SUCCESS STORY

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Software Competence Center Hagenberg GmbH

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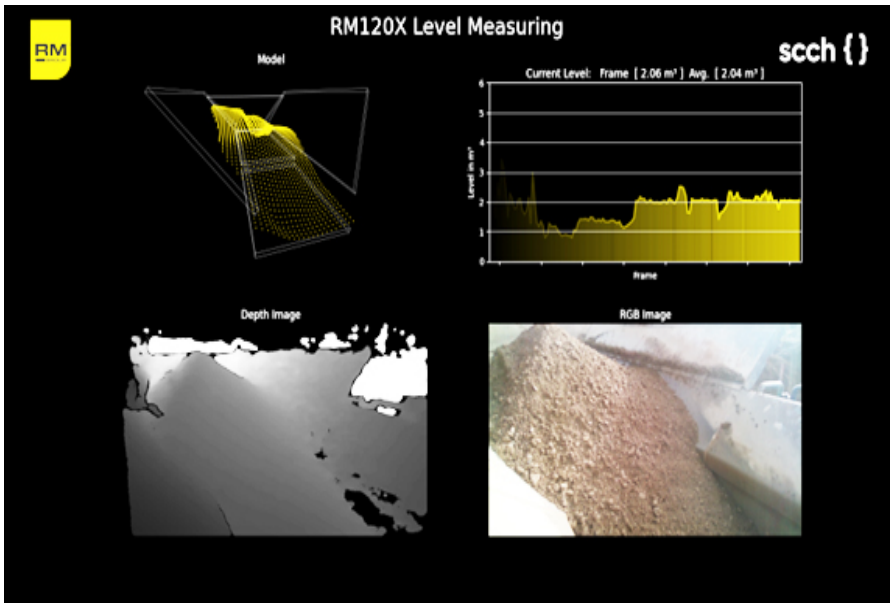

DIGITAL ASSISTANCE FOR STONE CRUSHERS

MONITORING AND ANALYZATION OF THE MATERIAL FLOW

The Software Competence Centre Hagenberg (SCCH) is working in close cooperation with the company Rubblemaster to improve mobile stone crushers. The use of digitalisation and artificial intelligence (AI) is intended to enable continuous monitoring and analysis of the material flow and other process parameters in the crusher. This in turn should improve the quality of the crushed material, increase the efficiency of the crusher and lead to simplified operation and fewer sources of error.

The research field of computer vision (CV) plays a central role here. Three stereo cameras are mounted at neuralgic points of the crusher - at the infeed or feeder, at the product discharge belt and at the oversize grain belt - which enables various process parameters such as the fill level, material speed, grain size distribution and other parameters to be analysed. The biggest challenges are the harsh and varying environmental conditions, such as intense sunlight, dust, fog, etc. and vibrations of the crusher. In addition, the diversity of the materials and the

„The biggest challenges are the surrounding conditions“

Key Facts

- **Process monitoring and material flow analysis in stone crushers using stereo cameras and classical as well as DL-based computer vision methods.**
- **Level measurement in the feeder using 3D point cloud transformations, extrapolation methods, and a comparison with a 3D CAD model of an empty feeder.**
- **Early detection of unbreakable stones in the feeder through transformer-based zero-shot deep learning methods.**

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different areas of application of the crushers make it difficult to develop reliable classic image processing algorithms and to generate diverse data for training of AI systems.

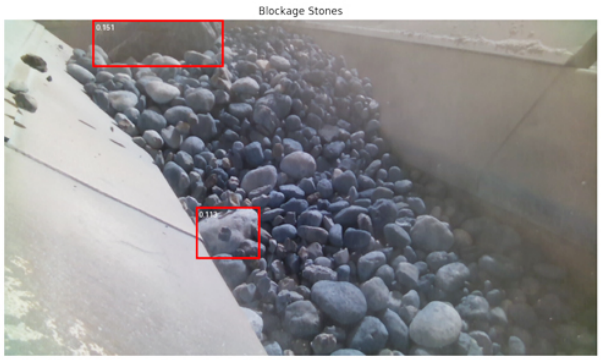
Two specific research successes in monitoring the material feed at the feeder are presented here: level measurement and blockage grain detection.

Fill level measurement

Precise knowledge of the current fill level of the feeder with material to be crushed is essential for the customer, as the best possible operation of the crusher is achieved with constant material feed. A fill level display and analysis help the operator to achieve the optimum material feed frequency. The 2D depth data recorded by the stereo camera is first converted into a 3D point cloud. This is then transformed into a previously created mathematical model of an empty feeder. Due to mechanical restrictions, the camera can only capture the front part of the feeder, which is why the rear part of the bulk material must be estimated using extrapolation methods. Furthermore, noise and small deviations due to camera inaccuracies and vibrations are counteracted using various methods such as filters or averaging. The current bulk material volume or fill level is then calculated using the height difference between the filled and empty feeder multiplied by the feeder area. As a result, the operator receives the material volume in cubic metres and the feeder fill level in percent.

Blockage detection

Not only the volume of the bulk material fed in, but also the grain size distribution of the material is of great importance. Grain sizes that are too large cannot be crushed and damage the crusher. To prevent this, a CV prototype was developed that recognises unbreakable stones in the feeder at an early stage and can warn the operator and stop the machine if necessary.



Transformer-based zero-shot deep learning methods are used to recognise objects. A key advantage of these methods is that they do not require any labelled training data. This is particularly important in this case, as realistic data for AI training can only be recorded with great effort. Blockage grains that are placed in the feeder to record data must be removed again in a time-consuming process before the crushing process so that the crusher is not damaged.

Project Partners

- Software Competence Center Hagenberg
- Rubble Master HMH GmbH

Contact

DI Clara Schachner
Research Team Lead Computer Vision and Representation Learning
+43 50 343 816
Clara.schachner@scch.at

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Software Competence
Center Hagenberg GmbH
4232 Hagenberg,
Softwarepark 32a
https://www.scch.at