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Towards Efficient Modularity in Industrial Drying: A Combinatorial Optimization Viewpoint

Alisina Bayati[1a], Amber Srivastava[2], Amir Malvandi[3], Hao Feng[4] and Srinivasa M. Salapaka[1b]

***Abstract*— The industrial drying process consumes approximately 12% of the total energy used in manufacturing, with the potential for a 40% reduction in energy usage through improved process controls and the development of new drying technologies. To achieve cost-efficient and high-performing drying, multiple drying technologies can be combined in a modular fashion with optimal sequencing and control parameters for each. This paper presents a mathematical formulation of this optimization problem and proposes a framework based on the Maximum Entropy Principle (MEP) to simultaneously solve for both optimal values of control parameters and optimal sequence. The proposed algorithm addresses the combinatorial optimization problem with a non-convex cost function riddled with multiple poor local minima. Simulation results on drying distillers dried grain (DDG) products show up to 12% improvement in energy consumption compared to the most efficient single-stage drying process. The proposed algorithm converges to local minima and is designed heuristically to reach the global minimum.**

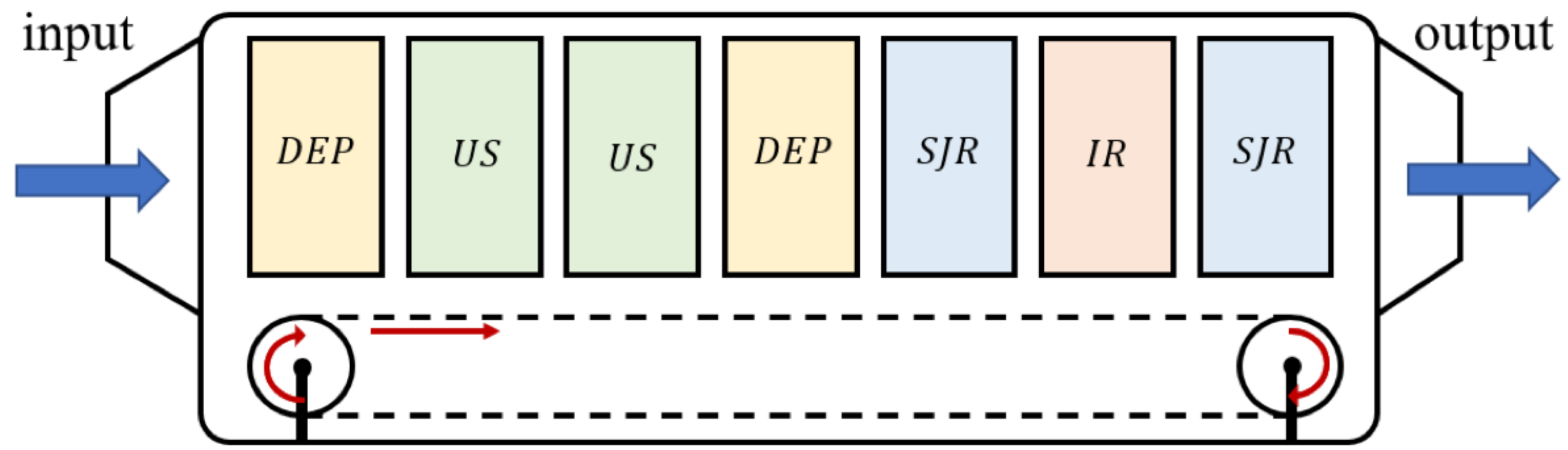

Fig. 1: Schematics of the continuous *smart* dryer prototype with seven buckets which accommodates multiple drying technologies to achieve better performance. In the example shown above, two DEP, two ultrasound, one IR, and two SJR modules are used in a specific order.

technology performs with different efficiencies in different settings. Depending on the operating conditions, some technologies may be more favorable than others. For example,