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## APPEL A POSTER - TEMPLATE

## POSTER TITLE: Robot motion controller physics-enhanced data-driven digital-twin

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**Summary** The proposed work is part of a German-French research project called GREEN-BOT-AI Frugal and adaptive AI for flexible industrial robotics. It aims to develop AI-driven algorithms in order to optimize robot motion control systems thanks to an improved interaction of the robot with its environment. This is achieved by the use of appropriate digital-twins acting in real-time and helping the system to govern the robot motion. A major objective is dealing with possible occurrence of unforeseen and random events involved by a human robot collaboration. One considers a robot whose task is to insert a mechanical component into a hole. Firstly, a cylindrical component with a circular section is considered in order to deal with the axis alignment issue. Secondly, a square section is investigated in order to add a larger number of degrees-of-freedom to the robot motion. The objective is to develop a mechanical physical modeling of the kinematics of the robot for a given initial position of the component and a given location of the hole. This model is thus used as a reference for the system control in order to adjust the real robot motion by minimizing the relative error between its current position and the reference motion. The motion is composed of translations and rotations. An ideal path is evaluated by using an energy minimization process. In a first step the model should lead to a motion without any contact. In a second stop an error on the hole location can be introduced, therefore it is necessary to introduce a contact model in order to describe the insertion of the component into the hole with an initial bad knowledge on the configuration geometry. Experiments have been performed and a big set of data is available. This sample provides measurements of forces and torques but also of positions of the robot and distances to the hole by considering their evolution in space and time. In the first step, the purpose is to use in an optimal way the real data coming from a real motion in order to incorporate them into a data-driven digital-twin

reproducing the robot motion. The obtained tool is then used in order to predict the robot motion starting from other initial states in terms of position, velocity magnitude and direction of the robot. In the second step, the development of a physically-enriched data-based digital-twin is performed. The physical model of the robot kinematics is used in order to predict real-time motions of the robot with a better accuracy than those obtained with the previous data-based digital-twin. The comparison is performed by using real measurements and the way of assimilating numerical and experimental data in the same model is addressed through AI algorithms. Moreover, the issue of contact is addressed iteratively thanks to the available experimental data.