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Fresh concrete characterization based on image sequences of the concrete mixing process using Deep Learning

Proposal for a Master thesis topic (DE/EN)

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The reduction of CO_2 emissions poses a significant challenge to the construction industry, with concrete production playing a decisive role. Concrete contributes to approximately 6.7 % of global anthropogenic CO2 emissions through cement production alone. To address this problem, research increasingly focuses on reducing cement usage, e.g., by incorporating alternative substances. Consequently, a trend exists for concrete to no longer be produced from just the three classical materials (cement, aggregate and water), but from several additional substances in order to reduce the amount of cement needed. However, this also leads to increasingly complex mix designs, which potentially compromises the robustness of the concrete. Thus, the control of concrete properties becomes more challenging, especially for the fresh concrete properties. The currently used quality assurance methods are not well suited to face this challenge, as they are only applied after production. In order to be able to react to possible deviations in the concrete properties, the properties must be determined during the mixing process.

The properties of the concrete influence its flow behaviour around obstacles. An obstacle can also be an object that moves through the concrete and thus sets it in motion like the paddle in the mixer. To predict the properties, one possibility is to observe the flow behaviour of the concrete and to derive the properties of the concrete based on the observations. As part of the thesis, a neural network (e.g., Recurrent Neural Network (RNN), long short-term memory (LSTM) or transformer-

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based models) should be trained to predict the fresh concrete properties. A data set consisting of image sequences taken of the concrete during the mixing process is available for training. The image sequences contain orthophotos, depth elevation maps (DEM) and optical flow images of the mixing process.

Good programming skills are a prerequisite. Experience with the deep learning packages such as pytorch is a great advantage, as is prior knowledge of image analysis. The thesis can be written in German or English and will be supervised by Maximilian Meyer M.Sc.

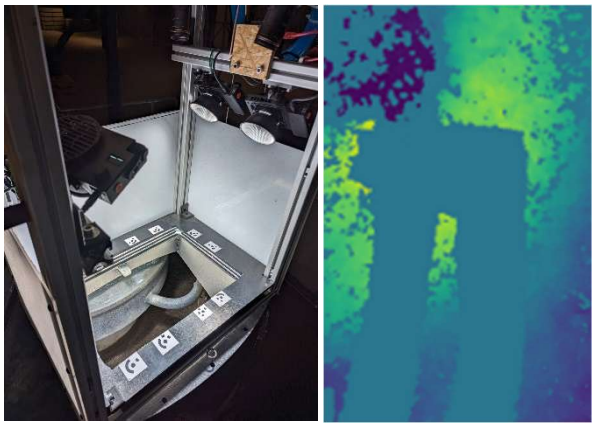

Figure 1: Data acquisition (left) and depth elevation map (right)