Hes·so
Ingénierie et Architecture

ORCADEMO - ASSISTANCE IN INTELLIGENT RECYCLING OF CONCRETE WASTE

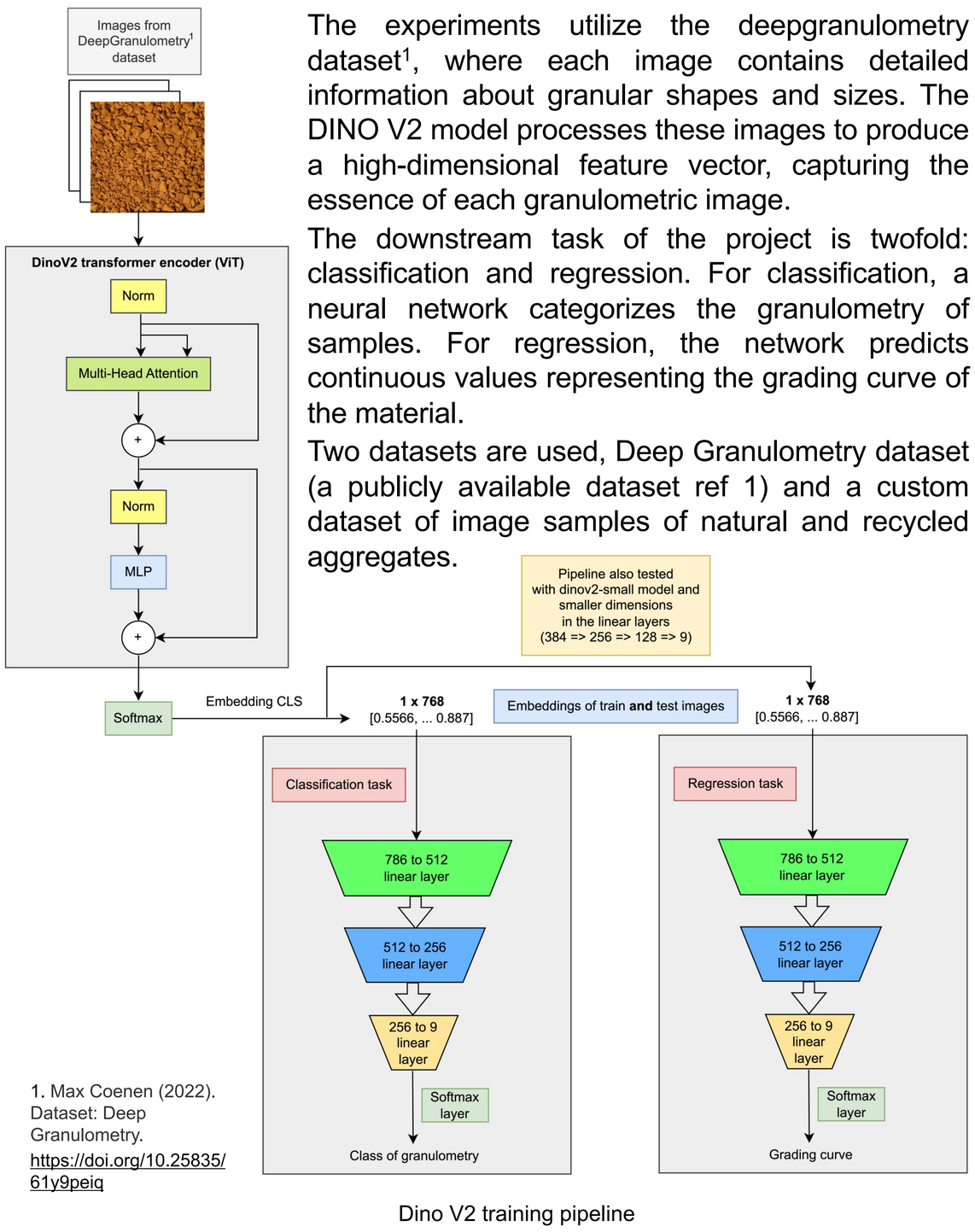
Samuel Fringeli, Benjamin Pasquier, Prof. Houda Chabbi, Dr Julien Ston, Prof. Daia Zwicky

USE OF SELF-SUPERVISED LEARNING TO IMPROVE GRANULOMETRY ANALYSIS

SUMMARY

The ORCADEMO project aims to provide industries with a pipeline powered by Deep learning approaches to help in predicting the properties of recycled concrete mixtures by automating the analysis of the particle size distribution, or granulometry, of aggregates from their images. For granulometry, conventional methods rely on costly techniques such as sieving. Our aim is to replace these techniques by automating the analysis chain through the development of a Deep Learning (DL) model that directly uses images of aggregates passing over conveyor belts. Besides we believe that such a model extracts meaningful features on the aggregates that can then be used to predict concrete properties such as compressive strength and workability.

METHODOLOGY AND DATASETS



Dino V2 training pipeline

The experiments utilize the deepgranulometry dataset[1], where each image contains detailed information about granular shapes and sizes. The DINO V2 model processes these images to produce a high-dimensional feature vector, capturing the essence of each granulometric image.

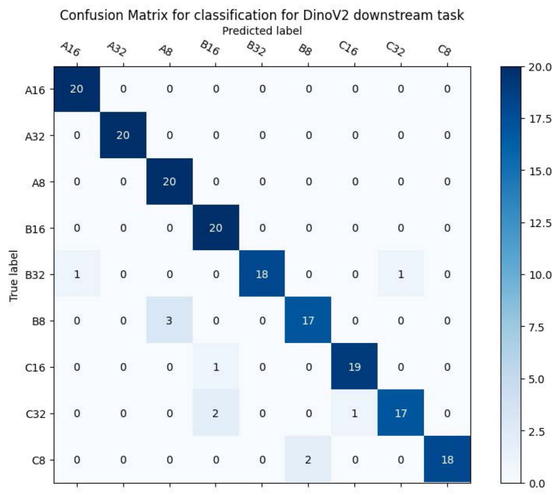
The downstream task of the project is twofold: classification and regression. For classification, a neural network categorizes the granulometry of samples. For regression, the network predicts continuous values representing the grading curve of the material.

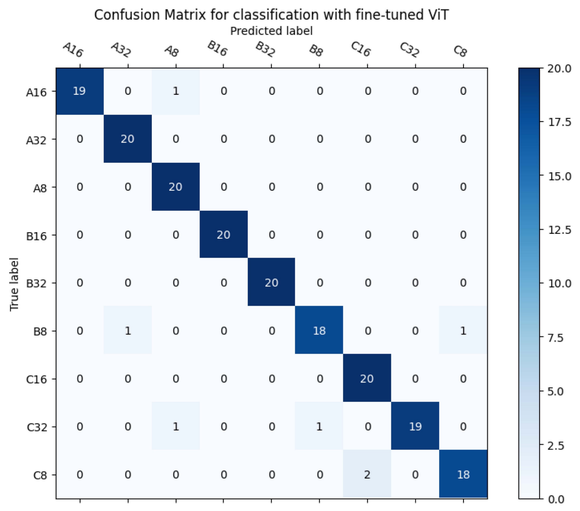
Two datasets are used, Deep Granulometry dataset (a publicly available dataset ref 1) and a custom dataset of image samples of natural and recycled aggregates.

1. Max Coenen (2022). Dataset: Deep Granulometry. https://doi.org/10.25835/61y9peiq

RESULTS

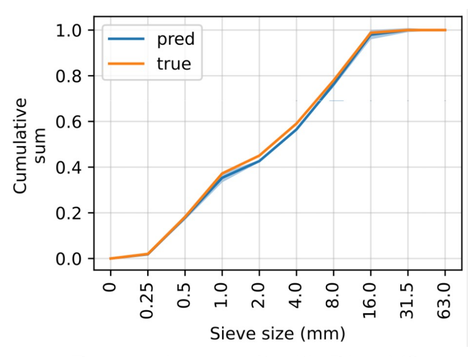
Our evaluation shows the effectiveness of the DINO V2 framework in handling complex, nuanced tasks without relying on labeled datasets, marking a significant advancement in the field of self-supervised learning and its practical applications.



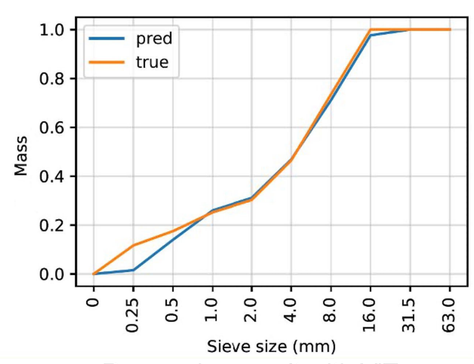


Notably, the performance of the DINO V2 model combined with a custom downstream task in these experiments demonstrates results that are comparable to those achieved by a fine-tuned ViT.

This similarity in performance highlights the potential of self-supervised learning models like DINO V2 to match the efficacy of supervised models, even in scenarios where labeled data is scarce or unavailable.



Regression result with Dino V2



Regression result with ViT

CONCLUSIONS

Innovative Automation: The project introduces a deep learning-based method to automate granulometry analysis for predicting recycled concrete properties, aiming to innovate construction industry practices.

Conventional Method Replacement: It proposes replacing traditional, labor-intensive methods like sieving with an automated, AI-driven approach to enhance efficiency and scalability.

Model Effectiveness: Evaluation results demonstrate that DINO V2's performance is on par with fine-tuned Vision Transformers, showcasing the potential of self-supervised learning to match supervised models in data-scarce scenarios.

Potential for Broader Applications: The success of DINO V2 in accurately analyzing granulometry suggests its broader applicability in other domains requiring nuanced image understanding without extensive labeled data.

ACKNOWLEDGMENTS

This research is supported by a grant of the Programme de recherche HEIA-FR / Smart Living Lab (AGP: 119149).

HEIA-FR HTA-FR
iTEC Institute of Construction and Environmental Technologies
iCoSys Institute of Artificial Intelligence and Complex Systems
smart living lab