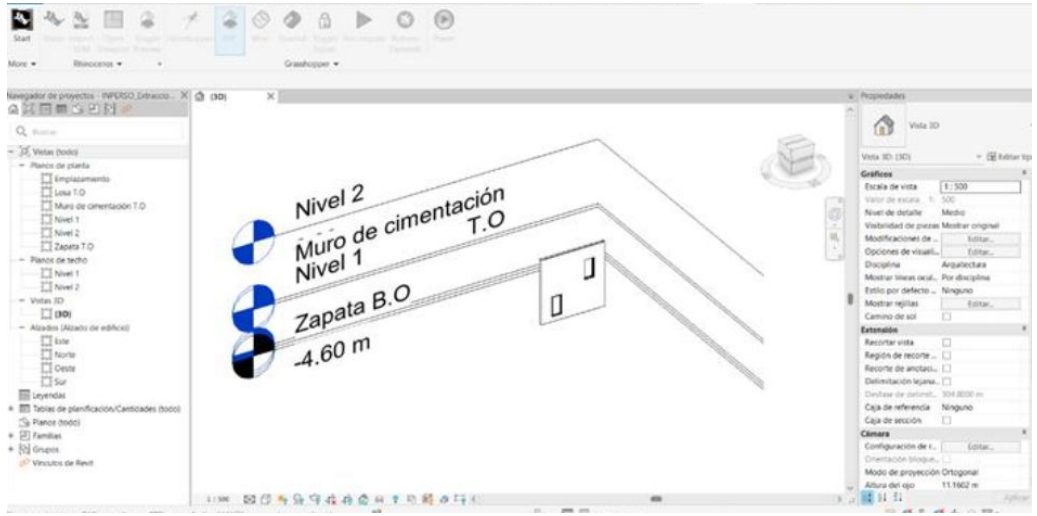
- UR20 robot, material pump, and an industrial PC were integrated as the main system
- The setup ensured full connectivity and control through preliminary subsystem tests
- The Flow-Matic extruder with dual cameras enabled remote monitoring via 3D-printed mounts
- Webots simulations modelled and tested subsystem and full-system performance

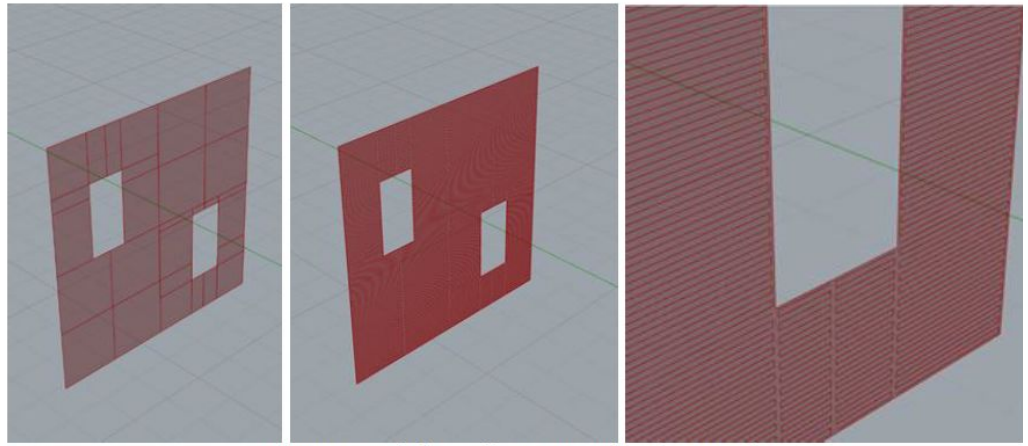
Laboratory setup

Work carried out

Software for BIM-CAM integration

- Segregation into **smaller áreas for better definition of trajectories**
- Trajectories definition that **aim for the shortest time and best adherence** and **surface quality**
- **Openings conditions** consideration





BIM to G-code process

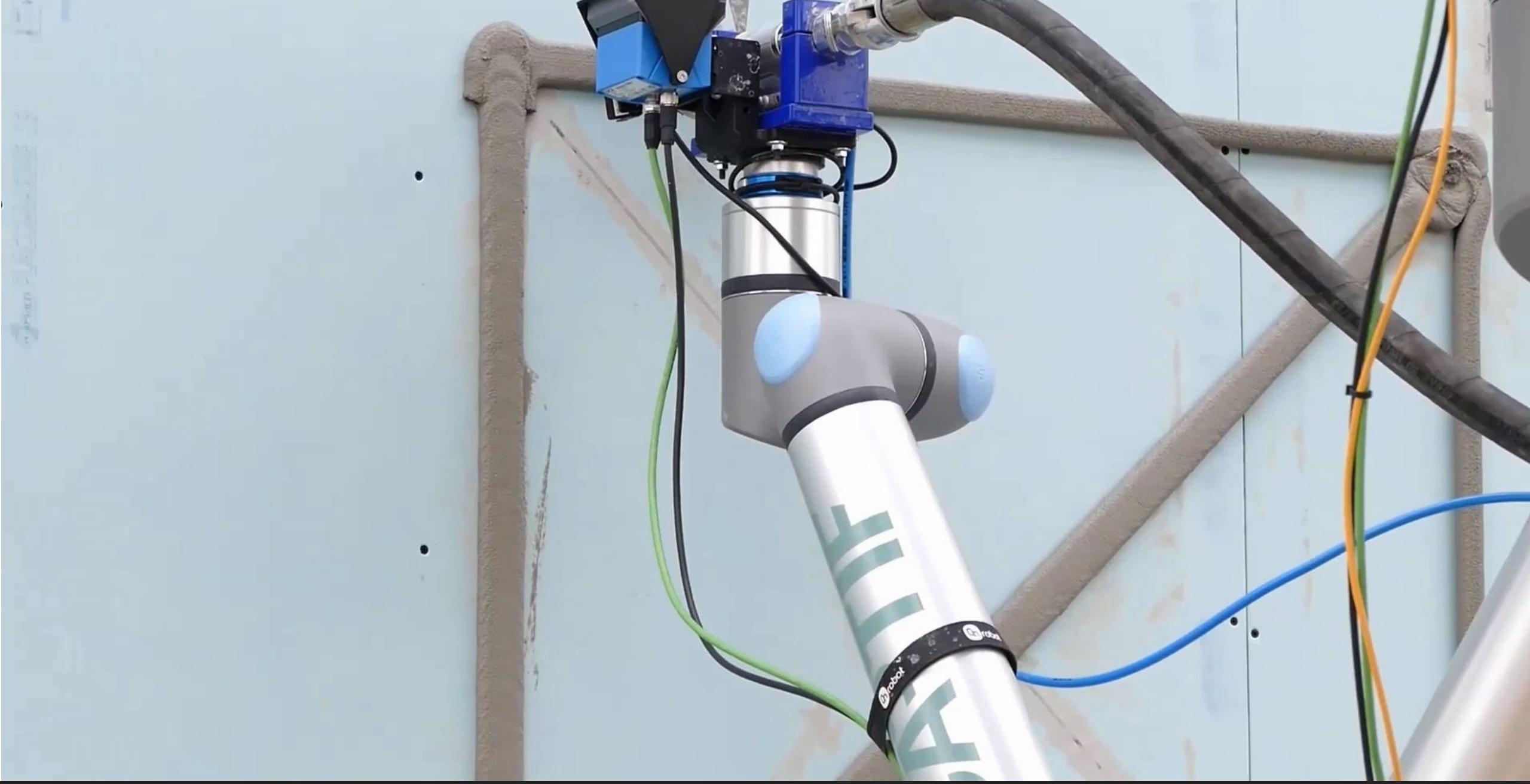
Work carried out

Printing process

- **Laboratory tests** carried out for **controlled printing areas** conditions
- **Thickness variation** ensuring the best **possible execution and waste reduction**
- The **aim is to perform** with **little human assistance**

Initial material deposition tests

Optimised material deposition



Main conclusions

Printing process

- The technology **aims for existing buildings**, focusing on **one of the biggest challenges in construction**, energy renovations
- **Insulating materials may be used** for obtaining better **energy performance**
- The **collision identification** makes it suitable for **identifying pre-existing facilities and overhanging elements** located **in the façade**
- **BIM-workflow integration** enables a more **practical coordination** and **flexibility in the designs**

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Thank you for your attention

For more information, scan the QR code

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