

# Supplementary Information for "SALSA: A low-cost self-driving lab modular add-on for salt solubility assessment for battery electrolytes"

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  - Fig. S14 S15 S16 show training loss, validation loss, and accuracy of the classification model respectively.
  - Fig. S18 shows the data point distribution for classification model training.

Component	Brand	Quantity	Total Cost (in USD)
Desktop	Dell Slim Desktop ECS 1250	1	~700
Aluminum Shaft	MakerBeam 10x10x10mm Starter Kit	1	~160
USB Dock	Atolla 16 Port Power USB Hub 3.0	1	~50
Peristaltic Pump	Longer L100-1S-2	2	~3,000
10-port Valve	VICI Valco VC-C12-310	1	~150
3-way Valve	Cole Pramer Valve	3	~800
USB Relay	Songle 8-channel	2	~40
Analytical Balance	Radwag AS 220.R2 PLUS	1	~1,700
12V DC Motor	Kamoer NKP	1	~10
Total	-	-	~6,610

(a) Bill of materials of components previously built in Clio

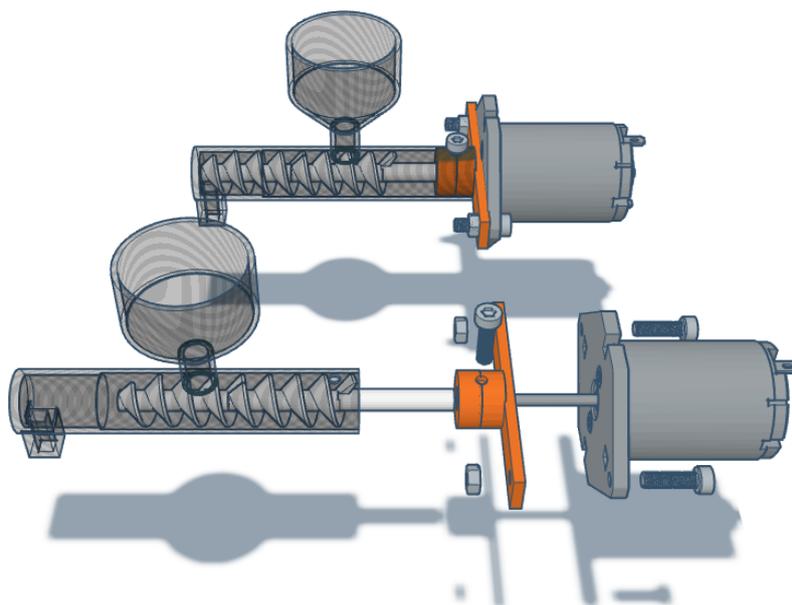
Component	Brand	Quantity	Total Cost (in USD)
12V DC Motor	Kamoer NKP	2	~20
Webcam	Logitech C920x	1	~60
Thermometer	Elitech LogEt5TE External-Temp	1	~20
3D Printing Part	Bambu PLA Filament	~50g	~5
Total	-	-	~105

(b) Bill of materials of components committed to build SALSA

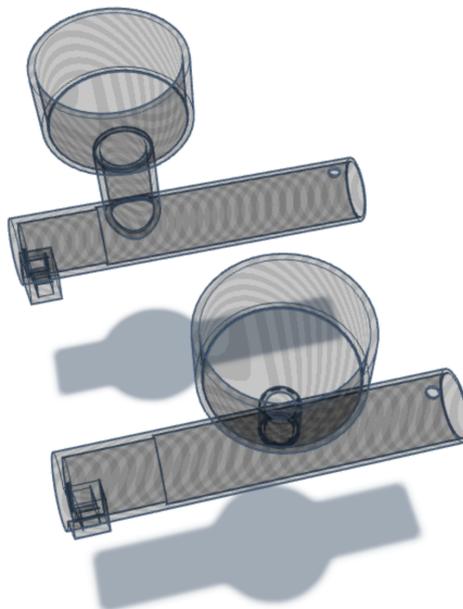
Table S1: Bill of Materials of previously built components and newly added components

	SALSA	Shiri et al.	Manual
Accuracy	$\pm 20\%$	$\pm 10\%$	subject to human eyes
Throughput	5-50 min	20-80 min	a few hours
Initial Cost	~6,610 USD	~90,000 USD	< 500 USD
Solvent Needed per Measurement	< 1mL	< 5mL	> 5mL

Table S2: Comparison table of SALSA, Shiri et al., and Manual



(a) Exploded and assembled view of the solid doser: The 3D printed connector was first attached to the 12V DC motor through two M3 size bolts and nuts. Then, the Archimedes screw was directly attached to the motor's spinning rod. Finally, the solid dosing tube was attached to the connector via one M3.5 size bolts to finish the assembly. All the 3D printed parts are printed using PLA materials.



(b) Solid doser dosing tube used for  $\text{Li}_2\text{SO}_4$  (top) v.s.  $\text{NaNO}_3$  (bottom): Given the material difference that  $\text{Li}_2\text{SO}_4$  is more "flour" like while  $\text{NaNO}_3$  is more "salt" like,  $\text{Li}_2\text{SO}_4$  doser is designed to have thicker neck diameter and shorter distance to the dispensing exit so that  $\text{Li}_2\text{SO}_4$  can be dispensed more smoothly

Figure S1: CAD screenshots of solid dosers used in SALSA

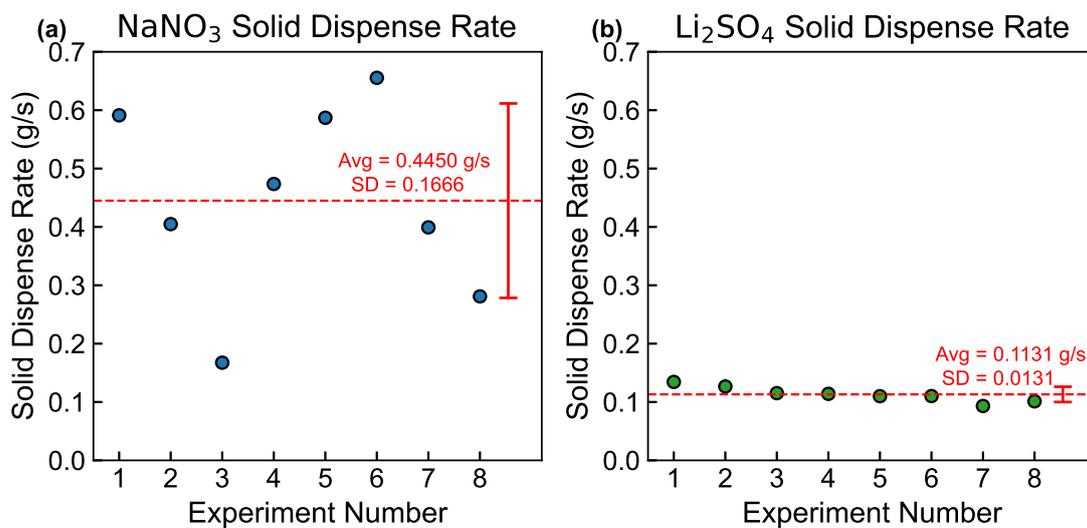


Figure S2: Solid dosing rate with error bar of (a)  $\text{NaNO}_3$  and (b)  $\text{Li}_2\text{SO}_4$

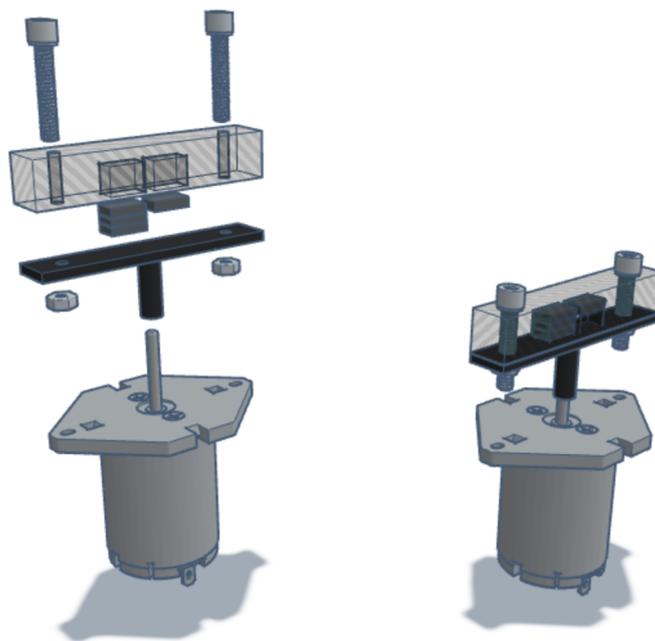


Figure S3: Exploded and assembled view of the magnetic stirrer: A 12V DC motor is connected to a 3D printed mounting. The mounting contains two columns of magnetic bars, with one column having one magnetic bar, and the other having three magnetic bars. Finally, the mounting are assembled via two sets of M3 bolts and nuts. All the 3D printed parts are printed using PLA materials.

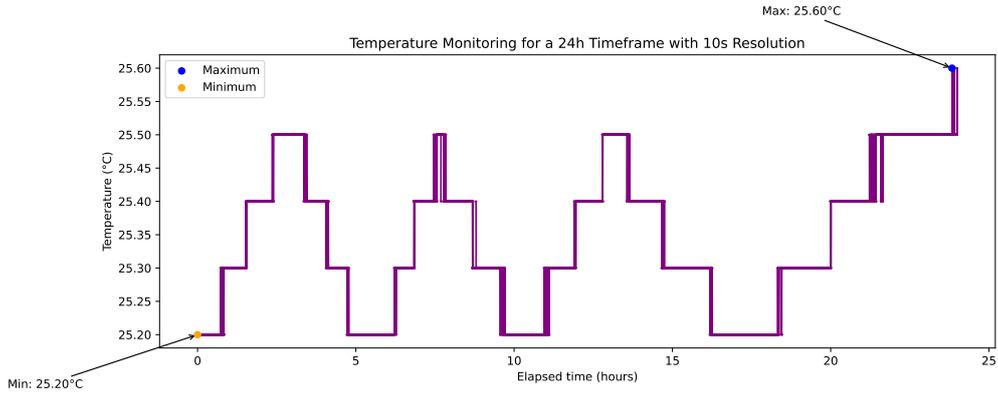


Figure S4: Temperature Monitoring of a 24-hour timeframe recorded at a resolution of 10 seconds

Parameter Name	Value
Number of Epochs	80
Batch Size	16
Image Size	640 × 640
Learning Rate	0.01
Label Smoothing	0
Optimizer	SGD

Table S3: Parameters used for YOLO vial detection model

Parameter Name	Value
Number of Epochs	250
Batch Size	16
Image Size	224 × 224
Learning Rate	$2.2 \times 10^{-4}$
Optimizer	AdamW
Label Smoothing	0.05

Table S4: Parameters used for YOLO dissolution status classification model

	Clear	Sediment
Train	55	105
Val	21	38

Table S5: Training and validation split by class for the solubility classification dataset.

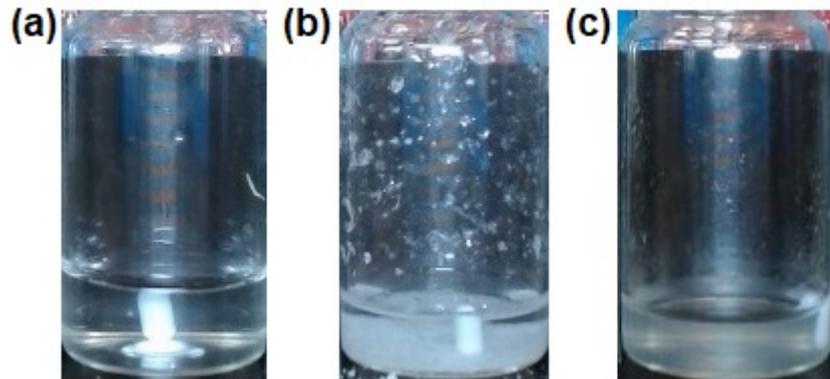


Figure S5: Example of data images with (a) clear liquid, (b) liquid with salt-like sediment, and (c) liquid with flour-like sediment.

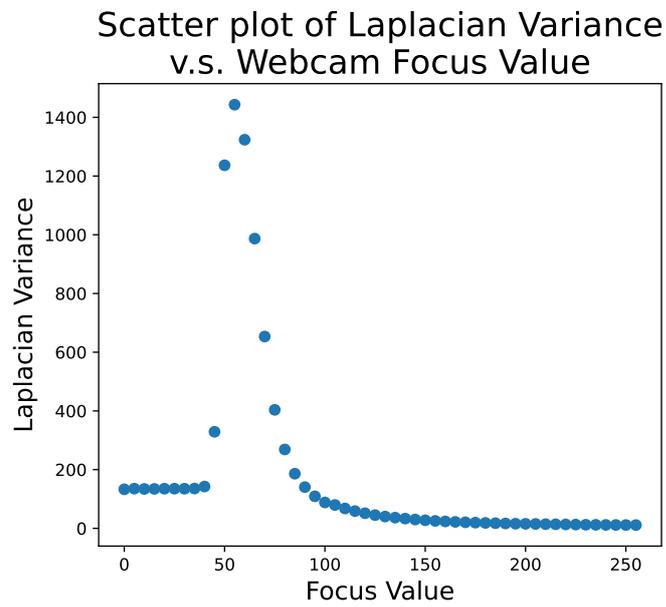


Figure S6: Laplacian Variance vs. Focus Value for Webcam. The optimal focus value is 55.

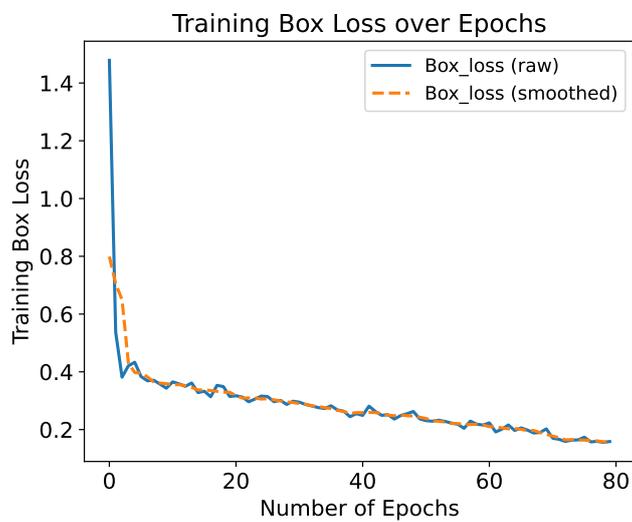


Figure S7: Training Box Loss vs. Number of Epochs for YOLO detect model

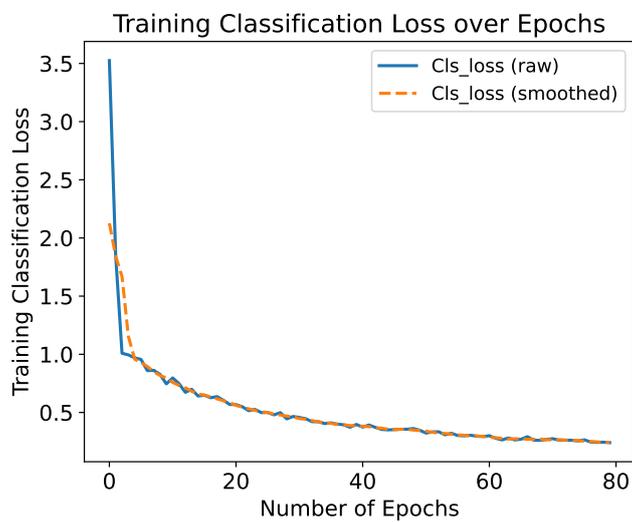


Figure S8: Training Classification Loss vs. Number of Epochs for YOLO detect model

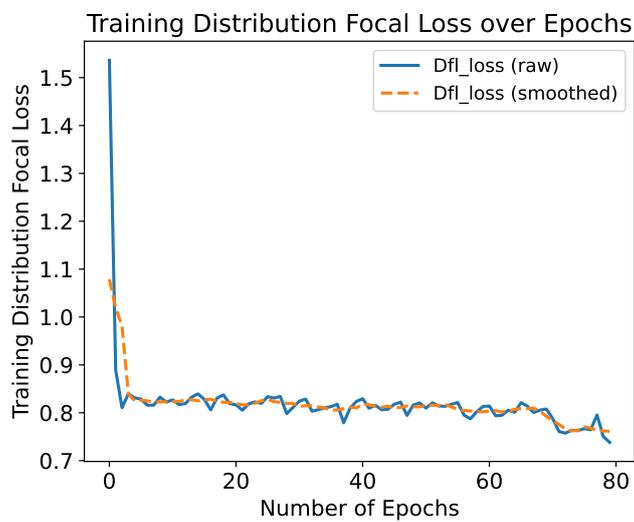


Figure S9: Training Distribution Focal Loss vs. Number of Epochs for YOLO detect model

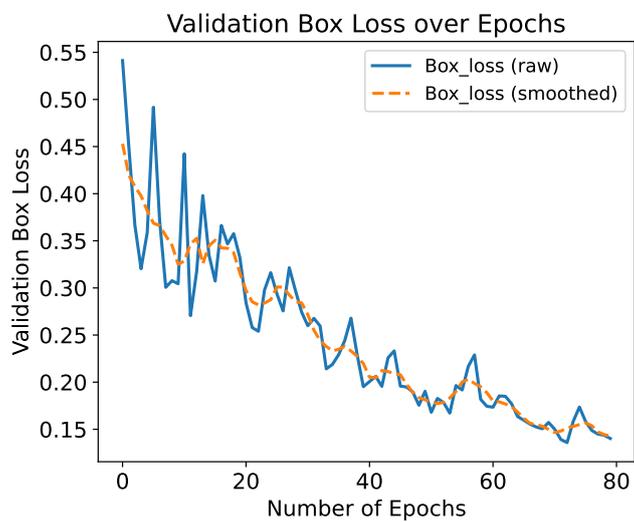


Figure S10: Validation Box Loss vs. Number of Epochs for YOLO detect model

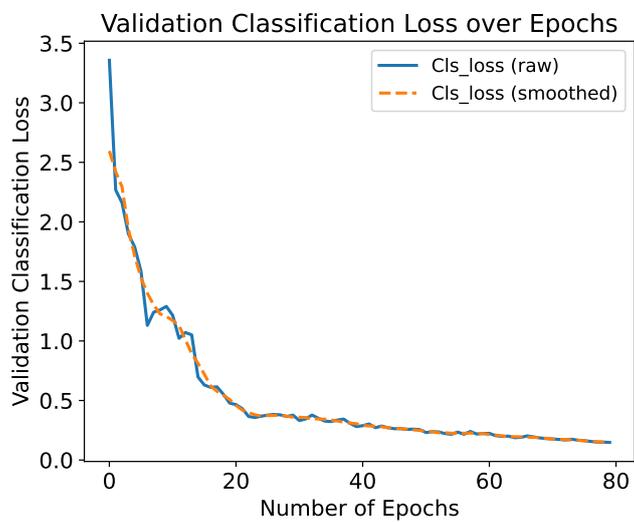


Figure S11: Validation Classification Loss vs. Number of Epochs for YOLO detect model

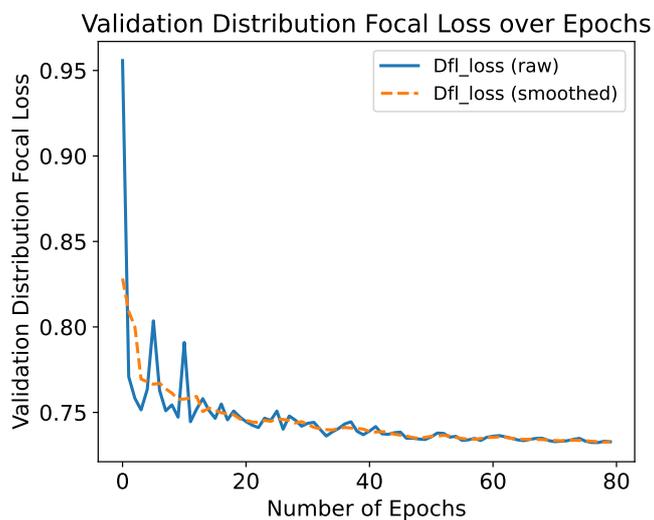


Figure S12: Validation Distribution Focal Loss vs. Number of Epochs for YOLO detect model

Confusion Matrix for YOLO Detection Model

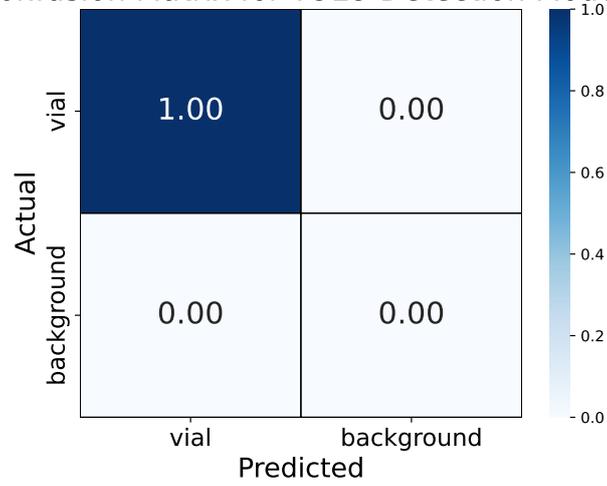


Figure S13: Confusion Matrix for YOLO Detection model. The model is not generating any errors.

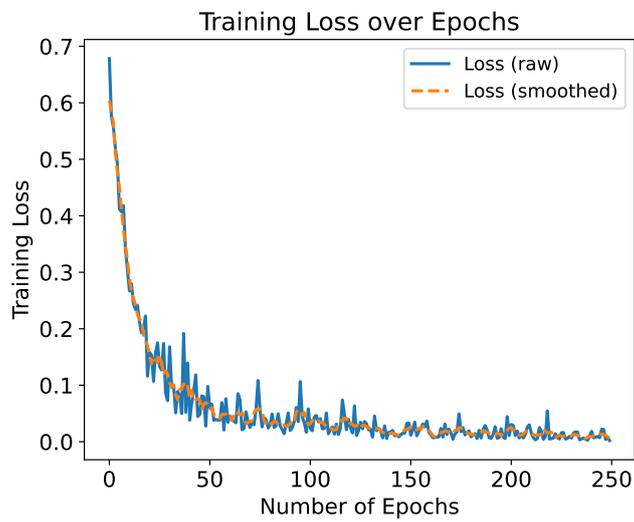


Figure S14: Training Loss vs. Number of Epochs for YOLO classification model

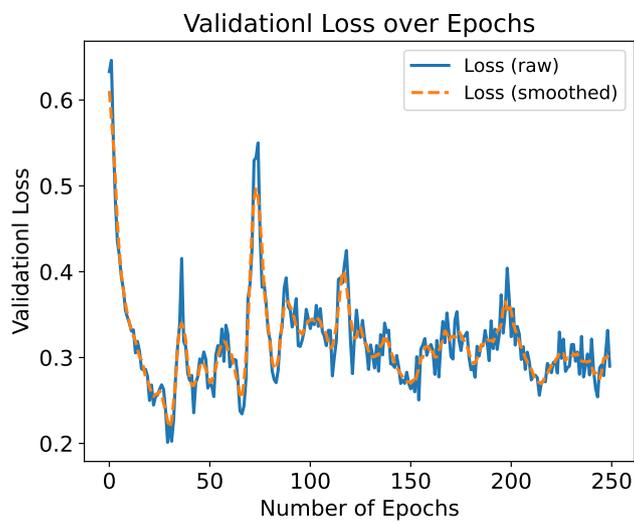


Figure S15: Validation Loss vs. Number of Epochs for YOLO classification model

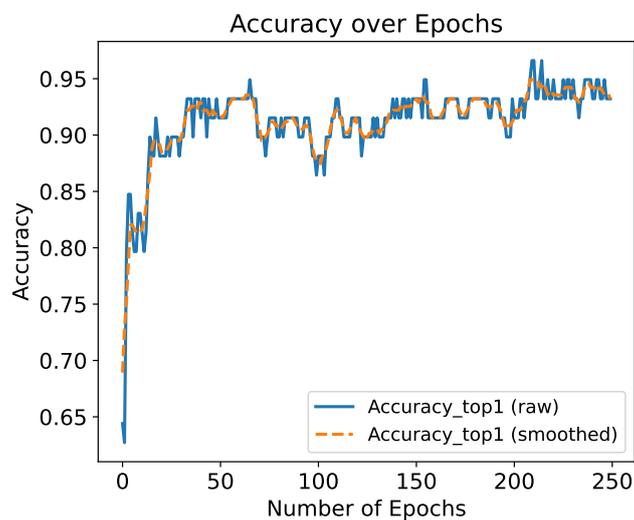


Figure S16: Accuracy vs. Number of Epochs for YOLO classification model

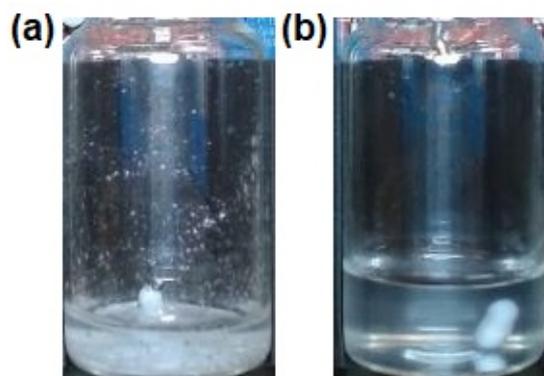


Figure S17: Example of images: (a) liquid and sediment but misclassified as "clear", (b) clear liquid but misclassified as "sediment"

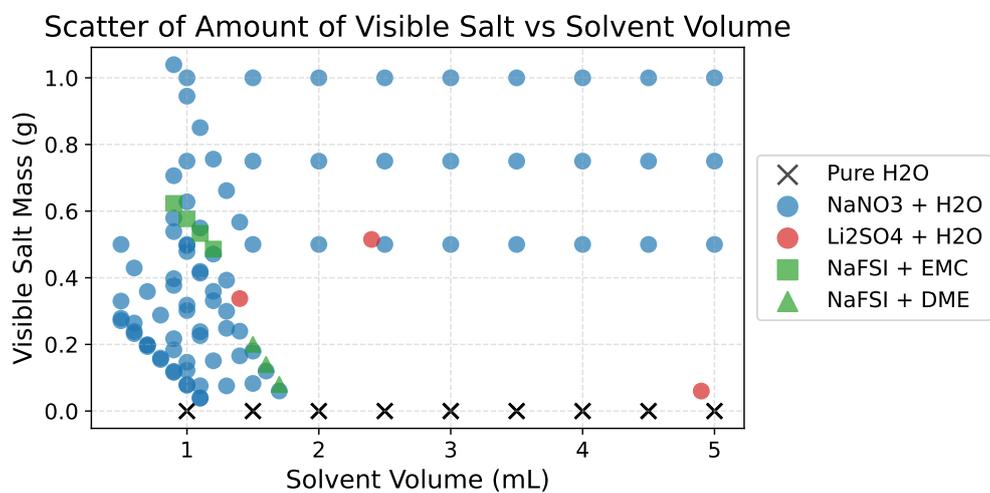


Figure S18: The distribution of liquid volume and solid mass of the data points in the dataset used for classification model training