

# MEASURING COASTAL SEDIMENT GRAIN SIZE INSTANTLY USING *INSTAGRAIN*, A HAND-HELD CAMERA WITH ON-DEVICE MACHINE LEARNING

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## INTRODUCTION

Grain size is a first order control on sediment transport rates and thus morphological change in coastal environments. In many coastal settings grain size can be highly variable over short space and time scales. Quantifying this variability is time consuming (e.g., sieve analysis, settling tube) or costly (e.g., laboratory instruments, labor). Furthermore all of these measurement techniques are typically performed in the lab, not in the field.

Previous work has investigated image-based methods to expedite grain size measurements (e.g., Rubin, 2004; Buscombe 2020) - and employed cameras that are handheld, remotely operated, or on autonomous vehicles (e.g., Barnard et al., 2017, Buscombe et al., 2014, Rubin et al., 2007, Soloy et al., 2020, Warrick et al., 2009). A key bottleneck with these methods is that the analysis step is not performed instantly in the field, and often requires transferring pictures from the camera to a computer for grain size determination.

Here we discuss the development of *Instagrain*, a new camera that enables instant grain size measurements (~2 sec.) in the field by bundling image acquisition and grain size analysis using on-device machine learning (Goldstein et al., 2022). We report results from coastal field sites in the USA.

## CAMERA DESIGN

The camera has 4 subcomponents - the electronics, the housing, the software, and the machine learning model. We briefly walk through these subcomponents, and discuss the field operation of the device.

The electronic system is anchored by a Raspberry Pi single board computer connected to a screen, lighting system, camera, and GPS. All electronics are mounted in a custom-machined enclosure and supplemented with a variety of 3D printed parts. The core software is a graphical user interface built with Python and shell scripts. The machine learning model is based on the MobileNetV2 architecture, and we use images from an existing catalogue of analysed sediment as training data.

Camera operation takes ~2 sec., and the machine learning model reports 11 levels of the cumulative grain size distribution as output - D2, D5, D16, D25, D50, D75, D84, D90, D95, D98 (in millimeters) - as well as a graph of the cumulative grain size distribution curve.

## FIELD TRIALS

We conducted field trials at various coastal sites in the USA (Fig. 1), and will report results from these field

tests by comparing output from the camera paired with sieve analysis.

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Figure 1 - Camera in use at a beach in New York, USA

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