Towards Integrated Data-Driven and Model-Based Systems Engineering (IDDMBSE) for Robotic Manipulation Systems in Manufacturing

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***Abstract*—**Automation in the manufacturing industry has led to the rise in the utilization of robots and other autonomous systems in this area. Research in safe and reliable robotic manipulation system development has been benefited and expanded as a result. Traditional robotic system development relies on the knowledge and experience of engineers from multiple disciplines. Robots being an instantiation of Cyber-Physical Systems (CPS) – complex and multidisciplinary – demand for an integrated approach in design, development, deployment, and maintenance. Current approaches instead decouple development of different parts of the system, and isolate the manufacturer, operator, maintainer, and user in most stages of the life cycle. The lack of an end-to-end framework in product life cycle management of robotic systems is one of the significant factors that lead to expensive automation costs and time management.

In recent times, interest in application of Model-Based Systems Engineering (MBSE) ideas to areas of autonomous systems, healthcare is notable. The core idea of MBSE is the employment of a digital model of a system (in a broader notion) rather than document-centric representations. The principles of MBSE bridge the different life cycle stages of a product, allowing control right from the idea conception stage, thereby providing room for rapid prototyping. In spite of rising interest towards MBSE, there is still a need for contribution towards computational development of MBSE activities to accelerate its application to autonomous system development. Though MBSE provides an end-to-end framework for designing, implementing, deploying, verifying and validating robotic manipulation systems, seamless integration of all these activities is possible only via development and incorporation of various computational tools in the form of a software tool suite. In addition to this, the recent trends in machine learning can be leveraged to overcome the difficulties of model-based methods and aid in activities such as hardware and software design synthesis, design space exploration, rapid prototyping. To this end, combining the best of both model-based development and data-driven engineering would be an interesting avenue to explore for design, manufacturing, maintenance, and operation of robotic manipulation systems.