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Data Article

RafanoSet: Dataset of raw, manually, and automatically annotated Raphanus Raphanistrum weed images for object detection and segmentation.

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A R T I C L E I N F O

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Dataset link: RafanoSet: Dataset of raw, manually, and automatically annotated Raphanus Raphanistrum weed images for object detection and segmentation (Original data)

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Multispectral
Segment anything model
Grounding DINO

A B S T R A C T

The rationale for this data article is to provide resources which could facilitate the studies focussed over weed detection and segmentation in precision farming using computer vision. We have curated Multispectral (MS) images over crop fields of *Triticum Aestivum* containing heterogenous mix of *Raphanus raphanistrum* in both uniform and random crop spacing. This dataset is designed to facilitate weed detection and segmentation based on manual and automatically annotated *Raphanus raphanistrum*, commonly known as wild radish. The dataset is publicly available through the Zenodo data library and provides annotated pixel-level information that is crucial for registration and segmentation purposes. The dataset consists of 85 original MS images captured over 17 scenes covering various spectra including Blue, Green, Red, NIR (Near-Infrared), and RedEdge. Each image has a dimension of 1280 $\times$ 960 pixels and serves as the basis

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for the specific weed detection and segmentation. Manual annotations were performed using Visual Geometry Group Image Annotator (VIA) and the results were saved in Common Objects in Context (COCO) segmentation format. To facilitate this resource-intensive task of annotation, a Grounding DINO + Segment Anything Model (SAM) was trained with this manually annotated data to obtain automated Visual Object Classes Extended Markup Language (PASCAL VOC) annotations for 80 MS images. The dataset emphasizes quality control, validating both the 'manual" and 'automated" repositories by extracting and evaluating binary masks. The codes used for these processes are accessible to ensure transparency and reproducibility. This dataset is the first-of-its-kind public resource providing manual and automatically annotated weed information over close-ranged MS images in heterogenous agriculture environment. Researchers and practitioners in the fields of precision agriculture and computer vision can use this dataset to improve MS image registration and segmentation at close range photogrammetry with a focus on wild radish. The dataset not only helps with intra-subject registration to improve segmentation accuracy, but also provides valuable spectral information for training and refining machine learning models.

Specifications Table

Subject	Computer Vision and Pattern Recognition, Artificial Intelligence, Applied Machine Learning
Specific subject area	Object detection, Object Segmentation, Automatic Annotation, Precision Agriculture, Deep Learning
Type of data	Raw images: MS images(s) in Portable Network Graphics (.PNG) format Segmentation Masks: Javascript Object Notation (JSON) Manual Annotations: Common Objects in Context (COCO) Automated Annotations: Pascal Visual Object Classes Challenge (PASCAL VOC) Code: Python (.Py)
Technical Specifications of the Imaging Sensor	Spatial resolution: 0.07 cm/pixel at 1 m altitude Frame rate: 1 image/second Wavelength: Red (668 nm), Green (560 nm), Blue (475 nm), Near-IR (840 nm), RedEdge (717 nm)
Data collection	The acquisition of the images was done in field environment, at noon on 13 January 2022 over 17 image scenes. In total 85 images were captured across 5 spectral channels. These images were captured at nadir using the MicaSense RedEdge-M at 1m AGL after radiometric calibration with a Lambertian target to obtain absolute reflectance values for each of the 5 RedEdge sensor wavelengths [1]. This activity was a handheld acquisition using a gimbal over the crop rows containing a mix of Wheat crop and Horseradish weed. The manual annotations were done using VIA annotator version 1.0.6. The automated annotations were done using a combination of Grounding DINO and Segment Anything Model. The script aimed to extract binary masks based on manual and automatic annotations was written in python.
Data source location	Acquisition site: Department of Agriculture Sciences, University of Napoli Federico II, Portici, Italy Coordinates: 40.814486118244915, 14.34678741979037 Data post-processing and storage location: Department of Engineering, University of Campania 'Luigi Vanvitelli,' Aversa, Italy Coordinates: 40.96846317808221, 14.208207168044456

(continued on next page)

Data accessibility	Repository name: Zenodo Data identification number: 10567784 Direct URL to data: https://zenodo.org/records/10567784
Related Research Article	Rana S, Gerbino S, Crimaldi M, Cirillo V, Carillo P, Sarghini F, Maggio A. Comprehensive Evaluation of Multispectral Image Registration Strategies in Heterogenous Agriculture Environment. Journal of Imaging. 2024; 10(3):61. https://doi.org/10.3390/jimaging10030061

1. Value of the Data

- *Raphanus raphanistrum*, commonly referred to as the wild radish, white charlock, or jointed charlock, belongs to the Brassicaceae family of flowering plants. Its natural habitats are in western Asia, Europe, and some regions of Northern Africa. This species has been spread to all corners of the globe and is often considered a harmful invasive species due to its impact on local habitats [2–4]. Hence, this openly accessible annotated MS dataset for *R. raphanistrum* highlighted here, encompasses data from both manually and automatically annotated wild radish leaves along with the ground truth ROI.
- The dataset contains raw and annotated MS image data broadly classified into six subdirectories according to the nature of annotations and operations performed over wild radish leaves. The manual and automatic annotations are available in COCO segmentation format [5] as well as PASCAL VOC format [6] respectively.
- These images were acquired about two weeks after sowing wheat, intended to observe early-stage occurrence of wild radish weed. The pixels-of-interest are annotated across five different spectra, i.e. Blue, Green, Red, Infrared and RedEdge.
- This dataset can be used by precision agriculture researchers to develop and train wild radish detection, classification, and segmentation models towards the development of new recognition algorithms amounting to its improved mapping.

2. Background

The primary motivation for compilation of this dataset was the creation of repositories containing diverse ways of annotated pixel information about the weed-of-interest, *R. raphanistrum*. Precision agriculture specialists and computer vision analysts can utilise this information to perform intra-subject registration towards improvement of close-ranged MS image registration and segmentation focussed on weeds. The underlying spectral information can be utilised to improve segmentation accuracy of external wild radish datasets from different geographical origins. Therefore, this annotated pixel-level data offers granular, precise spectral information to train and improve existing machine learning models and also opens the possibility of fuzzy logic-based segmentation improvement in annotated MS images.

3. Data Description

Our dataset is publicly available in a Zenodo data library [7]. Fig. 1 shows the schema of the dataset. The annotated wild radish dataset consists of 85 original raw MS images of *R. raphanistrum* in the subdirectory **‘Raw images’**. The nomenclature of image naming and sequencing is in such format: The nomenclature of sequencing and naming images and annotations has been in this format: IMG_<scene number>_<spectral channel number>

_1: Blue

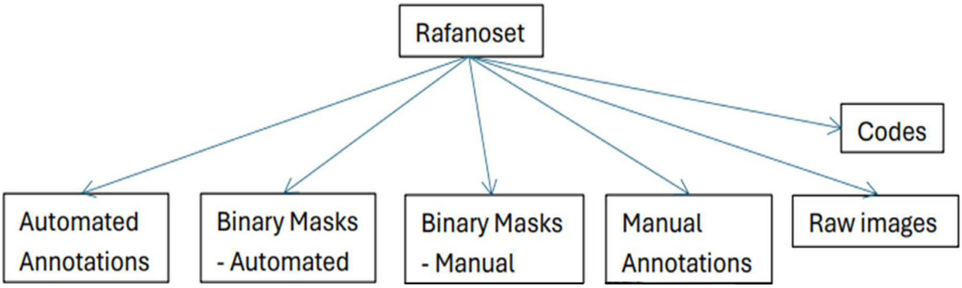

Fig. 1. Schema of dataset.

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[{"shape_attributes": {"name": "polygon",
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558, 556, 555, 557, 558, 561, 563, 564, 565,
569, 573, 575, 578, 581, 582, 583, 584, 585,
585, 584, 582, 581], "all_points_y": [393, 394,
397, 398, 399, 398, 396, 393, 389, 385, 383,
382, 380, 377, 375, 371, 369, 369, 369, 371,
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551, 552, 553, 555, 557, 560, 562, 559, 558,
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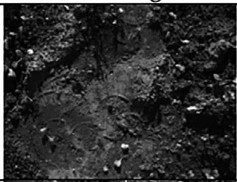
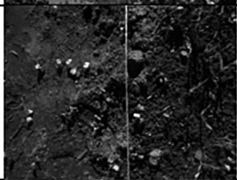
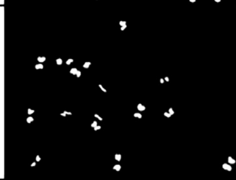
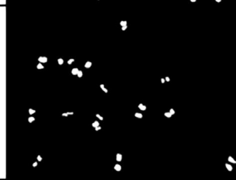
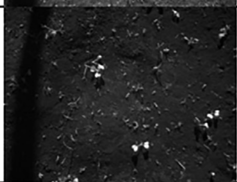
579, 581, 582, 583, 584, 584, 584, 584, 582,
581, 579, 575], "all_points_y": [416, 415, 415,
416, 418, 421, 424, 428, 431, 433, 434, 435,

Fig. 2. Manual annotations in COCO segmentation format.

_2: Green
_3: Red
_4: Near Infrared
_5: RedEdge

Example: An image name IMG_0200_3 represents the scene number 200 in Red channel. A few sample images from each of the subdirectories are demonstrated in Table 1. The **'Raw images'** subdirectory contains 85 MS images captured over seventeen image scenes [7] and demonstrates different spectra in Blue, Green, Red, NIR (Near-Infrared) and RedEdge spectrum. Each image was originally captured in **.TIFF** format and later exported in **.PNG** format to cater towards annotation and compression requirements [8]. The manual annotations were performed in VIA annotator [9] using polygon region shape to label wild radish leaves and the annotations were saved in COCO segmentation format as JSON (JavaScript Object Notation) titled **'region_data'** (Fig. 2) in the subdirectory **'Manual Annotations'**. This file contains the annotations information of the ground truth regions of interest (ROI) of individual wild radish instances [5]. The segmentation masks of the ground truth ROI are saved in **.JPG** format in the subdirectory **'Binary Masks – Manual'**. The automated annotations are saved as **.XML** files (Fig. 3) sharing the same

Table 1
Details of the dataset with examples.

File	Folders		
	Raw Images	Binary Masks – Manual	Binary Masks – Automated
IMG_0200_1			
IMG_0287_2			
IMG_0296_3			
IMG_0297_4			
IMG_0299_5			

filenames as of the images stored altogether in the subdirectory **'Automated Annotations'**. The segmentation masks derived using the automated annotations are saved as .PNG files in the subdirectory **'Binary Masks – Automated'**. Through randomly selected images and segmentation masks, we emphasize to demonstrate variation in terms of segmented instances, spectral reflectance and shape of wild radish instances. We have retained the original names of the image files from the primary image source (Table 1). The segmentation masks derived through the different annotation types are provided under categories **'Manual'** and **'Automated.'** The program to perform automated annotation and extraction of binary masks is provided in the subdirectory **'Codes.'** In a segmentation mask image, white pixels represent wild radish, and the black pixels represent the background.

```
▼<annotation>
   <folder/>
   <filename>IMG_0295_5_png_jpg.rf.17c111f9799cf962e1d718be42a8105e.jpg</filename>
   <path>IMG_0295_5_png_jpg.rf.17c111f9799cf962e1d718be42a8105e.jpg</path>
 ▼<source>
     <database>roboflow.com</database>
   </source>
 ▼<size>
     <width>1280</width>
     <height>960</height>
     <depth>3</depth>
   </size>
   <segmented>0</segmented>
 ▼<object>
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     <pose>Unspecified</pose>
     <truncated>0</truncated>
     <difficult>0</difficult>
     <occluded>0</occluded>
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       <xmax>585</xmax>
       <ymin>369</ymin>
       <ymax>402</ymax>
     </bndbox>
   ▼<polygon>
       <x1>556</x1>
       <y1>382</y1>
       <x2>554</x2>
       <y2>386</y2>
```


Fig. 3. Automated annotations in Pascal VOC segmentation format.

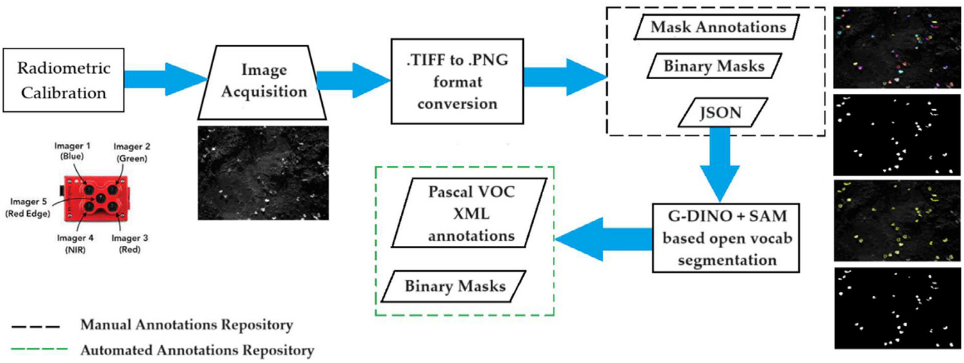

Fig. 4. Manual and Automated annotation workflow.

4. Experimental Design, Materials and Methods

Annotating weeds in close-ranged MS images is a time and resource demanding task. The challenge associated with analyzing close-ranged MS images is primarily intra-subject registration [10,11]. To ameliorate the process of automatic annotation, we trained a Grounding DINO + Segment Anything Model (SAM) based deep learning architecture to achieve annotation of model using the manually annotated images [12–14]. Grounding DINO and SAM are robust Artificial Intelligence (AI) models which assist in annotating datasets. Grounding DINO detects any object in an image without prior training, supplemented by SAM to transform these detected bounding boxes into detailed instance segmentation masks.

Using this trained Grounding DINO + SAM architecture, we generated weed leaf-bound annotations for 80 MS images using the annotated images. The annotation quality was the key priority during the initial stage of data curation. The accuracy of both the underlying repositories '**Manual Annotations**' and '**Automated Annotations**' were kept in check by extraction and evaluation of binary masks. The codes used for these operations are available in the '**Codes**' subdirectory of our data repository. The overall dataset creation workflow is shown in Fig. 4.

Limitations

One image scene, i.e. 5 images (IMG_0081_1, IMG_0081_2, IMG_0081_3, IMG_0081_4, IMG_0081_5) across different spectra were removed from '**Automated Annotations**' due to intrasubject mis-overlap. The resulting masks [7] suffer from few segmentation errors, particularly over-segmentation.

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief and confirming that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

Data Availability

RafanoSet: Dataset of raw, manually, and automatically annotated Raphanus Raphanistrum weed images for object detection and segmentation (Original data) (ZENODO)

CRediT Author Statement

Shubham Rana: Conceptualization, Conceptualization, Software, Validation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization; **Salvatore Gerbino:** Investigation, Writing – review & editing, Supervision; **Domenico Barretta:** Validation, Formal analysis; **Petronia Carillo:** Investigation, Writing – review & editing, Supervision; **Mariano Crimaldi:** Data curation, Investigation, Writing – review & editing; **Valerio Cirillo:** Supervision, Investigation; **Albino Maggio:** Resources, Project administration; **Fabrizio Sarghini:** Project administration.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] United States Geological Survey, “Radiometric Calibration of MicaSense RedEdge® Multispectral UAS Imagery.” Accessed: Feb. 01, 2024. [Online]. Available: https://uas.usgs.gov/nupo/pdf/RadiometricCalibration_poster.pdf.

[2] S.V. Eslami, G.S. Gill, B. Bellotti, G. McDonald, Wild radish (Raphanus raphanistrum) interference in wheat, Weed Sci. 54 (4) (2006) 749–756, doi:10.1614/ws-05-180r2.1.

[3] L. Kebaso, et al., Biology, ecology and management of Raphanus raphanistrum L.: a noxious agricultural and environmental weed, Environ. Sci. Pollut. Res. 27 (15) (2020) 17692–17705, doi:10.1007/s11356-020-08334-x.

[4] S.V. Eslami, Ecology of wild radish (Raphanus raphanistrum): crop-weed competition and seed dormancy, School of Agriculture, Food and Wine, The University of Adelaide, Adelaide, 2006 https://api.core.ac.uk/oai/oai:digital.library.adelaide.edu.au:2440/59619.

[5] T.-Y. Lin et al., “Microsoft COCO: common objects in context,” 2014, [Online]. Available: http://arxiv.org/abs/1405.0312.

[6] M. Everingham, L. Van Gool, C.K.I. Williams, J. Winn, A. Zisserman, The pascal visual object classes (VOC) challenge, Int. J. Comput. Vis. 88 (2) (Jun. 2010) 303–338, doi:10.1007/s11263-009-0275-4.

[7] Shubham Rana, Salvatore Gerbino, Mariano Crimaldi, and Domenico Barretta, “RafanoSet: Dataset of manually and automatically annotated Raphanus Raphanistrum weed images for object detection and segmentation in Heterogenous Agriculture Environment,” Aversa, 2024. 10.5281/zenodo.10567784.

[8] Adobe, “PNG v/s TIFF,” Adobe Creative Cloud. Accessed: Feb. 01, 2024. [Online]. Available: https://www.adobe.com/creativecloud/file-types/image/comparison/tiff-vs-png.html.

[9] M. Aljabri, M. AlAmir, M. AlGhamdi, M. Abdel-Mottaleb, F. Collado-Mesa, Towards a better understanding of annotation tools for medical imaging: a survey, Multimed. Tools Appl. 81 (18) (Jul. 2022) 25877–25911, doi:10.1007/s11042-022-12100-1.

[10] Y. Li, A. Fang, Y. Guo, W. Sun, X. Yang, X. Wang, Smooth fusion of multi-spectral images via total variation minimization for traffic scene semantic segmentation, Eng. Appl. Artif. Intell. 130 (2024), doi:10.1016/j.engappai.2023.107741.

[11] S. Rana, S. Gerbino, P. Mehrishi, M. Crimaldi, Comparative analysis of feature and intensity based image registration algorithms in variable agricultural scenarios, in: J. Kacprzyk (Ed.), *Lecture Notes in Networks and Systems*, vol. 514, Springer, 2022, pp. 143–160, doi:10.1007/978-3-031-12413-6_12.

[12] T. Ren et al., “Grounded SAM: assembling open-world models for diverse visual tasks,” 2024, [Online]. Available: http://arxiv.org/abs/2401.14159.

[13] S. Liu et al., “Grounding DINO: marrying DINO with grounded pre-training for open-set object detection,” 2023. [Online]. Available: http://arxiv.org/abs/2303.05499.

[14] A. Kirillov et al., “Segment anything,” 2023, [Online]. Available: http://arxiv.org/abs/2304.02643.