AUTONOMOUS ROBOTS FOR POWDER COATING ON HIGH DIVERSITY AND LOW VOLUME PRODUCTION LINES

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ABSTRACT

Industry 4.0 is emerging as new manufacturing philosophy, characterized by interconnecting the full manufacturing supply and value chains to optimize production. It enables more flexible and efficient manufacturing systems by leveraging cutting edge technologies such as big data analytics, artificial intelligence (AI), internet of things and advanced robotics.

In parallel, the current economic and labour environment in developing countries is defined by a shortage of qualified workers, which is confirmed by the low rate of unemployment. This affects businesses by lowering product quality, increasing delivery delays and reducing enterprise profitability. AI driven robots can help to alleviate labour shortage and reduce hazardous situations. However, AI applied to robotics is still an emerging research area and a major challenge is to ensure that a robot understands and finishes a task to be accomplished. Generally, AI – a machine with capability to mimic human cognitive skills – is composed of multiple layers of artificial neurons that are linked together to form a neural network (NN), simulating human neurons functions such as vision. One of the key challenges is understanding how the connection between a NN and a robot impacts its learning and performance.

The presented study aims to contribute in addressing this issue and explore its use for industrial applications such as the - still highly manual operated - powder coating process. This study reports a novel method to teach a robotic arm to powder coat parts on a high diversity and low volume production line. A digital twin has been created to simulate a robotic arm and the powder coating process. As a first step, a methodology was designed to test different operational environments (continuous and discrete) and multiple strategies to drive a robotic arm. In the continuous environment, the NN is constantly asked to analyse the operational situation and to take actions. In the discrete environment, the NN is only asked when the action is completed. Articulation driven and end-effector driven strategies are compared to drive the robot, respectively to use the NN for driving each joint of the robot and to use the NN for driving the position of the end of the robotic tool.

Ongoing and future work include exploring the impact of the neuron types and size of the NN. Moreover, a hybrid curriculum comprised of a phase of imitation learning to teach basic strategy and a phase of reinforcement to improve certain criteria will be tested.