## User Story 1: Load Images from a Folder

## Status: In progress

* **Priority:** High
* **Acceptance Criteria:**
  + The software can access and load a large set of images that includes all the images acquired during the SIA processing of a single slurry sample. The sample information will be passed to the application through the command line parameters during the calling of the application by the HMI/Controller software.
  + Configuration file specifies the folder location containing the images.
  + The software should return an error code if unable to load images.

## User Story 2: Segment Bitumen Droplets

* **Priority:** High
* **Acceptance Criteria:**
  + The software accurately segments bitumen droplets in images for the SIA sample.
  + Each individual bitumen droplet within the images is correctly identified as a separate object.
  + The software should return a warning code if unable to segment images or if no bitumen droplets are found.

## User Story 3: Measure Bitumen Droplet Characteristics and Save in File

* **Priority:** High
* **Acceptance Criteria:**
  + The software measures various characteristics of all bitumen droplets identified during segmentation.
  + The bitumen characteristics measured and saved are the following: Centroid-X, Centroid-Y, Area, Velocity, Major Axis Length, Minor Axis Length, Orientation, Mean Intensity-Red, Mean Intensity-Green, Mean Intensity-Blue, Mean Intensity-NIR, Solidity, Eccentricity, and Radius.
  + Measurement results are accurate and saved in a comma separated values (CSV) ASCII text file of the same format as the file that was created by the previous SIA V1 application, with any deviations that may be required from that format clearly outlined in the supporting documentation. Each object will have its own row or line in the CSV file, and each line will be terminated with the standard Windows® carriage return and line feed sequence.
  + The CSV file will have a descriptive header row for each column.
    - Each analysed sample should be stored in a separate CSV file and the file name should be descriptive in such a way that the user can easily trace back to the sequence number and time the sample was taken. The CSV file name should also be easily matched with other supporting files that are created in this process. For example, file name could be SIAV2\_YYYY-MM-DD\_hh-mm-ss where: YYYY = year, MM = Month, DD = Day, hh = hour (24-hour clock), mm = minutes, ss = seconds. This date and time should reflect the sample time (not processing start or end).
  + The created CSV file should be importable into Microsoft® Excel® for further analysis without any need for editing or correction of format.

## User Story 4: Load Configuration File

* **Priority:** Medium
* **Acceptance Criteria:**
  + The software correctly loads and parses a configuration file each time it is started.
  + The configuration file should specify drive locations of interest, such as the folder that contains the input Line Scan image set to be processed, and folders where to save the outputs (segmented images and resulting CSV files).
  + The configuration file should specify which output files can be flagged as ON or OFF. For example, segmented images can be saved or not saved, summary statistics can be automatically generated or not generated.
  + The configuration file should include adjustable image processing variables, such as region of interest, thresholds, and any other required parameters.
  + The software should return an error code if unable to load the configuration file.
  + The actual format of the configuration file will be decided during development, but should be easily parsed, human readable where possible, and use an industry standard such as JSON, XML, or key value pairs.
  + The location of the configuration file should be the same directory as the program files, or in a central configuration file store location if other custom applications on the SIA V2 use a central configuration file store location. NOTE: The configuration values will not be stored in the Windows Registry, they will be stored in a file with a file name that clearly designates it to be a configuration file.

## User Story 5: Error Logging

* **Priority:** Medium.
* **Acceptance Criteria:**
  + The software shall store all status and errors to two separate error log files the first is the ongoing error log, and the second is the last sample log file.
  + The purpose of the ongoing error log is to have a longitudinal timeline of all errors of the application since the error log was created (or last cleared)
  + The last sample log file is to provide the HMI with feedback as to any issues that are occurring with the sample analysis application so they can be displayed to the user and potentially, depending on severity, illuminate the error light on the front panel.
  + The format of the error log file should be, in CSV format, the date with time, sample sequence number, error code, and a useful description of the error that occurred followed by a new line (in Windows® this is a carriage return and line feed). If no error occurs than that will be recorded. For example:

2023‐08‐27T13:19:15, 1232,0,”Analysis completed successfully in XXXs. No error found.”<CRLF>

or

2023‐08‐27T13:24:15, 1233,1,”Configuration file not found. Application exited. Analysis incomplete.”<CRLF>

Where in both of these examples the <CRLF> is actually the byte character 0x0D followed by the byte character 0x0A.

* + The format of the last sample log file shall be several values delimited by a comma. The first is the sample sequence number, followed by a “,” followed by the error code. The key summary statistics for the last entry may also be provided to the HMI through this file as well, or this might be replaced with entries in the shared binary file.
  + If the error files cannot be created then a message box will be displayed to the user indicating that a fatal error in the analysis software has been found and that samples are not going to be analyzed. This will be the only time that the application will interact directly with the user not through the HMI.

## User Story 6: Save Segmented Bitumen Images

* **Priority:** Medium
* **Acceptance Criteria:**
  + The software provides an option to save the segmented bitumen droplet images, which is useful for visually verifying the accuracy of the image analysis software.
  + The flag and the output folder for saving segmented images is in the configuration file.
  + The software saves all resulting segmented images as Portable Network Graphics (PNG) files.
  + Each segmented image file should be stored in a separate file and the file name should be descriptive in such a way that the user can easily trace back to the sequence number and time the sample was taken. The file name should also be easily matched with other supporting files that are created in this process such as the CSV file.
  + The software should return a warning code if unable to save images.

## User Story 7: Segment Sand and Air Objects

* **Priority:** Low
* **Acceptance Criteria:**
  + The software accurately segments sand and air objects in SIA sample.
  + Each individual sand and air object within the images is correctly identified and classified as a separate object.
  + The software should return a warning code if unable to segment images or if no sand or air objects are found.

## User Story 8: Measure Sand and Air Object Characteristics and Save in CSV

* **Priority:** Low
* **Acceptance Criteria:**
  + The software measures various characteristics of sand and air objects.
  + The object characteristics measured and saved are the following: Centroid-X, Centroid-Y, Area, Velocity, Major Axis Length, Minor Axis Length, Orientation, Mean Intensity-Red, Mean Intensity-Green, Mean Intensity-Blue, Mean Intensity-NIR, Solidity, Eccentricity, and Radius.
  + Measurement results are accurate and are saved in the same comma separated values (CSV) file used for bitumen droplets of the same sample (outlined in User Story 4).
  + Each object will have its own row or line in the CSV file and the same formatting will be used as for bitumen droplets.
  + A column “Object Class” will be added to the CSV file to indicate the object type: “UKN” – Unknown, “BIT”—Bitumen, “SND”—Sand, and 4—“AIR”.

## User Story 9: Save Segmented Sand and Air Object Images

* **Priority:** Low
* **Acceptance Criteria:**
  + The software provides an option to save the segmented sand and air objects images, which is useful for visually verifying the accuracy of the image analysis software.
  + The flag and the output folder for saving segmented images is in the configuration file.
  + The software saves all resulting segmented images as Portable Network Graphics (PNG) files.
  + Each segmented image file should be stored in a separate file and the file name should be descriptive in such a way that the user can easily trace back to the sequence number and time the sample was taken. The file name should also be easily matched with other supporting files that are created in this process such as the CSV file.
  + The software should return a warning code if unable to save images.

## User Story 10: Calculate Summary Statistics and Save in CSV

* **Priority:** Low (could be coded later as a separate batch process for all samples).
* **Acceptance Criteria:**
  + The software calculates statistics for all identified bitumen droplets.
  + Statistical information includes relevant metrics for the bitumen droplets:
    - PSD metrics by both number and volume.
    - Average bitumen diameter and volume-weighted average diameter of droplets.
    - Software should allow for a clear place to plug in code to calculate additional statistics in the future should it be required. These statistics could also drive additional types of outputs such as analog output 4-20mA loops from the PLC though a MODBUS connection instead of saving to the CSV files; however, any of that type of work is out of scope for this first version and a separate functional design specification for that work package can be developed in the future.
  + The CSV file will have a descriptive header row for each column.
  + The summary statistics should be created for each analysed sample and be stored in a separate CSV file. The file name should be descriptive in such a way that the user can easily trace back to the sequence number and time the sample was taken. The CSV file name should also be easily matched with other supporting files that are created in this process.
  + Key summary statistics will be passed to the HMI for display.