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HUMAN-CENTERED AI DESIGN TO CHALLENGE HEALTH AND INDUSTRIAL PERFORMANCE : INTEREST OF A MIXED IT-ERGONOMIST PROJECT TEAM.

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SUMMATIVE STATEMENT: Cobotics can be a promising solution for supporting industrial performance and preserving operator health (Barcellini et al., 2023). But it needs to focus on future users and work situations, in order to be flexible and implementable in the industrial environment.

KEYWORDS: UX, Human-Robot-Colaboration (HRC), cobotics, AI, variabilities.

PROBLEM STATEMENT: As cobots are still not widely used in industry due to a lack of adaptation to real workplace conditions, it is necessary to better pilot their design. When designing robot collaborators, several programming choices can facilitate Human-Robot collaboration (HRC). In this paper, we will outline the challenges of using planning as an AI method to make the robotic solution flexible and favorable to occupational health.

OBJECTIVE/QUESTION: User-centered cobotic design makes industrial robots more adaptive. This poses technical challenges (detection and adaptation), and ergonomics challenge like choosing criteria for assessing the impact of these solutions on human activity.

METHODOLOGY: The user-centered cobotic design approach is based on the establishment of a clear classification of the hazards and variations present in a situation of use, which will serve as a case to test the adaptive qualities of a cobotic solution. Once identified, an experimental framework is set up to test the technical choices made to increase the Human-Robot collaboration. This involves experimental test of technical solutions. We choose to focus on an assembly task, for which the quality and efficiency of HRC are measured through direct measurements (time, errors, precision, sensitivity, number of gestures, physical load) and indirect measurements (cognitive load, acceptability). This tests conditions are compared to the same task performed by a human alone or in collaboration with another human (control condition). All the robot are controlled by an AI method call planification program.

RESULTS: We present in this symposium 3 design tests, and the effects of collaboration on human activity and performance. In the first situation, we tested the effects of programming by demonstration. The results show that an operator new to programming can teach a robot a movement by directly manipulating the robotic arm (Liang et al., 2022). But to facilitate this demonstration, an interface has to be added. In the second situation, we tested the effects of adapting the cobot to the assembly order chosen by an operator in an assembly task, and to the operator's dominant hand. We found that cobotic collaboration reduced assembly errors, lowered cognitive load, reduced the number of gestures and increased robotic acceptability (Fournier et al., 2022). Adaptation to the dominant hand had no particular effect. Technical problems in detecting human activity in real-life situations led to longer assembly times, but this set-up was very promising. Finally, in the third situation, we tested the effects of adapting the cobot to operator risk-taking (Fournier et al., 2024). We observed that when the cobot is programmed to

give priority to parts that are dangerous for the operator, it promotes a reduction in the human's exposure to risk, while maintaining manufacturing performance.

DISCUSSION: We are committed to an incremental design approach to human-robot collaboration. To achieve this, we carry out a number of user tests to determine which adaptations seem the most relevant to achieving a performance and health objective in the workplace. On the technical side, we note on the one hand problems of detection, i.e. understanding of human activity, intentions, difficulties and variabilities by a capture system. Our research prospects focus on this first point. On the other hand, cobot adaptation possibilities relate to trajectory and task planning. The trajectories chosen by the cobot to handle parts close to a human operator are constrained by safety issues. The speed of the robot arm is reduced in order to limit potential collisions with the human arm. But the scheduling of actions, the means of interacting with the human, and the human's understanding of the cobot's operation are technical possibilities that support flexible collaboration. The PDDL language (Pellier & Fiorino, 2018) used in these set-up are very usefull to real-time adaptation, and is explainable, that lead to better transparency. Our future work will continue in this direction.

CONCLUSIONS: Cobotics can be a promising solution for making industrial jobs more attractive, and for reducing WMSDs. But there are a number of technical hurdles to overcome. A design approach focused on end-users seems to be necessary to adjust cobots to industrial realities.

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