With the rapid development of process industries like fine chemicals, pharmaceuticals, steels, automobiles, robotics, there are significant increment of batch manufacturing systems for procuring more products with better quality and higher profits. Meanwhile, it has become more challenging or even impossible to model the dynamics of such a manufacturing system with increasing nonlinearity and complexity, for the purpose of control system design and performance optimization in engineering practice. Also, advanced measurement technologies have been widely explored for real-time monitoring of various manufacturing processes in the past two decades, effectively facilitating process control and batch run. It has therefore attracted a lot of research attentions for developing data-driven (rather than model based) control methods for batch manufacturing systems in both the academy and industry.

Therefore, the objectives of the project include developing data-driven control and optimization methods for industrial nonlinear batch manufacturing systems, along with active disturbance rejection control methods for batch run optimization.

To overcome the drawbacks of the developed control methods in the existing references for batch manufacturing systems, robust data-driven iterative learning control (ILC) methods will be explored in this project to address the challenging issue of time-varying uncertainties involved with batch run in practice, based on only using the real-time measured input–output (I/O) data and historical batch data, rather than the process models difficult to be established. Moreover, novel ILC methods in combination with the active disturbance rejection control approach will be developed to overcome the negative influence from non-repetitive or periodic type load disturbances often encountered in process operation, e.g. feeding raw materials or discharging products, which could seriously degrade the control performance of existing ILC methods or even destabilize the resulting manufacturing systems. In addition, adaptive data-driven ILC methods will be developed for nonlinear batch processes subject to nonidentical initial conditions and variable batch periods, since these problems bring difficulties to the existing ILC methods for batch process optimization, or even destroy the control system stability. Correspondingly, new data-driven ILC theory will be established to clarify the convergence of all the proposed ILC methods for batch run, together with robust stability analysis.

Clearly, this research project will present a great opportunity for improving coordination and synergy between research groups from Dalian University of Technology, Jiangnan University, and University of Zielona Góra. In particular, focusing on the significant challenge of model-free control methodology by direct data-driven analysis for complex nonlinear batch manufacturing systems like pharmaceutical crystallization and steel-making engineering, the project will significantly extend bilateral collaboration between Chinese and Polish teams, and launch for new collaboration with industrial partners at both sides. As such, it might well constitute an important step toward an integrated Chinese-Polish academic/industry research environment in the challenging field of control engineering for modernized process industry.
Additionally, the planned outcome of the project include:

- publish more than 30 high-quality research papers in well-reputed international and domestic journals and conferences in the fields of Control Science & Engineering,
- establish pilot-scale experiment & application testbeds of batch control systems,
- jointly supervise 3 Ph.D students and 3-5 M.Sc students at both sides (the project encourages M.Sc students to continue research and pursue a doctoral degree),
- the knowledge gained by the research teams will be shared into the teaching curriculums of their institutions and other universities in China and Poland.