PRESS RELEASE
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Rossini's recent advances in the cognitive layer for collaborative robot control - Part B

The *Rossini* project aims to increase industrial efficiency by making the most of the collaboration between robot and human operator, improving the synergy between them. In modern collaborative robotic cells, a worker and a robot share the workspace, each having their own set of tasks. Such a collaboration brings great changes in the working environment and affects the worker's job quality. Job quality is influenced by how tasks are allocated and scheduled between the operator and the robot. It can be improved by monitoring the operator's tasks and adapting the task allocation and scheduling whenever needed. In the *Rossini* project all this is managed by the "cognitive layer", which has the goal to generate an optimal schedule for the worker and the robot.

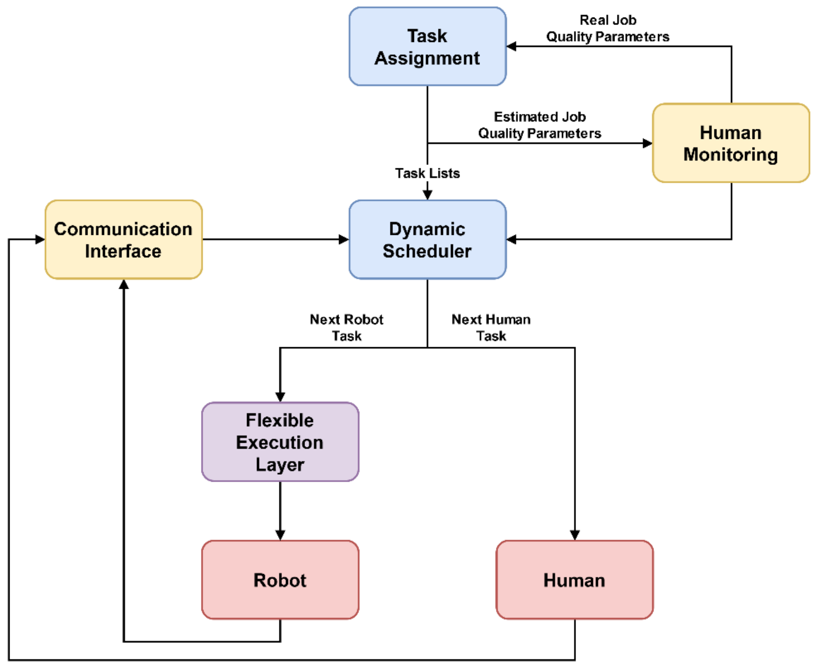
Job quality is a multi-dimensional concept that brings together a wide range of factors ranging from job security to job demands such as time pressure. The *Rossini* project focusses specifically on the factors related to the quality of the working environment. This part of job quality is influenced by many factors that fall in four main categories: physical, cognitive, psycho-social and environmental aspects. Project partner TNO focused on translating job quality factors into outcome metrics that can be taken in the workplace, for example measuring the time a person performs heavy lifting task during a day.

Starting from these metrics, project partner UNIMORE is responsible for building the optimal schedule, also exploiting the data coming from the "perception layer". The perception layer combines data from multiple sensors in the working environment and facilitates reasoning about task allocation and scheduling. As human behaviour has a limited predictability, creating a pre-set scheduling strategy with no connection to what the worker actually does, would lead to a suboptimal solution. Therefore, in order to deal with this human unpredictability and to allow the robot and the operator to negotiate about the tasks to be executed, the "cognitive layer" adapts the schedule online. However, continuously and automatically changing the order of the tasks assigned to the human can lead to confusion and reduce the operator's efficiency. Thus, the "cognitive layer" reschedules online only the list of tasks assigned to the robot. The list of tasks assigned to the operator changes only when he decides to execute a task assigned to the robot or when the robot cannot execute a task and asks for the help from the operator.

The proposed architecture is shown in Fig 1, where two main components can be distinguished:

- The **Task Assignment Layer** generates an initial nominal schedule for the robot and the human, based on the maximum parallelism criterion. This first layer optimally solves a multi-objective *Mixed Integer Linear Programming* (MIP) problem considering nominal execution times of tasks, the order in which tasks can be executed, and the job quality outcome metrics.
- The **Dynamic Scheduler Layer** dynamically adapts the schedule, taking into account the real execution time and the requests coming from the human and from the robot.

Fig 1. The overall architecture. The blue blocks represent the two layers. The yellow blocks, instead, symbolize the strategies implemented to provide richer information to the layers. The red blocks represent the two agents.



The “cognitive layer” aims at creating an effective and intuitive cooperation in a human-robot collaboration scenario, improving the operator’s well-being in the working environment. To achieve this, it exploits a **Human Monitoring** algorithm, allowing an estimation of the operator’s actual execution time and a calculus of job quality indices. If the worker requires more time to accomplish a task, the actual execution time is exploited by the Dynamic Scheduler to reschedule a new task for the robot based on the increased required execution time. The job quality indices are updated every time a new job is concluded and used as input when a new Task Assignment is required.
To reach a more harmonious synergy, a **Communication Interface** is used to enrich the Dynamic Scheduler with the decisions that the operator and the robot are taking about their activities. Based on this communication, the Dynamic Scheduler improves the schedule, making the collaboration more natural.

About the project

ROSSINI is a project funded by EU's Horizon2020 research and innovation program, with an aim to design, develop and demonstrate a modular and scalable platform for the integration of human-centered robotic technologies in industrial production environments.

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