Annex 8.1
Technical offer. Part I

Requirements of the software proposed.

EGI/2023/OP/0001

1. Functional requirements

Describe the specific features and functionality that the software must have in order to meet the objectives.

ID	Type	Description according to technical specifications (Describe your proposal)
General functional requirements		
GFR_1	System	The whole system (web application) will be shared as open source software under Apache License 2.0. It means that the whole source code can be used, modified and redistributed without any issue. Source code and appropriate documentation will be shared under well-known Git repositories like GitHub/GitLab.
GFR_2	System	The whole system will be developed in-house and hosted on premises approach without the access to any popular cloud solution (GCP, AWS, AZURE, etc.). Web application will be developed in JAVA language. The deployment will be prepared for Linux platform to avoid any additional cost and to be in compliance with Apache license 2.0.
GFR_3	System	The whole infrastructure on premises will be designed for high availability on every layers OSI model. Moreover, web application will be deployed at high availability (HA) services as well. It means that the full environment including application layer will be fault tolerant with no services interruption. All above assumptions will allow the ability to run operationally in the Market Place EOSC for a minimum one year from delivery.
GFR_4	System	Web application will be compatible with most of current version browsers for Windows, Mac, Android, iOS systems. Moreover for more reliable compatibility and more convenient work under browsers mobile systems (Android and iOS) conversion to PWA (Progressive Web App) application will be considered. In case of REST API, this is browser independent and will work as usual API based on well-known HTTP request/response communication using JSON format.
GFR_5	Users	In the system min. 3 roles will be developed: 1. Administrators 2. Power users – users of cameras and analysis tools 3. Users - analytical tools user On the basis of the roles created 3 types of users will be introduced.
GFR_6	Users	During sign up functionality each user will create detailed profile in which she/he should provide at least the following information for statistical purposes: 1. University, Faculty, Department

		2. Expertise level (degree, student, etc.)
		3. Research field
		4. Purpose of use
GFR_7	Admin	The standard functionality of accounts and profiles in the system will be implemented. Moreover, admin communication with users of different types will be also implemented.

Specific functional requirements

Data acquisition and storage (DAS)

SFR_DAS_1	Camera data	At least two data sources will be used in the system. The data will be collected from two types of cameras. There will be CropView 10Mpx from Pessl Instruments (Austria) or 12 MPx Dahua from Dahua Technology (China) - and Dahua IP 5MPx from Dahua Technology (China). Both types of cameras contain configurable image stream schedule and have possibility to download image database on the scheduled time with defined frequencies (e.g. every 30 mins.). The communication functionality will be configurable in the system independently based on logged in administrator/power user. Additional types of camera/devices can be considered (API standarization).
SFR_DAS_2	Camera data	Except the two types of cameras mentioned in point SFR_DAS_1 it will be planned to use additional camera/data source on premises, located on tenderer side. The functionality of additional camera/data source will be similar but it lets verify properly implemented services and functionalities using devices located at own premises.
SFR_DAS_3	Camera data	All cameras which will be used in the project will have functionality to transfer data/images from SD Card (if any). This functionality allows to download images on demand directly saved in SD card. Notification of current usage SD Card space will be implemented to maintain operational continuity without any services interruption.
SFR_DAS_4	Input data	Due to the resolution of camera type 1 (10MPx at minimum) and type 2 (5MPx), the narrow of mobile bandwidth (sim card - UMTS/3G network or 2G/GPRS services) and bit depth of image which should be colorful image, the most appropriate image standard should be JPG/JPEG which should generate size of every image approximately: 12MB and 7MB respectively for camera type 1 and type 2. This standard will provide a good balance between the size of the file to be sent using a mobile transmission and the quality of the image
SFR_DAS_5	Camera data	The standard functionality which will be implemented is scheduled download image data from camera for predefined configuration (e.g. frequency every 30minutes, desired resolution, number images per day, window time excluded based on sun elevation or/window time per day with proper Sun elevation). In case of any issue regarding communication with cameras, there will be the possibility to download images data directly from SD Card.

SFR_DAS_6	Camera data	One of the important system feature is email notification functionality. There are 4 types of notification in the system. The first one is confirmation which only informs user that something is changed in the system. The second is reminder notification and it lets user remind about something in the system e.g. the scheduled image downloading will be run today at specific time. The third type of notification is a warning in the system. The example of this notification can be that almost 90% capacity of SD CARD is used. The last type of notification will be Error notification that something is wrong in the system or communication between system and camera is lost.
SFR_DAS_7	Camera auxiliary data	Except the desired data (image data) downloaded from cameras, additional data will be downloaded and stored in the system. There will be: meta data, parameters, site location, configuration, information about storage space. Above data will be stored according to defined camera in the system and user logged in interpedently.
SFR_DAS_8	Camera auxiliary data	On the basis of provided auxiliary data there will be planned functionalities such us: 1. Manage 2. Shape, 3. Clean, 4. Filter, 5. Upload historical and actual data in the form of images 6. Time series e.g. json , xlsx
SFR_DAS_9	Third-party data sources	For any analytics functionalities in the system it can be useful to map current data analyzed from camera with meteorogical data from the nearest weather stations. Automatic or on demand downloading of meteorogical data will be implemented in the system to have above mentioned functionality of its usage along with image data analyses. It can result in much more advanced analysis and get more interesting inferences.
SFR_DAS_10	Image data	The set of functionalities as below is planned to develop: - load image/images - zoom in/zoom out - select all ROI/mmROI - delete ROI/mmROI - add custom attributes e.g. class: fruit, leaf, e.g. - possibility of region shape to choose: rectangle, circular, elliptical, polygon, point, polyline, etc. - save to to file e.g. csv/xlsx/json - Data can be stored (sample) as below
SFR_DAS_11	Image data	Universal image searching module in the system will be implemented which will be mostly used in ROI definition module. Universal image searching module will have many criteria (metadata, tags, etc.) in the filter to allow the user to get appropriate image/images.
SFR_DAS_12	Image data	Images that are too bright or too dark will be automatically selected by the script after determining the critical values

		defined in the system or/and automatically select images which can be suspected based on calculation of the Sun at the camera location.
Data analysis (DA)		
SFR_DA_1	ROI definition	After loading the raster image it will be possible to select and modify the points of the raster image. The final result will be converted to the appropriate regional shape such as: rectangle, circular, elliptical, polygon, point, polyline which will be stated as of one single ROI. This single ROI will be saved in appropriate format: csv/xlsx/json file or other.
SFR_DA_2	ROI definition	After loading the raster image it will be possible to select and modify the points of the raster image. In this functionality there will be possible to mark more than single ROI (mmROI). The result – mmROI will be converted to the appropriate regional shape such us: rectangle, circular, elliptical, polygon, point, polyline (vertex) format and saved to a popular format, e.g. a json file or other.
SFR_DA_3	ROI definition	After loading the raster image it will be functionality (dedicated button on the web page) which invokes automatic detection of ROI (aROIs) based on machine learning algorithms. Web application will enable to upload external user model for automatic detection of ROI but external user model must meet criteria/requirements mentioned in provided documentation. It will be provided the example user model with already implemented machine learning algorithm which automatically segment mmROI on image based on proper class of ROI e.g. fruits, organic parts, e.g. It is planned to take into consideration the following segmentation machine learning algorithms which currently are the state-of-the-art as the minimum: - UNET, - MASK-RCNN It should be noted that for any segmentation machine learning models based on which atomically will be aROIs detected, it will be necessary to create ground truth dataset. The ground-truth dataset will be mandatory for training process.
SFR_DA_4	ROI definition	Machine models which can be provided by users (external models) or sample already provided can be read (deserialized) from one of the popular serialization approach, e.g.: Pickle, HDF5, JSON, XML, etc. It is mandatory that predefined/pretrained models should meet criteria/requirements according to documentation provided.
SFR_DA_5	ROI data	For segmented ROIs, functionality of ROI analytics data will be provided: RGB indexes, height, width, area.
SFR_DA_6	ROI data	For segmented ROIs, functionality of ROI additional analytics data will be provided e.g. Pairwise correlation, across all pixels in the ROI, between red DN and green DN, red DN and blue DN, and green DN and blue DN at minimum.
SFR_DA_	ROI data	For segmented ROIs, functionality of ROI additional analytics

7	-averaged	data will be generated: averaged RGB in ROI approach: computation of red, green, blue digital numbers (DN, from 0-255) over ROI at minimum
SFR_DA_8	ROI data-averaged fitting	For chosen ROI appropriate analytics data points in time will be provided in form of chart and based on the points approximated/interpolation line will added/fitted.
SFR_DA_9	Image & ROI meta data	For all files/images/data acquired to the system, time and date (timestamp) must be stored in database for any later purposes. Moreover all records with important data should have additional column with timestamp (can be called 'created') which will state date and time when row is created. The most important thing during date and time obtained from external system is verification/validation of time zone based on which external devices it works. There may be significant recalculation or just save datetime in UTC
SFR_DA_10	Image and ROI data - custom	User can have functionality to upload his own script for customized colour indexes method (CIs) under assumption that external script will meet all the criteria/requirements defined in provided documentation.
Built-in examples of trained AI models (AIM)		
SFR_AIM_1	Apple AI model	On the basis of the training provided images, ready-to-use in service AI model for automatic ROIs detection/segmentation for apple fruit will be developed and deployed. Desired quality of the model: mIoU>0.75.
SFR_AIM_2	Flowering AI model	On the basis of the training provided images, ready-to-use in service AI model for automatic ROIs detection/segmentation for flowering stage of European linden will be developed and deployed. Desired quality of the model: mIoU>0.70.
Data visualization (DV)		
SFR_DV_1	Image & ROI	The possibility of printing and exporting image or selected ROI objects in the format: jpg, png will be prepared. For a given photo, it will be possible to print the analysis results for defined ROI objects in the form of a table, e.g. xlsx, csv. You will be able to select ROI(s) from a given image.
SFR_DV_2	Image & ROI	A screen will be prepared presenting the taken images in the form of a list with thumbnails of photos. The list can be limited by camera, genre, date range. After selecting an item from the list, a full-size image will be presented and defined ROIs will be marked on the photo.
SFR_DV_3	Image & ROI	A screen will be prepared that allows you to present the changes recorded on the selected ROI from the recorded images in the form of a slide presentation. It will be possible to limit the time range of the photos taken. In addition, information on the number of identified objects will be presented for each ROI. Presentation of changes in identified objects for ROI will also be possible in the form of graphical charts.
SFR_DV_4	ROI data	A screen will be prepared enabling the presentation of changes registered for the ROI with the selection of the analysis parameter, e.g. size, staining over time. It will be possible to limit the time range of available results. The presentation of the results will be presented in the form of graphs of parameter variability over time.
SFR_DV_	ROI data	A functionality will be prepared to enable the presentation of

5		changes in the analyzed attributes, e.g. NDVI, size, etc. for ROI by. type, area. The presented data can be calculated, for example, as averages or real data derived from the analysis.
SFR_DV_6	ROI data	Functionality will be prepared enabling presentation of various classification graphs defined by the user. Setups can be stored and recovered by the user for future use. This graphs can be modified online by the user to match the required final shape.
SFR_DV_7	ROI data	A screen will be prepared on which images will be presented with information on whether they contain the sought-after objects. It will be possible to narrow down the presented data according to criteria, e.g. camera, date range.
SFR_DV_8	ROI data	The application will be able to present the identification results for a given ROI. The presentation will include a graphics area and a metadata area. The space in the ROI that contains the identified object is selected in the graphics area. Each identified object will have its own identifier and name. For each object, the ROI will show the available metadata obtained in the analysis process. These can be, for example, the number of objects, size/size and other attributes, e.g. color.
SFR_DV_9	Camera data	The application will be able to present data collected from devices. After selecting the device, you will be able to specify a time period to limit the number of images that meet the time criterion. For each image, metadata will be presented, e.g. photo type (zoom, wide angle), photo name, time of taking the photo, etc.
SFR_DV_10	Camera data	Based on the location data of the camera, a screen will be prepared for presenting the location of devices using Google Maps. Locations will be visible on the screen in the form of "pin" markers with descriptions displayed after hovering over the object. Depending on the presentation area, Google Maps will display the location data of devices within the presentation area.
SFR_DV_11	User data	The screen will be prepared to present data for specific premium user or user. It will be possible to filter data for specific user, groups of users, timeframes, types of data. Finally, this will be visualized in forms of graphs.
SFR_DV_12	Admin data	The set of user use cases, alerts, system messages will be defined on the administrative level. All of them will act as a response to specific user activities. Special screen with a report about the use cases, alerts, system messages generated by the specific user in the specific time frame will be prepared. There will be a possibility to filter users, timeframes, use cases, alerts, messages. Finally, this will be visualized in forms of graphs.
Data export		
SFR_DE_1	Image data	It will be prepared the possibility to export taken images to local storage media in the format in which the photo was imported, e.g. jpg, png. Export will be possible for single images or collective for selected photos, including filtering, e.g. by time period, type, location.
SFR_DE_2	Analysis data	It will be prepared the ability to export recorded analysis results to local storage media in formats such as csv, xlsx.

		Export will be possible for single analysis results, e.g. ROI or collective for selected ROIs, including filtering, e.g. by time period, type, location.
SFR_DE_3	ROI data	It will be prepared the ability to export ROI data (polygon coordinates) to local storage media file in formats such as csv, xls. Export will be possible for single analysis results, i.e. one ROI or collective for selected ROIs, including filtering, e.g. by time period, type, location.

2. Performance requirements

Specify any performance-related requirements, such as response time, scalability, and availability.

Performance requirements (Describe your proposal)	
PR_1	The proposed Service Level Agreement (SLA level) will be at 99.5 % level. It means that periods of allowed downtime/unavailability are the following: - Daily: 7m 12s - Weekly: 50m 24s - Monthly: 3h 37m 21s - Quarterly: 10h 52m 2.2s - Yearly: 1d 19h 28m 8.8s The proposed durability of data (system also) will be at 99.99% level and it refers to the continued persistence of data. This will be achieved by improving durability of the data (source code also) and the storage infrastructure. High level of durability ensures that the data does not suffer from bit rot, degradation, or any form of corruption or data loss. Traditional/regular web page request will respond within 1000 milliseconds. But some of functionalities especially based on machine learning algorithms can exceed above time response caused by complexity of algorithms. The potential batch (if any) process must complete its processing withing 60 minutes.

3. Platform and infrastructure requirements

Specify any platform or infrastructure requirements, such as operating systems, databases, or development tools.

Platform and infrastructure requirements (Describe your proposal)	
PIR_1	The whole infrastructure will be on-premises (non-cloud solution). In case of servers (most Dell servers) high availability approach will be applied based on virtualization/containerization. Web application and REST API solutions will be exposed by at least 2 nodes (web servers) with load balancer which allows to distribute application traffic across a number of available servers. Load balancers will be used to increase capacity (concurrent users) and reliability/availability of applications (web application and REST API). In case of data, data arrays will be used with redundant power supply, iSCSI controllers with redundant connection to servers. Every data array will have at least one hot spare disk (for every type of disk). Moreover, every data array will have automatically

	replication/synchronization process to protect data and different RAID (RAID 1/5/6/10/50/60) solutions will be applied depending on requirements.
	Server room will have redundant Internet access provided by at least 2 Internet Service Provider and at least 2 power supply at different phases/providers.
	Most of the system will be based on Linux (Ubuntu), etc.which provide more stability than Windows operating system.
	Machine learning models will be provided by Python environment based on tensorflow/pytorch framework and exposed to web form application developed in Java.
	The whole source code, documentation and any required documents will be placed at repository system in public access exposed by Apache License 2.0.

4. Support and maintenance requirements
Clearly state the requirement for the software solution to be maintained and supported.

Support and maintenance requirements (Describe your proposal)	
SPPM_1	The documentation/tutorials will be provided in English and Polish language and of course will contain information regarding 1) camera connection, 2) data processing and analysis, since the service will cover the needs of the agriculture research community.
	In order to guarantee the quality of the software developed and its perfect functioning, the maintenance tasks will be necessary until 30th September 2023.
	Moreover, a dedicated customer support system (ticket system e.g. osTicket) will be provided to maintain user ticket send regarding web application.

Place and date:
Głogów Małopolski, 15th March, 2023
Name (in capital letters), function, company and signature
KRZYSZTOF BOBRAN, Chairman of the Board, Seth Software sp. z o.o.

Podpisano przez/ Signed by:
KRZYSZTOF
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Data/ Date: 15.03.2023 21:38
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