deepsoil

grai

User's guide

Table of contents

1 Photobox

The images are taken with smartphone cameras in a photo box to avoid light reflections. The photo box consists of two parts: the lower part serves as a base and holds the soil, while the upper part acts as a spacer and support surface for the smartphone. The photos are taken through a specially designed opening.

There are two ways to obtain the photo box:

1. Do-it-yourself: You can build the photo box yourself according to the dimensions in Figure 1.
2. Contact: Alternatively, you can contact us at enrico@deepsoil.at. We offer the photo box shown in Figure 2.

Please note: If the dimensions differ, we cannot guarantee the correct functioning of the AI.

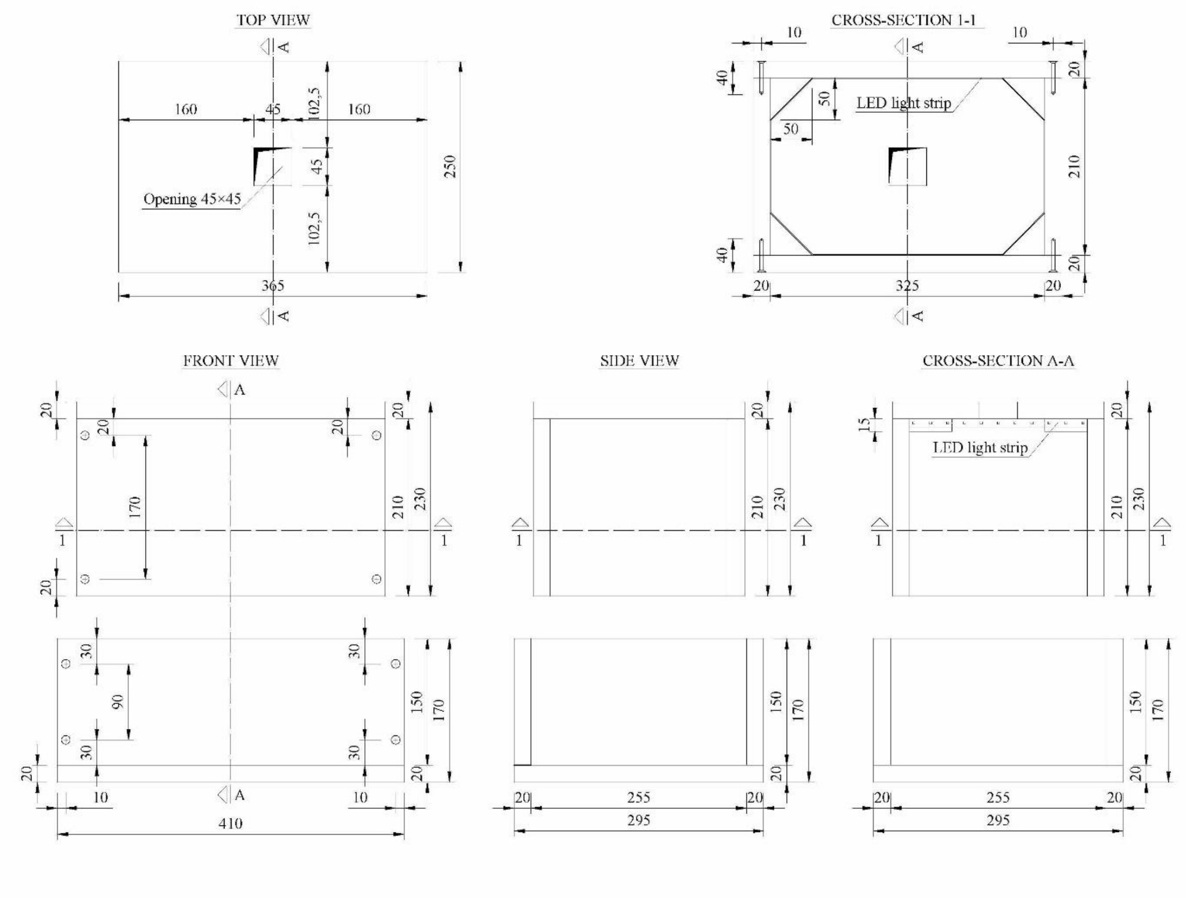

Figure 1. Dimensions of the photo box for image acquisition.

Figure 2. Rendering of the photo box for image acquisition.

1.1 Insertion of soil samples

The soil samples are first homogenized (e.g., using a cement mixer) and then oven-dried. Afterwards, the soil is evenly sprinkled into the lower tray.

1.2 Standardization of pixel density

Because each smartphone has its own resolution and the photographed soil area has different physical dimensions, model generalization must be ensured. For this reason, all images must be scaled to a uniform pixel density of 4.6 PPM (pixels per millimeter). This step is comparable to a calibration.

Specifically, the physical dimensions of the photographed area and the corresponding number of pixels are required. In Figure 3, the number of pixels in the horizontal and vertical directions of the red rectangle is determined. Subsequently, the diagonal (hypotenuse) is calculated and compared with the length of the ruler (20 cm).

1.2.1 Supported smartphones and resolutions

Our AI works with all smartphones. However, our AI recognizes automatically the following models (Table 1). Only some of these models were used to train the AI and therefore deliver the best results. We are continuously working to expand the list of supported devices. If additional smartphones are desired, please contact us at enrico.soranzo@boku.ac.at.

If a smartphone is not recognized, the pixel density is obtained by assuming an angle of view (AOV) equal to 70°. This is an average value for smartphone cameras, based on our experience. The PPM is then equal to

$$PPM = \frac{\max(w, h)}{l} \quad (1)$$

where

w is the image width in pixels,

h is the image height in pixels,

l is the photographed length in mm which is obtained as

$$l = 2d \tan \frac{AOV}{2} \quad (2)$$

where

d is the distance from the smartphone camera to the soil is assumed to be 210 mm (Figure 1) and AOV is assumed to be 70°, as explained above. With these values, Equation (2) returns

$$l = 2 \cdot 210 \tan \frac{70°}{2} = 294.087\ mm \quad (3)$$

and Equation (1) returns

$$PPM = \frac{\max(w, h)}{294.087} \quad (4)$$

Table 1. Smartphone models automatically recognized

Smartphone	Resolution	Original PPM	Used for AI training?
Huawei p9 Lite 2017	2976×3968	13.741	No
iPad Pro	3024×4032	14.961	No
iPhone 13 mini	3024×4032	13.568	No
iPhone 14	3024×4032	13.942	Yes
iPhone 14 Pro	3024×4032	12.279	No
iPhone 15 Pro	3024×4032	12.788	No
iPhone 16	4284×5712	19.525	No
iPhone 16 Pro	3024×4032	12.619	No
Motorola Edge	1800×4000	11.492	Yes
Motorola Edge 60 fusion	2304×4096	12.465	No
Motorola G7+	3456×4608	18.286	No
Motorola G30	3472×4624	17.582	No
Samsung A32	6000×8000 2250×4000	25.817 12.910	No
Samsung A52	6936×9248	26.126	Yes
Samsung Galaxy S23	3000×4000	12.487	No
Samsung Galaxy S23 Ultra	3000×4000	11.860	No
Samsung Galaxy S24	3000×4000	12.26	No
Vivo X60	3000×4000	15.444	No
Xiaomi 15	3072×4096	12.537	No
Xiaomi A2	3000×4000	15.686	No

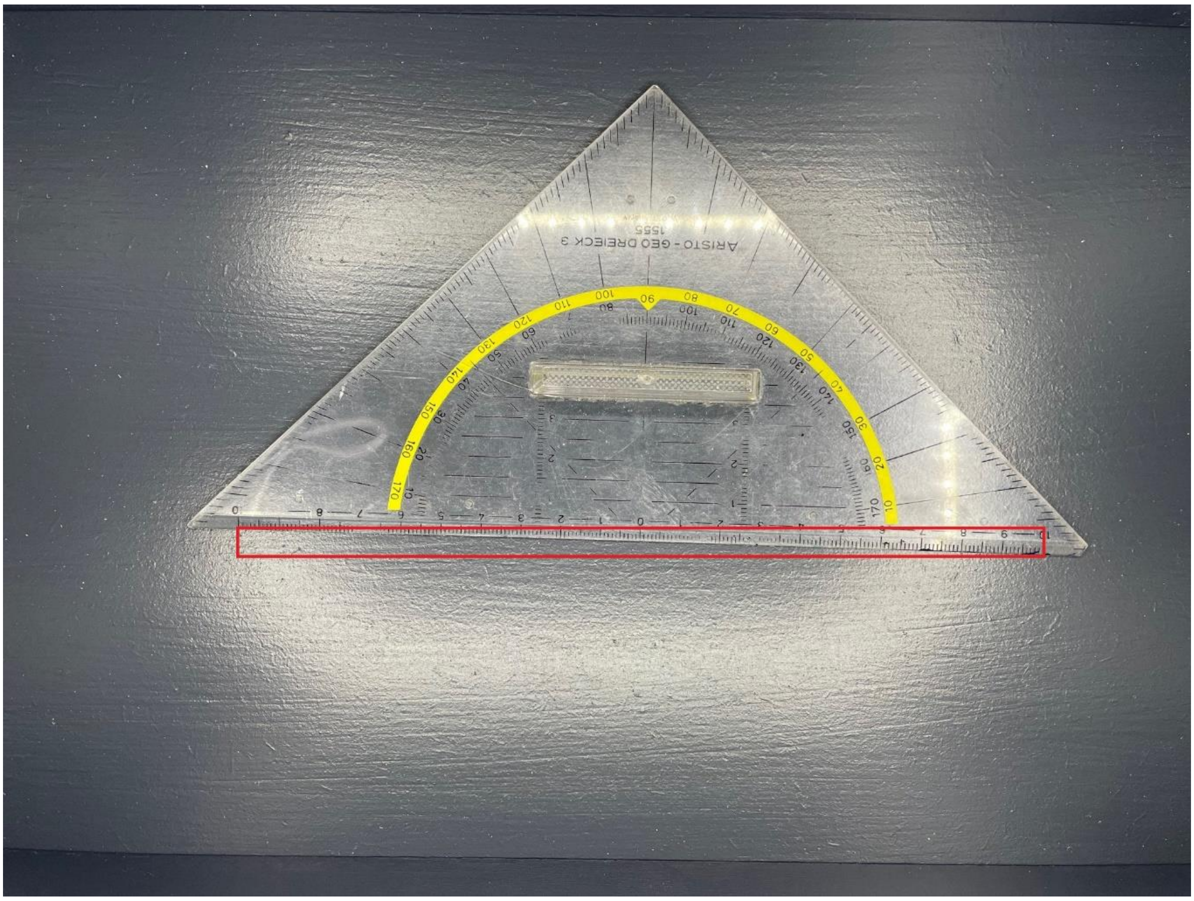

Figure 3. Calibration of the pixel density.

2 References

Soranzo, E., Guardiani, C., Wu, W. (2025) Convolutional neural network prediction of the particle size distribution of soil from close-range images. Soils and Foundations 65(1):101575. doi: 10.1016/j.sandf.2025.101575

Soranzo, E. (2025) Machine Learning Prediction of Soil Particle Size Distribution from Smartphone Images. Proc. of the 3rd Workshop on the Future of Machine Learning in Geotechnics (3FOMLIG), Florence (Italy), October 15-17, 2025:87-92