Towards Intelligent Robotic 3D Concrete Pritning: Data Collection from the Deposition and Construct

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Introduction

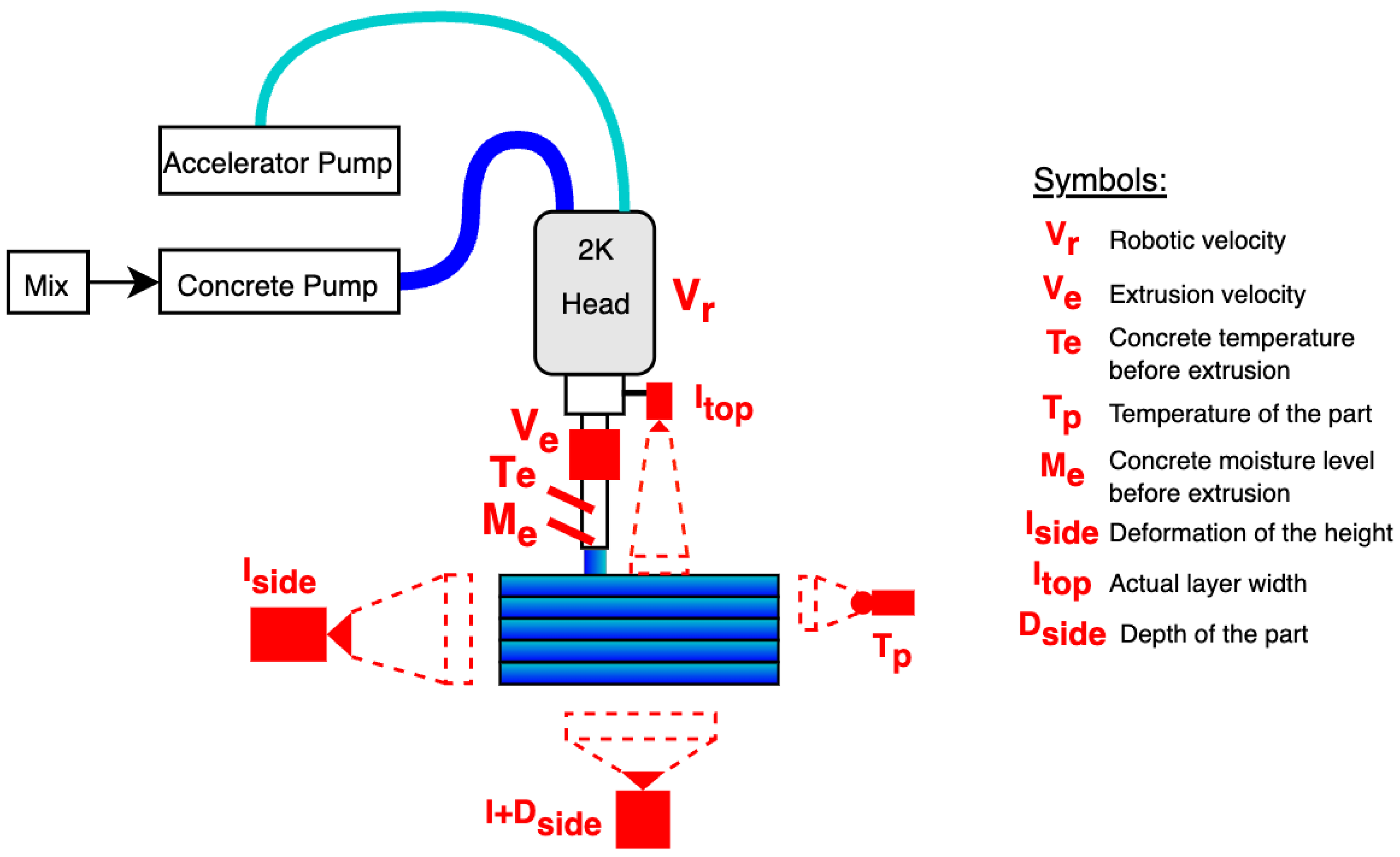
Robotic 3D Concrete Printing (3DCP) enhances geometric flexibility for optimized construction. However, it faces challenges like geometric inaccuracies, deformation, and inconsistent extrusion quality. Current methods lack real-time adaptability. Our research develops an real-time sensing framework to monitor deposition and construct in real-time, ensuring geometric precision, detecting deformation, and optimizing extrusion quality.

Methodology

The developed methodology involves a structured approach comprising several critical steps:

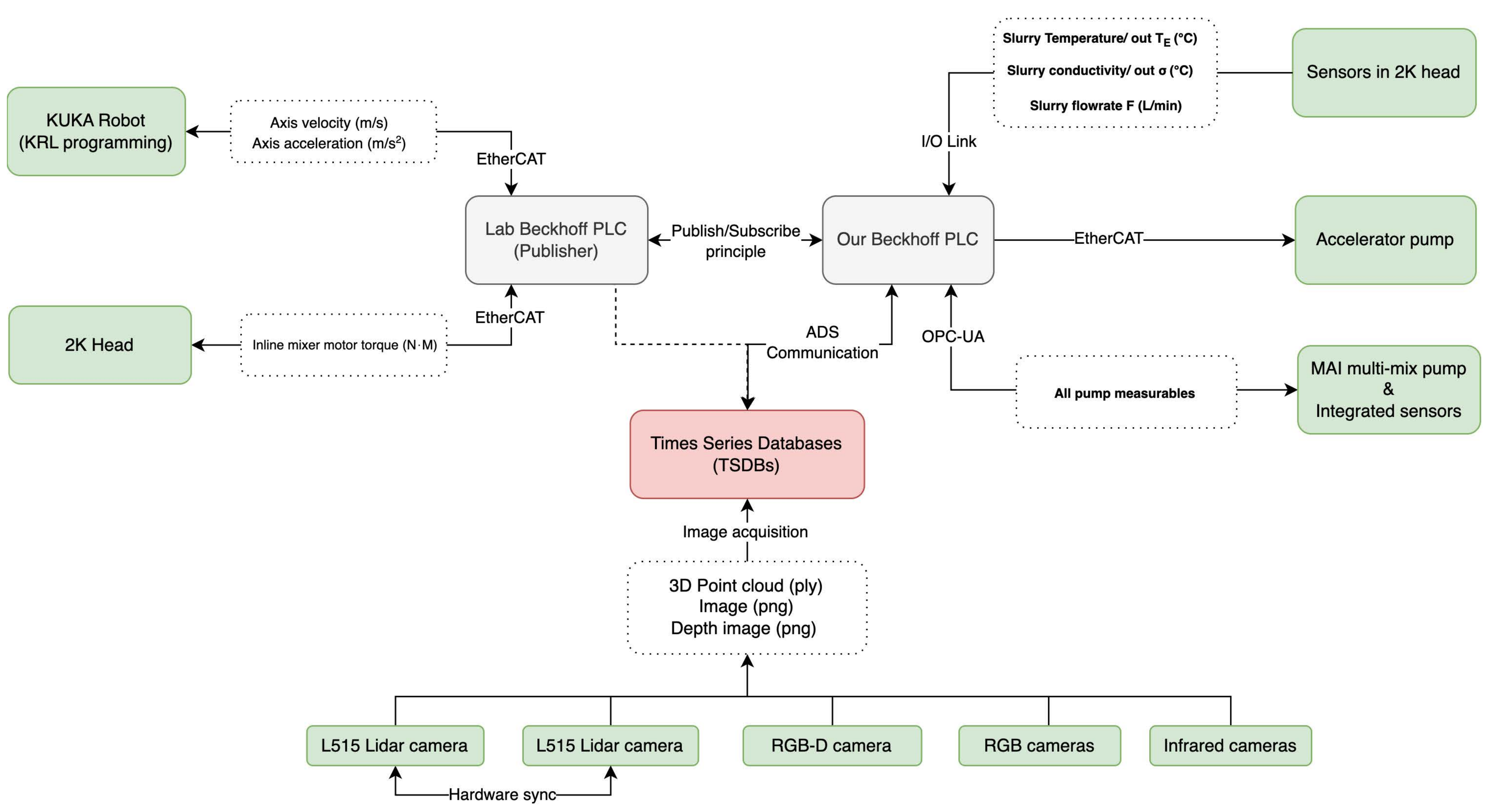
1 Real-time Monitoring Sensor Setup

The diagram illustrates the sensor configuration used to capture critical parameters duirng the Robotic 3DCP process.



2 System Architecture and Data Processing

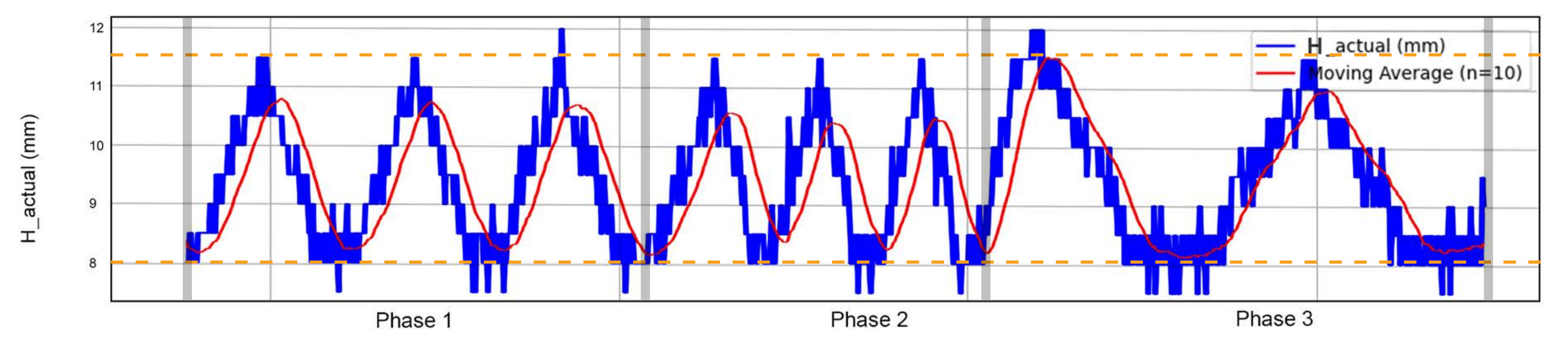
This flowchart shows the comprehensive data acquisition, communication, and synchronization between robotic control, sensor networks, and data analysis systems during the printing process.



Results

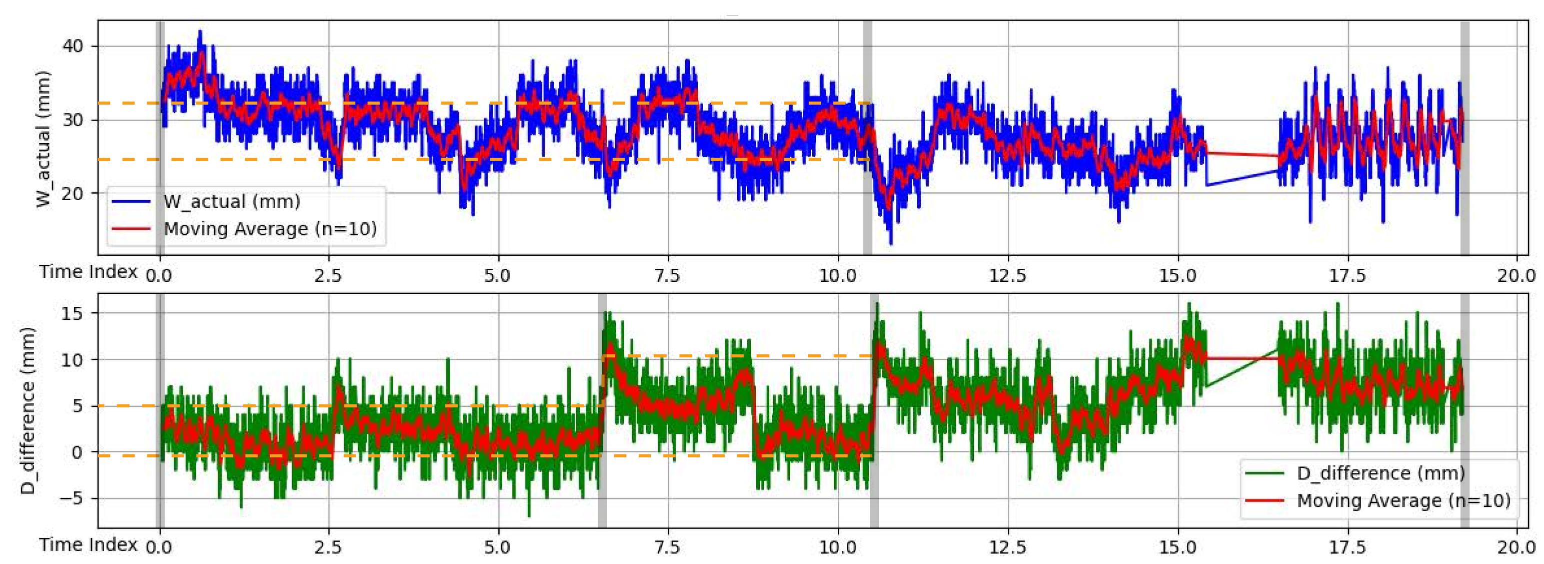
1 Result 1 - Layer Height Accuracy

Real-time layer height accurately monitored (error <1 mm at ~50 mm/s).

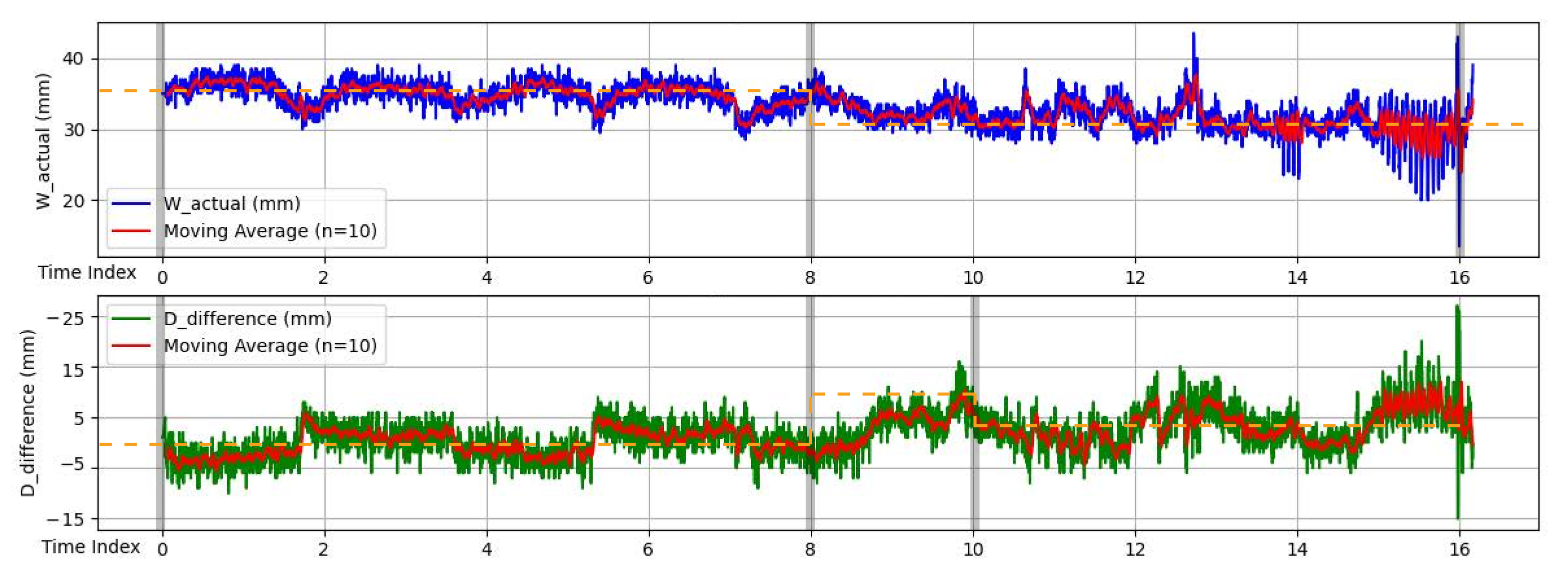


2 Result 2 - Deformation Detection

Horizontal Deformation Detection: Detected filament narrowing and uneven heights due to gravitational slump.

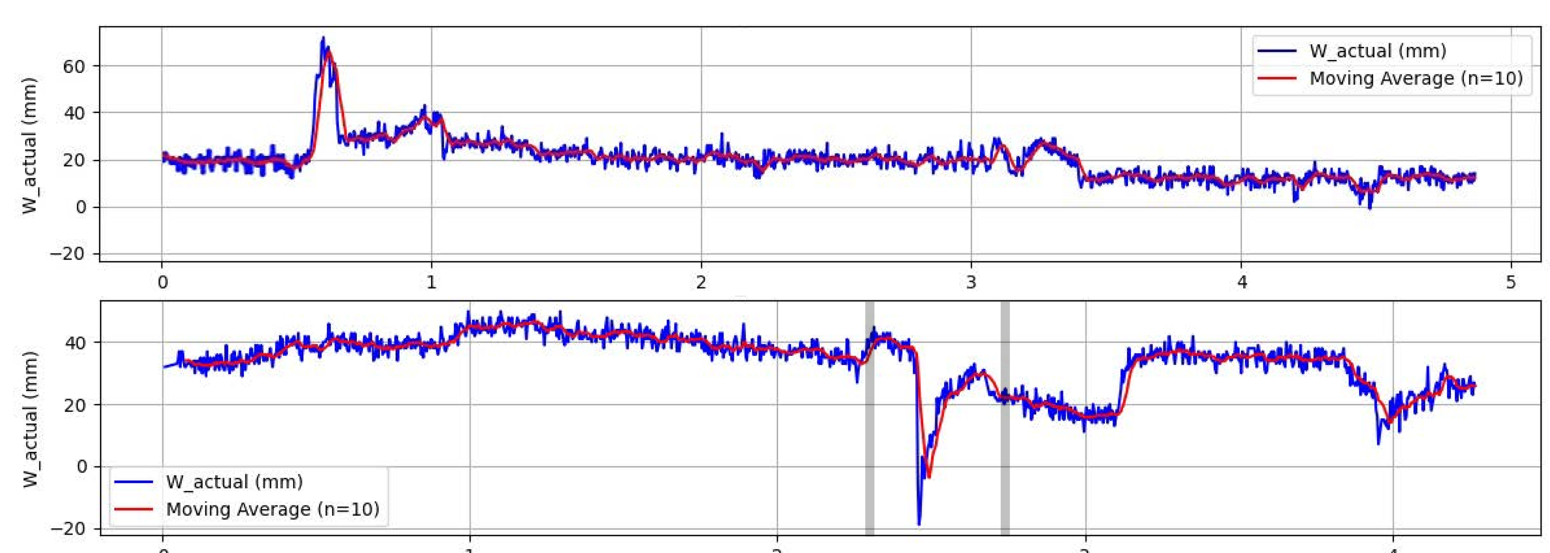


Buckling and Gravitational Slump Detection: Identified positional shifts (≤10 mm), indicating buckling and collapse risk.



3 Result 3 - Extrusion Quality:

Monitored filament width effectively captured over/under extrusion.



Conclusion and Future work

The sensing framework significantly improves robotic 3DCP through real-time data acquisition, enhancing accuracy, deformation control, and extrusion consistency. Future research will broaden monitoring capabilities, refine sensor integration, and develop real-time feedback controls for comprehensive structural monitoring.