Breakout Session D-3: Robotics

Lead: Jennifer Pazour; **Scribe:** Moritz Roidl
Participants: Christian Landschützer, Ching-Jung Ting, Anike Murrenhoff, Kai Furmans, Fabiana Tornese, Debjit Roy, Sadan Kulturel-Konak, Davir Šourek

Definition of Robotics and Automation within Material Handling

1. Discussed the definition of a robot and what is the difference between material handling technology, automation, and robotics. Discussion centered around the physical and cognitive aspects of robotics. The group initially felt that robotics is a subset of automation where it is more flexible and has some version of intelligence, versus non-robotic automation is more fixed and is designed to perform the same function(s) in a repeatable way.
2. The conundrum of automation vs. robotics vs. humans: Noted that robots are often considered either anthropomorphic or substituting a human, leading to debate about whether tasks performed by completely non-human-like machines still fall under robotics. In automation, one thinks of a system of simple components (i.e., a conveyor) of low complexity which lends itself to facilitate static analysis. This view still mostly holds as long as robots are considered subcomponents of an automation system with a locally limited function. However, with the advent AMRs the complexity and dynamicity of the overall system affects the ability to analyze its behavior with classical methods from material handling.
3. Like humans, robots are able to perceive their environment (through sensors) and respond to changing circumstances (through advanced software). The classical automation system, therefore, might not be considered a robotic system if it lacks the ability to adapt and make autonomous decisions. Conversely, a simple object like a pallet could be considered a robot if it has sensors, software, and other hardware that allows it to respond adaptively to its environment. However, these distinctions are not absolute, and the lines between automation and robotics are continually blurred as technology advances.
4. Challenges still exist today with robotics solutions in material handling scenarios being scalability and achieving adequate robustness of tasks.
5. We also discussed what's the best way to think about robotics – should we be trying to replicate how a human does a process, or think about robotic tasks that go beyond human capabilities, or even that automate a process, but in a different way than a human would tackle the manual process. Likely there is room for all kinds of solutions, and it would matter what the application area was.

Reflection of the group at IMHRC in relationship to Robotics

1. We (the material handling research community) tend to be a field of synthesizers and integrators. This contrasts with robotics researchers, which tend to break down a problem and then focus on optimizing one component of it (e.g., robot motion planning).
2. We need each other and it would be good to think about ways to lure the robotics community into the material handling research community and vice versa.

3. The material handling community has some impactful problems that could benefit from robotics researchers' expertise and capabilities.
4. Given robotics is a highly competitive field, with lots of researchers, this could be an opportunity to pose impactful problems for the robotics community to work on. Would require posing this as a challenge they could connect to.
5. One challenge we talked about – was that robotics researchers working on say surgery or other "societally important problems currently out of the reach of humans" makes it difficult to attract such researchers to logistics/material handling field.

Integration of Robotics and Logistics Communities

1. Discussed the opportunity to tie this group to MHI's The Robotics Group.
2. Discussed MHI creating and hosting a Robotics Material Handling Research Challenge
    a. Create a challenge the robotics community could connect to.
    b. Open question: what type of material handling problems/challenges would make for a good competition.
        i. Piece picking, store restocking, pallet creation, pallet deconstruction, how do you automate to remove plastic wrap from pallet and not destroy the pallet, etc.
    c. The challenge would have challenges in how to market this, how to make it accessible and of interest to researchers, how to make sure it would be of use to the industry.
    d. Discussion around virtual competitions or making sure that teams would have access to the hardware or work on similar systems or sending a "starter kit" to potential teams.
    e. Possible steps to create a competition:
        i. Establish Objectives: Clearly define the goals of the competition. What are challenges in material handling that the industry is currently facing in regards to robotics? What innovative solutions do they hope to inspire through the competition? (Maybe: „The MHI Robotics & Material Handling Challenge aims to address the fundamental and practical complexities in achieving scalable, reliable, and robust robotic solutions within the multifaceted, dynamic, and diverse landscape of material handling.")
        ii. Competition Design: Determine the structure of the competition, including its phases, criteria, rules, and evaluation methods. Should it be an annual event? Should it have different categories? What type of projects or ideas are eligible? In focusing on the key challenges of scalability, reliability, and robustness in robotic material handling, initially concentrate on the practical domain of facility logistics, excluding generalized applications that are focussed not only on logistics such as cleaning robots.
        iii. Prizes and Recognition: Consider what types of incentives would attract the best competitors. This could be monetary rewards, internships, partnerships, or simply recognition within the industry.
        iv. Expert Panel: Assemble a team of industry experts, academics, and possibly representatives from the successful participants of similar

competitions (like the Amazon Picking Challenge). They can help in judging entries, mentoring participants, and ensuring the event's credibility. Could the MHI group on robotics be connected to the IMHRC to jointly organize the challenge?

Robots and Human Society

1. Discussed thinking about humans helping robots versus robots helping humans. Some people prefer to be led by a robot versus some like to lead a robot. There are likely cultural differences.
2. Dichotomy between robots aiding humans and humans assisting robots: Balancing this interaction may lead to optimized workflows where each entity plays to their strengths, the humans providing flexibility and judgment, and robots ensuring precision and consistency.
3. Impact on Human Workforce: Discussion around unions in Europe becoming pro robot because can't get the workers needed to support the work needed to be done. As demographics shift towards an aging population in many developed countries, the utilization of robots to perform tasks traditionally carried out by humans could address workforce shortages, maintain productivity, and ensure essential services are maintained.
4. Ergonomics: The deployment of robots can also be vital in replacing tasks with poor ergonomic conditions, reducing the risk of work-related injuries and improving overall workplace safety and efficiency.
5. Addressing cultural fears within the workforce about robotics is essential for successful integration. Transparency about intentions, educating employees on the benefits and limitations of robots, and demonstrating that robotics is a tool to assist rather than replace human workers can help mitigate these concerns.

Performance Evaluation and Standardization of AMRs in Warehousing

1. Discussed difficulty in how to compute performance of different material handling systems, specifically AMRS, currently on the market (e.g., Autostore) which have their own proprietary simulation and software.
2. There is a need for a FEM guidelines similar to how ASRS guideline on throughput (this is more difficult with the new AMRS systems due to their dynamical and decentralized complex system control nature – that is throughput is not a function just of crane velocity and rack dimensions, but now there are so many more interactions and decisions being made)
3. The group agreed that the understanding of AMRs necessitates a shift from focusing solely on kinematics to a comprehensive analysis of system behavior, which can be modeled and explored mostly through (behavioral) simulations.
4. Yet, the business advantage is for individual manufacturers to not share their proprietary simulations/controls. This leads to a blackbox to outsiders trying to evaluate and make recommendations on which system is best for a given customer.
5. This makes it hard to dimension these systems and for customers to determine which is the best system for their given criteria and inputs.
6. Data sharing: Highlighted the need for robotics manufacturers to share more data with the research community to foster academic discussions. A balanced approach could be pursued where manufacturers share certain non-critical aspects of their

technology that can still support meaningful academic discussion and research. Reverse engineering might provide some insights (however, it could potentially infringe on intellectual property rights).

7. Interesting research question (that could potentially be of interest to MHI's The Robotics Group) is to set up a system in which individual companies do not need to provide their proprietary simulation/controls, but would need to provide a way to validate estimations of performance. An independent body (researchers/MHI) would validate that these estimations are accurate or follow some standard protocols. Or a project could be to create a way that is able to do this (validate trade-offs with different systems) in a way that balances the need for proprietary information/systems to stay private and that provides a rough-cut planning estimate. Open research questions include at what level do we need to know what things for this to be able to balance both, often competing criteria.