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Programming of Collaborative Robot (Cobot) to Selectively Disassemble Products to Obtain Critical Materials

Brittany Felder

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WAYNE STATE
College of Engineering

Brittany Felder

Dr. Jeremy L. Rickli

Industrial and Systems Engineering

Opportunity and Significance

End-of-life products that contain critical materials, such as rare earth magnets, are often discarded even though there is remaining value that can be fed back into a remanufacturing process.

- Critical materials exist in products today
- Scarce supply for materials and highly controlled
- Essential materials in advanced technologies

Technical Objectives

The overall objective is to diversify the supply of critical materials by mining salvaged electric machines. This will lead to additional value streams to maximize accessibility. This research aims to assist the project in developing high throughput and economic value recovery from electric machines.

- Recover products that contain critical materials
- Automation is required for this process to be cost effective
- Creation of flexible automation line by using cobots to train the line

Technical Approach, Accomplishments and Results

A virtual collaborative robot cell was created in the ROBOGUIDE program by FANUC.

- CR-4*i*A collaborative robot (Figure 1)
- Design of workcell setup based on Figure 4
- Simulation created using workcell
    - To model real robotic movements and possible collisions with workstation, part, or human
- Trajectory pulled from simulation
    - Models a screw being removed and discarded

Figure 1: Collaborative Robot

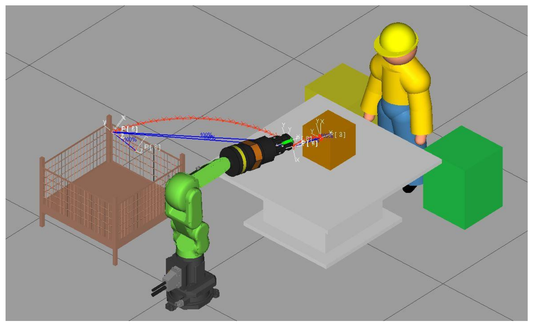


Figure 2: Work cell in ROBOGUIDE software, blue line is the trajectory

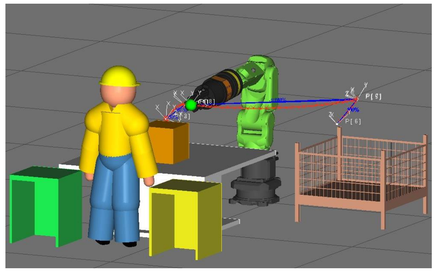


Figure 3: Work cell in ROBOGUIDE software

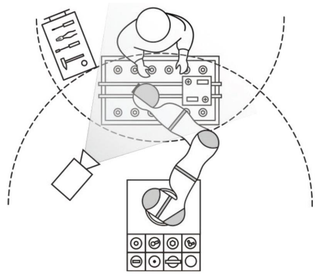


Figure 4: Man-machine shared work space [2]

Related Work and State of Practice

K. Wegner, et al. discusses the effects of the inscrease in electronic batteries reaching thir end-of-life usage

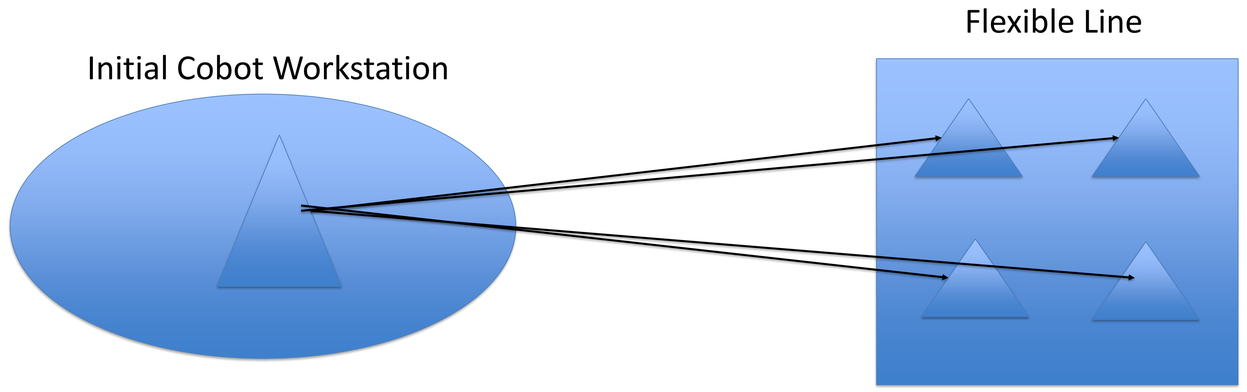
- It would be cost efficient to recycle and remanufactuer batteries for reuse
- Disassembly is a challenge due to unpredictable models and intricacy of batteries
- Proposal of a human-machine workcell

Next Steps for Development and Test

Now that a trajectory can be pulled from the simulation software and input into a co-bot, the next steps will be to use the cobot to disassemble an actual product. Oak Ridge National Laboratory will send a Nissan Leaf electric drive train to disassemble.

Commercialization Plan & Partners

This research is part of a project with Oak Ridge National lab in partnership with LKQ through the Critical Materials Institute.



References

[1] S. Vongbunyong and W. Hua Chen, *Disassembly Automation: Automated Systems with Cognitive Abilities.* Sidney, Australia: Springer International Heidelberg, 2015

[2] K. Wegener, W. H. Chen, F. Dietrich, K. Droder, S. Kara, *Robot Assisted Disassembly for the Recycling of Electric Vehicle Batteries.* Braunschweig, Germany: Procedia CIRP, 2016=5.

[3] A. Djuric, R. J. Urbanic, J. L. Rickli, *A Framework for Collaborative Robot (CoBot) Integration in Advanced Manufacturing Systems.* Detroit, MI: SAE International, 2016

[4] Critical Materials Institute, Oak Ridge National Laboratory, *Value Recovery from Salvaged Automobiles and Electric Machines.*

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