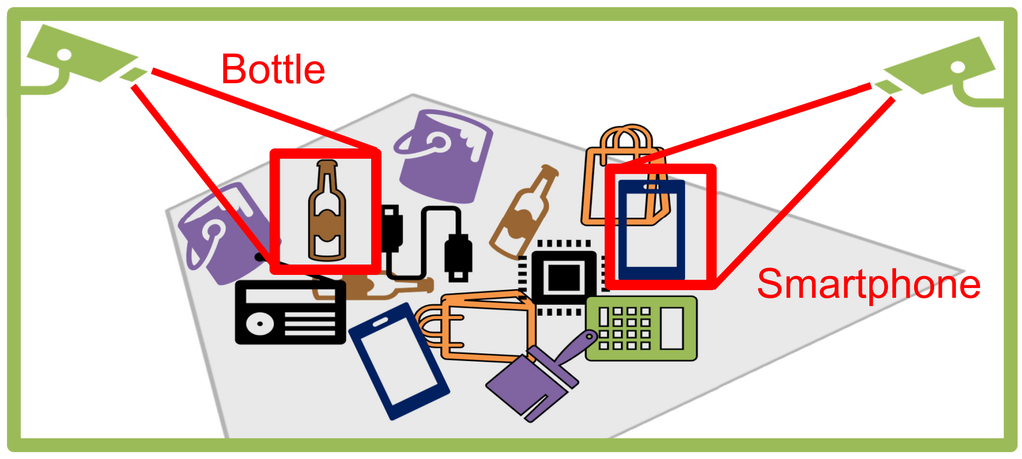
Plant Control for Fully Automated AI-Driven Product Type Recognition

The development and implementation of an AI-driven control system into an automated process is described. Special emphasis is placed on optimizing raw material recovery by classifying recyclable devices. The developed system is an example of the interlocking of mechanics, electronics and AI in recycling technology.

In the recycling sector, the automatic recognition and classification of products using artificial intelligence (AI) is becoming important:

- Device Classification,
- Device Specification,
- Using multiple Sensors to detect Internal Components,
- Building Datasets semi-automatically,
- Communication with robotics.



N. Abou Baker, P. Szabo-Müller, and U. Handmann. Transfer learning-based method for automated e-waste recycling in smart cities. EAI Endorsed Transactions on Smart Cities, 5(16):1–9, 4 2021.
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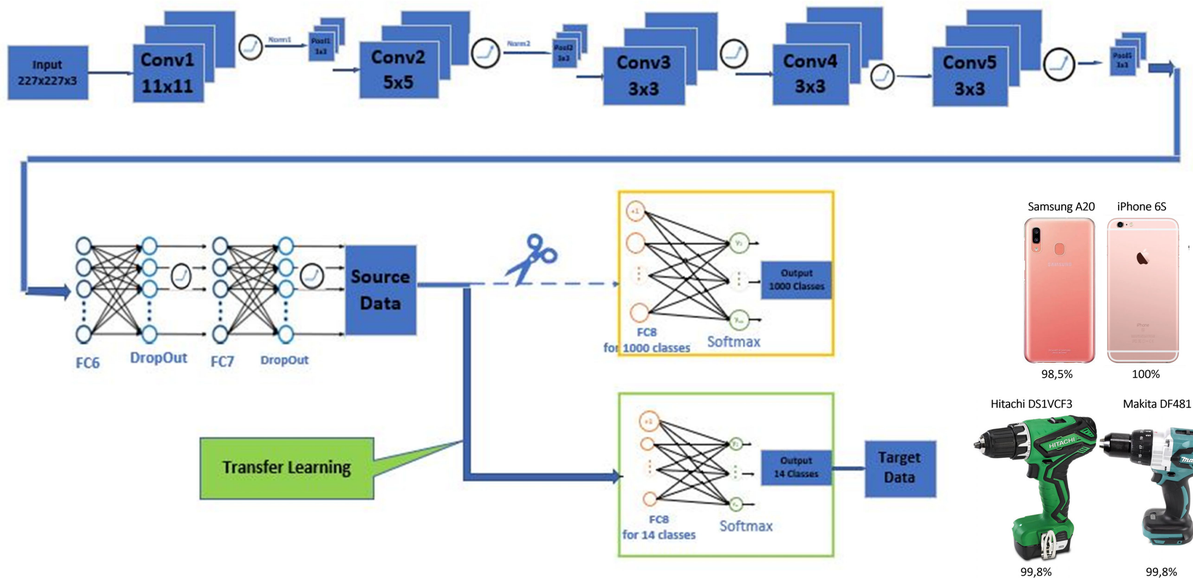
Transfer learning is a machine learning technique that uses previously acquired knowledge from a source domain to enhance learning in a target domain by reusing learned weights. This technique is ubiquitous because of its great advantages in achieving high performance while saving training time, memory, and effort in network design:

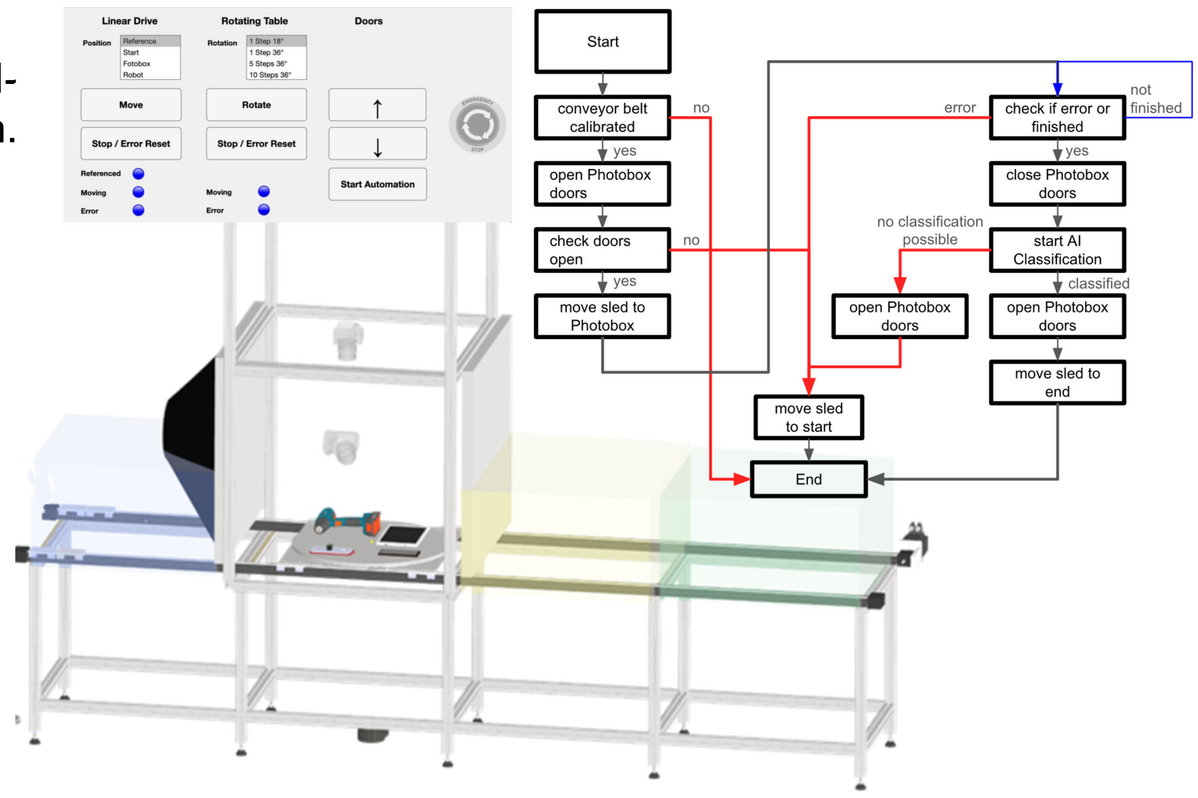


- Neural Network based Classification,
- Use of X-Ray, IR- and RGB-Sensors,
- Net Crawler Technology for Training Data Acquisition,
- Transfer Learning Concept.

N. Abou Baker, D. Rohrschneider, and U. Handmann. Battery detection of xray images using transfer learning. In The 30th European Symposium on Artificial Neural Networks (ESANN 2022), Bruges, Belgium, 2022.
N. Abou Baker, N. Zengeler, and U. Handmann. A transfer learning evaluation of deep neural networks for image classification. *Machine Learning and Knowledge Extraction*, 4(1):22–41, 2022.
N. Abou Baker and U. Handmann. Don't waste SAM. In *The 31th European Symposium on Artificial Neural Networks (ESANN 2023)*, Bruges, Belgium, 2023.

Plant Control for Fully Automated AI-Driven Product Type Recognition. Implementation of the Prototype:

- System Setup,
- Hardware Configuration,
- Development of the Automation Control Software,
- Evaluation.



N. Abou Baker, J. Stehr, and U. Handmann. Transfer Learning Approach towards a Smarter Recycling. In 31st International Conference on Artificial Neural Networks (ICANN 2022), volume 13529 of Lecture Notes in Computer Science (LNCS), Springer, Cham, 2022.
D. Rohrschneider, N. Abou Baker, and U. Handmann. Double transfer learning to detect lithium-ion batteries on x-ray images. In 17th International Work-Conference on Artificial Neural Networks (IWANN 2023), volume 14134 of Lecture Notes in Computer Science (LNCS), Springer Nature, Switzerland, 2023.
N. Abou Baker, J. Stehr, and U. Handmann. E-Waste Recycling Gets Smarter with Digitalization. In *10th IEEE Conference on Technologies for Sustainability (SUSTECH 2023)*, pages 205–209, Portland, USA, 2023. IEEE.
N. Abou Baker and U. Handmann. An approach for smart and cost-efficient automated E-Waste recycling for small to medium-sized devices using multi-sensors. In *IEEE Sensors 2022*, Dallas, USA.
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