Additive Manufacturing in Construction
2nd funding period: The Opportunity for Large Impact

AMC TRR277

B05

Principles of Mobile Robotics for Additive Manufacturing in Construction

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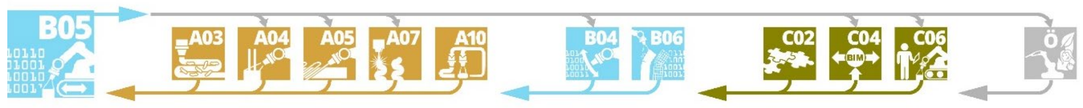
Project aims of 2nd funding period

- Extending in-situ and in-place AM with different deposition-based processes (concrete, fibres and metals, and earth) using Autonomous Mobile Robots (AMRs) in single and cooperative modes.
- Combining process, sensor, and mechanical data with design data, and storage of in-process data within FIMs.
- Conception of an untethered material deposition system.
- Modelling and path-planning strategies for part-based AM (print-drive-print approach) and expanding towards continuous AM (print-while-driving) approach for single and cooperative robots.
- Continued conception and integration of on-board localisation and positioning methods for part-based AM.
- Implementation of print-while-driving control methods by chaining multiple sensor systems with differing resolutions to further employ autonomous operation of the system.
- Experimental validation for different architectural scenarios at 1:1 scale.

Key collaborations in 2nd funding period



- **A03, A04, A05, A07, A10**: Implementation of additive processes into mobile robotics
- **B04**: Holistic control methods for mobile robotics and localisation using on-board sensing.
- **C02, B06**: Structural integrity and stability evaluation integration into design tools.
- **C04**: Fabrication Information Model integration of as-planned, in-process, and as-built information.
- **C06**: Interfacing of environmental information through external construction site equipment.

Methods

Interface between design, planning, and control

Establishing intuitive control of AM with mobile robots inside the design modelling environment

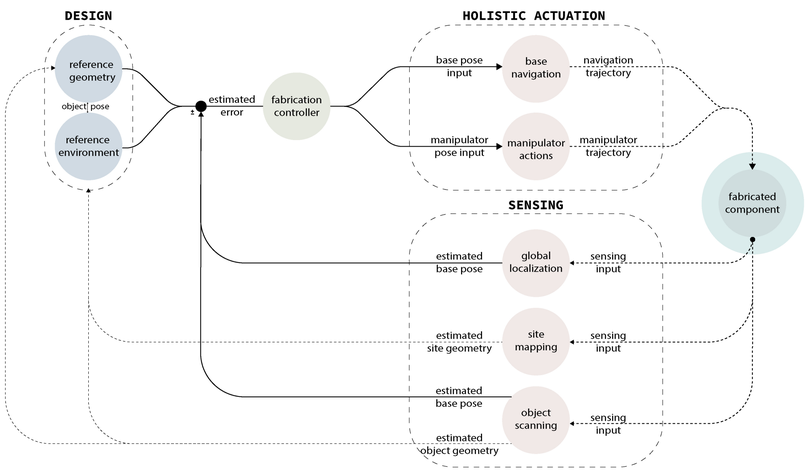


Figure 9: Diagram of sensor-integrated print-while-driving control for mobile robots in on-site scenarios

Scenarios for cooperative AMRs using AM processes

Coordinated actions between two AMRs for the construction of large scale objects

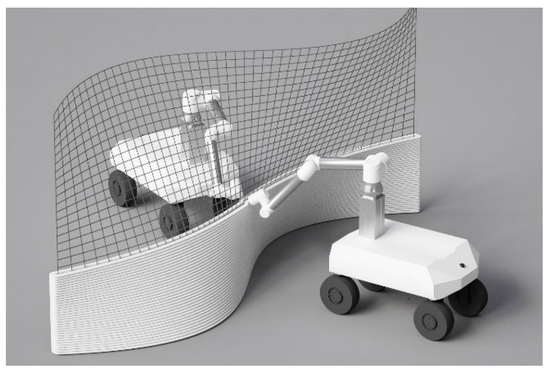


Figure 10: Multi-AMR extrusion-based AM on a mesh for the creation of a complex wall geometry.

Figure 11: Multi-AMR extrusion-based AM on longitudinal beams for the creation of a vaulted ceiling geometry.

In-place AM for existing contexts

In situ repair with AM through object reconstruction using scene capture and 2D laser scanning

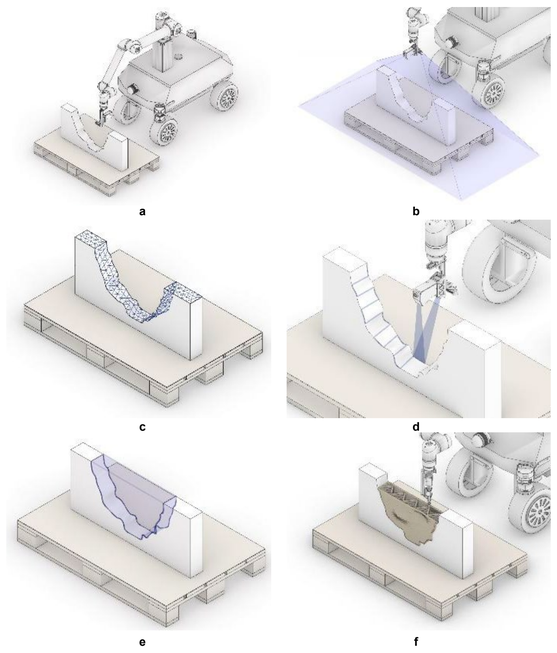


Figure 13: Proposed workflow for in situ repair of an incomplete wall geometry by means of in-place 3D printing.

Figure 14: In situ repair of existing building components, shown using clay extrusion.

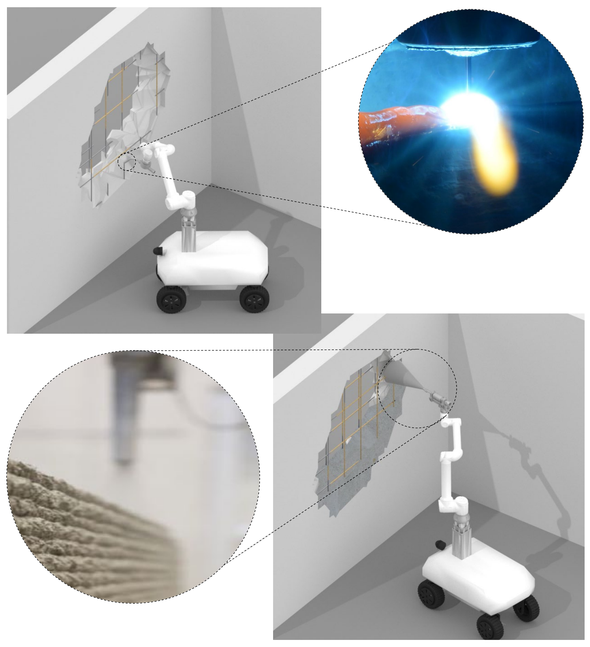


Figure 15: Conceptual in situ repair using WAAM and Shotcrete 3D printing

Work Programme 2nd funding period

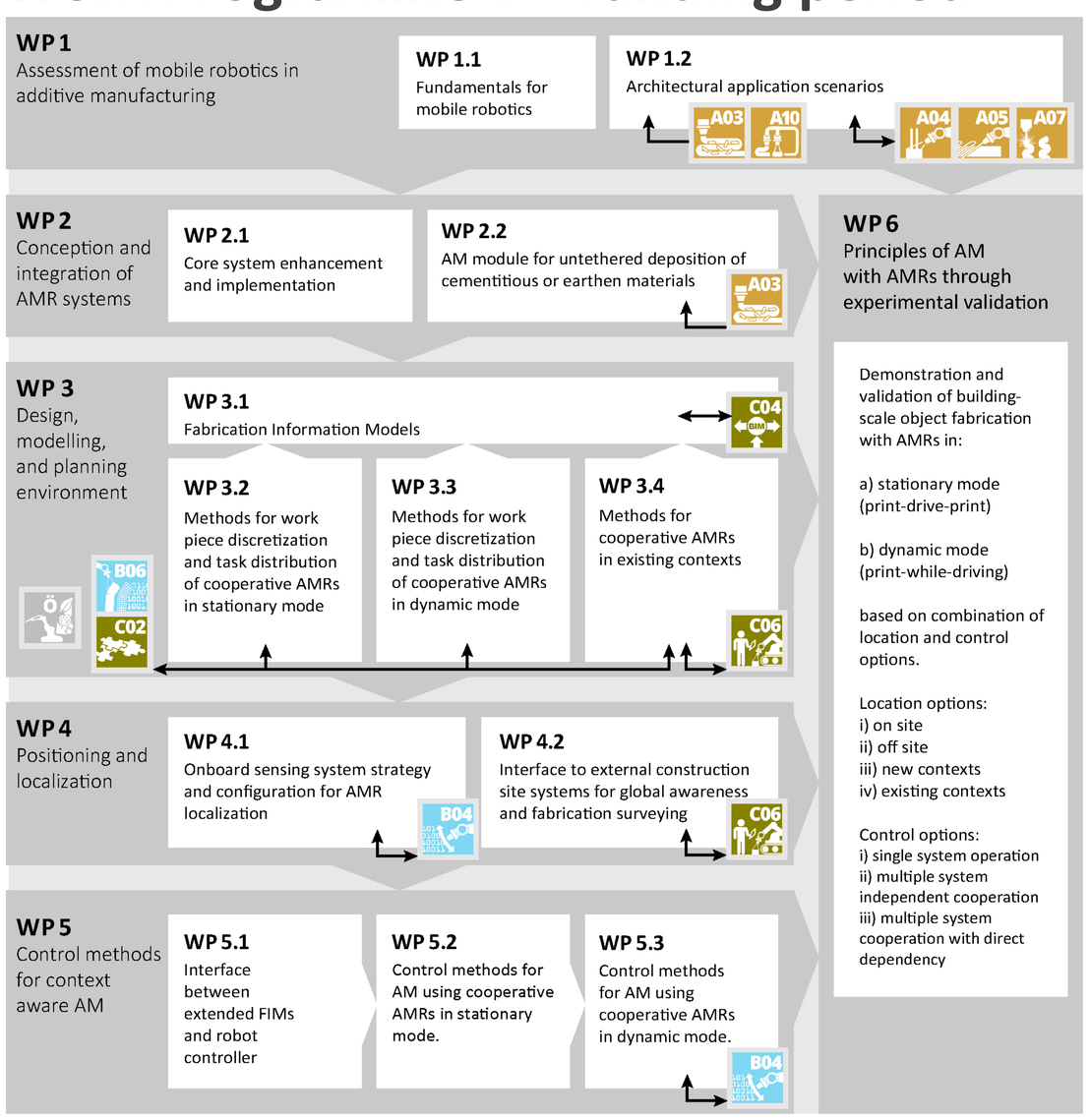


Figure 12: Work programme with work packages and collaborations

Outlook 3rd funding period

- Implementation of the autonomous system in unstructured, on-site conditions.
- Investigation of adaptive task distribution to increase construction effectiveness, enabling AMRs to dynamically distribute tasks based on availability.
- Establishing collaborative operation between different systems, with expansion of the currently available systems with a larger scale mobile unit capable of handling heavier construction tasks.
- Control methods are to be extended to include adaptive site conditions, with mobile systems capable of handling uneven ground.

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