Concept for a Guided Dismantling Process of used Industrial Batteries

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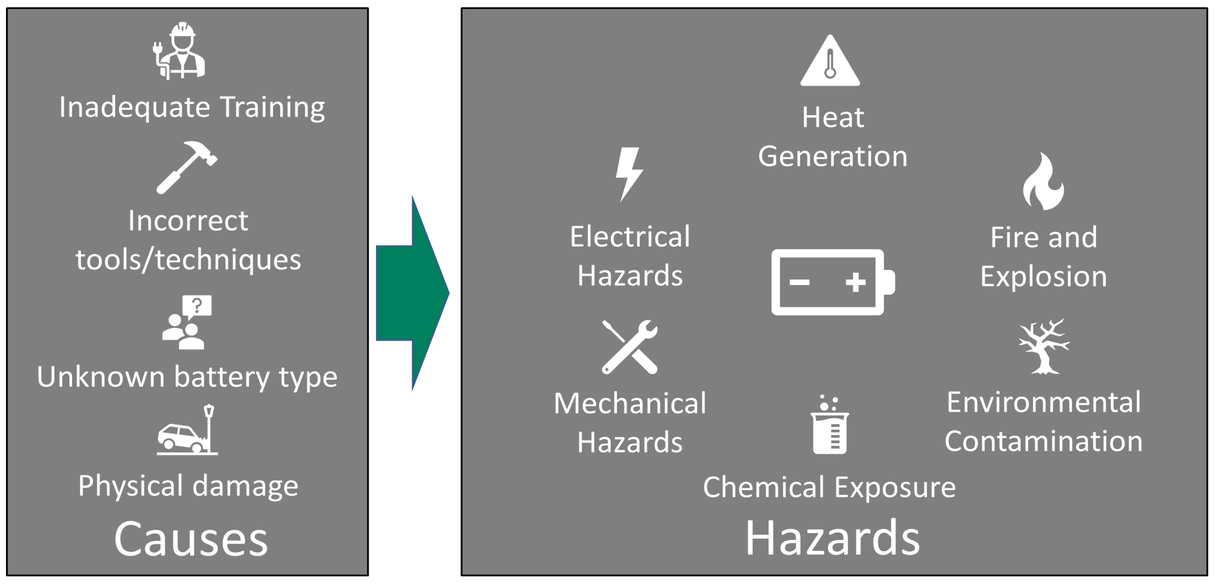
MOTIVATION

- Battery manufacturers are **obligated** to **take back used batteries and** implement the **life cycle approach** according to the new European Battery Regulation[1]
- In addition to the direct reuse of these batteries, the **dismantling** and **reuse** of **battery components** offer significant potential for **resource savings** (e.g. BMS, cell modules)
- The challenge arises from the **lack of a standardized structure or cells** in industrial batteries, especially those designed for specific purposes
- This lack makes **automated disassembly** and documentation **difficult**
- Nevertheless, the manual dismantling of such batteries involves considerable **potential hazards**, including short circuits and fires
- The goal of this work was to develop a **guided** and **automatically documented dismantling process** with safety measures and flexibility for different battery systems, aiming to reduce the hazard risk

ANALYSIS OF DANGER

- To evaluate the danger that can be caused by old or defective batteries, a **hazard analysis** and **risk assessment** (HARA) was first carried out



CONCEPT AND RESULTS

Measuring Unit[3]

- Modular multi-sensor system (PicoLoggers + Master)
- Distributed data acquisition system (DAQ)
- Automatic sensor detection and configuration (Plug and Play)
- Gas, I, V, T, CAN, …
- Remote access

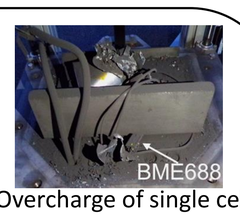

PicoLogger

I. Result

II. Result

Gas Classification

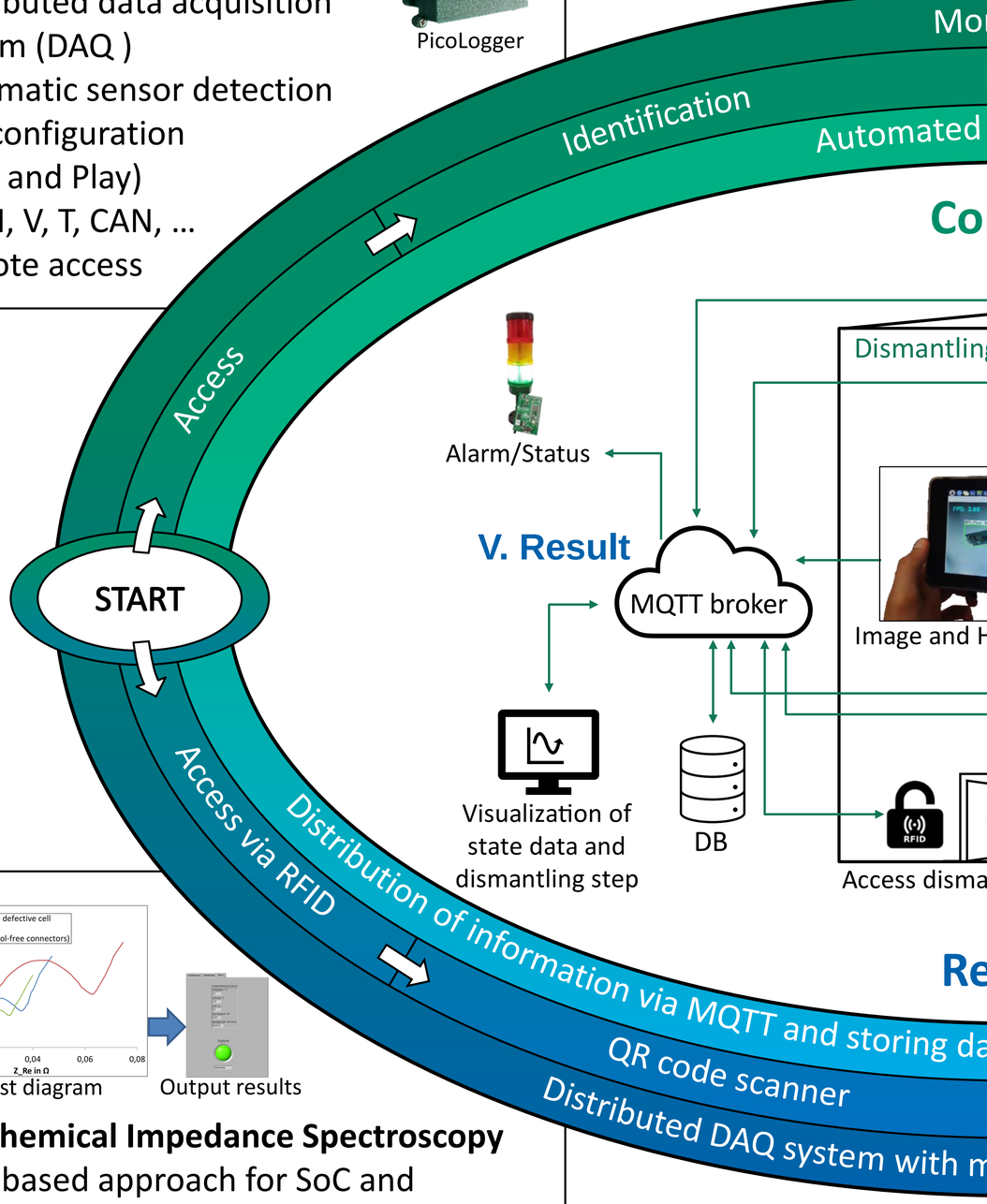
- Enables assessment of the hazard potential
- Normal air, electrolyte, fume, …



Overcharge of single cell

		Prediction			Details
		Normal Air	DMC	EMC	Deep neural network
Actual class	Normal Air	13	0	0	Training/Test data 70/30 %
	DMC	0	64	1	Batch size: 4
	EMC	0	0	22	ADAM optimizer
					FP: 1.45%

Confusion Matrix



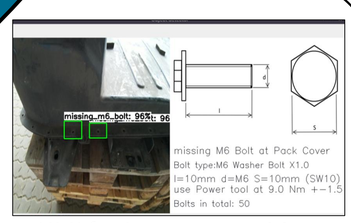
Nyquist diagram

Output results

Electrochemical Impedance Spectroscopy

- Data based approach for SoC and $SoH_{R,C}$ estimation with data validation
- Cells and modules can currently be classified (up to 300 V, 30 A, 5 kHz)

III. Result



HMI for Image recognition

Image Recognition[2]

- Automatic generation of training data from CAD data
- Detailed description of the dismantling step

IV. Result

SUMMARY AND CONCLUSION

- A concept of a novel dismantling station for industrial batteries was developed with a **distributed sensor system**, **image recognition** and further **safety-relevant components** to **guide** the **operator safely** through defined dismantling steps
- Moreover, the solution is designed flexible enough to monitor battery systems of several types and applications
- Countermeasures were developed and successfully demonstrated for the most important points identified in the **HARA**
- This includes **leakage** and **hotspot detection** as well as **mechanical damages** recognition
- Enable the classification of End-of-First-Life Batteries for **Re-X** approaches (Reuse, Remanufacturing, Recycling)

REFERENCES
1. Regulation of the European Parliament and of the Council concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC. 2023
2. Grunau. Detektion von Gefahrensituationen während der Zerlegung von Batteriesystemen (unpublished interim presentation of diploma thesis). 2024
3. Schwibs. Entwicklung und Aufbau eines modularen Multisensorsystems zur Überwachung eines Batterieprüflabors (unpublished bachelor thesis). 2023

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