UNIVERSIDADE NOVA DE LISBOA
FCT - Departamento de Engenharia Electrotécnica
Secção de Robótica e Manufatura Integrada

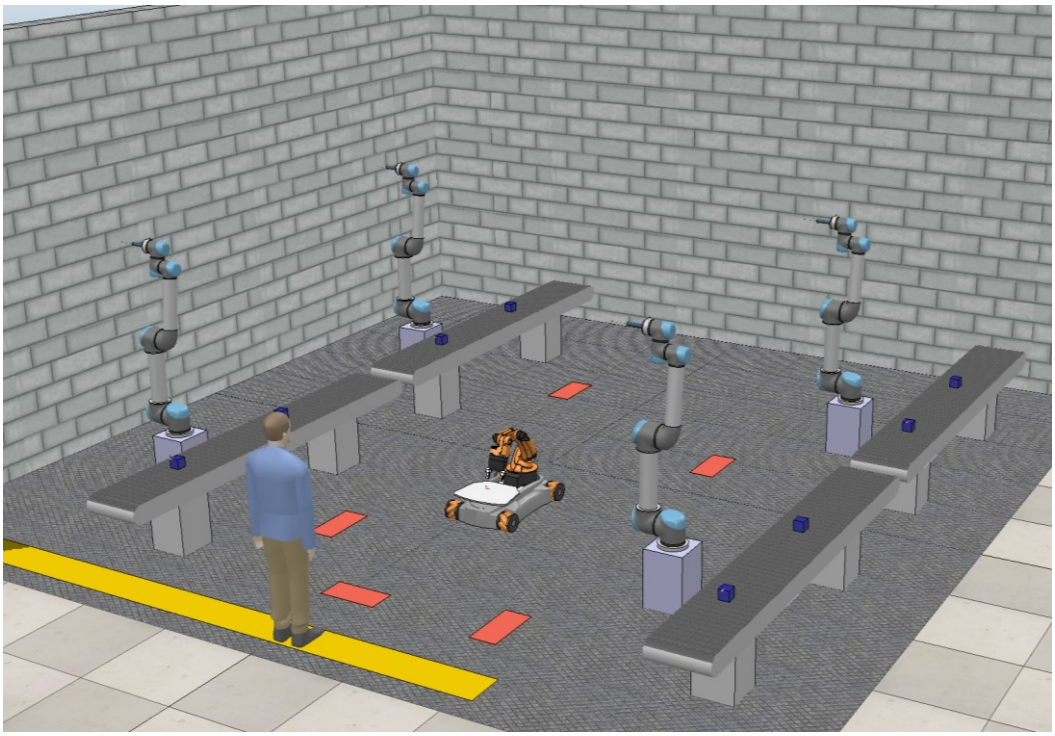
NOVA SCHOOL OF SCIENCE & TECHNOLOGY

Robotic Systems and CIM

2022/2023

Lab Assignment 1

Agile Cyber-Physical Production System using MAS



Duration: 5 Lab Classes

Submission: Project submission on Moodle

1. The Job Shop Environment

In this assignment, the environment will be the same as the one described in Lab 1, as shown in Figure 1.

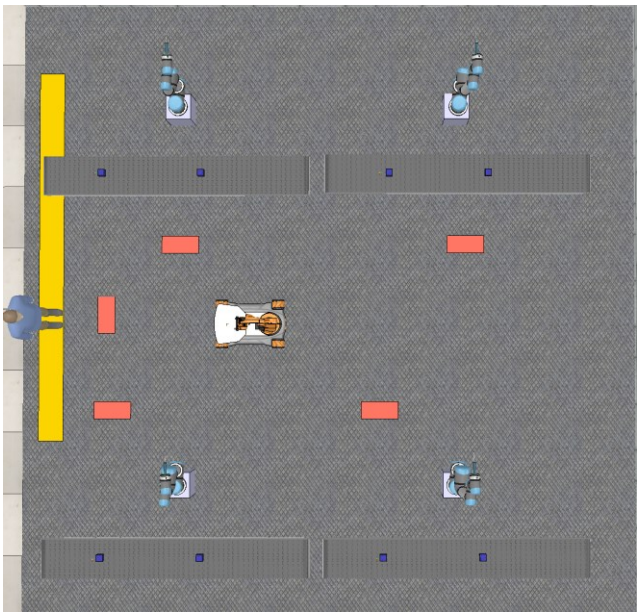


Figure 1 - The SRCIM Flexible Job Shop

As it can be observed, this system is constituted by four stations, particularly glue application workstations that apply structural adhesive to a product part. Additionally, there's one Autonomous Ground Vehicle (AGV) responsible for moving the product between stations. Each resource/station is capable of performing the following operations/skills:

Table 1 - Skill distribution per Station

Resource/Station	Location ID	Skill ID
Glue Station #1	GlueStation1	Glue Type A, Glue Type B
Glue Station #2	GlueStation2	Glue Type A, Glue Type C
Glue Station #3	GlueStation3	Glue Type B, Glue Type C
Glue Station #4	GlueStation4	Glue Type A, Glue Type B, Glue Type C
AGV	-	Move
Operator	Source	Pick-up, Drop

The entry (pick-up) and removal (drop) of the product is performed by an operator (which can be abstracted as a resource). In this system, let us assume products are introduced in a given entry point. The AGV must move to the entry point (source), pick-up the product from the operator, then move it to an appropriate glue station. The glue station must be chosen based on the product requirements (its production process / plan) and their availability. Then, depending on the plan, it either moves the product to the following station or to an exit point (sink), through which the product leaves the system once more with the aid of the operator.

The product variants are described in Table 2:

Table 2 - Description of the product variants

Product	Plan
Product A	Pick-up, Glue Type A, Glue Type B, Drop
Product B	Pick-up, Glue Type A, Glue Type C, Drop
Product C	Pick-up, Glue Type A, Glue Type B, Glue Type C, Drop

2. Proposed Work

In this assignment, students develop a multiagent system capable of controlling the production in a manner that is agile and flexible. In order to accomplish this, three generic agent types are proposed and described in Table 1. However, students are free to adapt this based on their modelling, as long as the overall functionality and characteristics of the system are ensured.

Table 3 - Description of the different agents and their roles

Agent	Description
Product Agent (PA)	This agent is the entity responsible for controlling the entire execution of the process for a specific product in the job shop. Each product is abstracted by an agent of this type in a one-to-one relationship. For this, the PA should: • Negotiate with the RAs which one should execute the next skill in the product's execution list; • Send a request to the TA to ask for transportation from its current location to the location of the RA chosen in the previous step; • Send a request to the RA to perform the execution of the correct skill.
Resource Agent (RA)	This agent is responsible for abstracting a physical resource within the shopfloor, which depending on the level of granularity could be a robot, a gripper, or a station for example. Each resource is capable of executing a certain number of operations (represented in this assignment as skills), which can include for instance applying glue of a certain type, as required by the product's execution list. Therefore, the RA should be capable of handling the product's

Agent	Description
	negotiation and request messages, as well as of performing the necessary skills using the appropriate library.
Transport Agent (TA)	The TA is the agent responsible for abstracting the AGV or AGVs that transport the products from point A to point B. Thus, the TA should handle the requests from PAs that require transportation to the location of a certain resource within the job shop.

The goal of this assignment is to implement and integrate the PA, RA and TA required to control the job shop using the JADE framework.

During the initial development stages, the project can be tested using JADE's sniffer tool to verify the messages being exchanged between the agents, as well as a hardware test library which mimics the behaviour of the system sending the results to the output console.

Afterwards, it will be possible to use the simulated environment by changing the hardware test library to the simulation communication library provided by the teaching staff. The simulation is capable of simulating the entire process, including the glue application process and the transport system.

To change this, we can pass a different library name as an argument upon launching the agent, as shown in Figure 2:

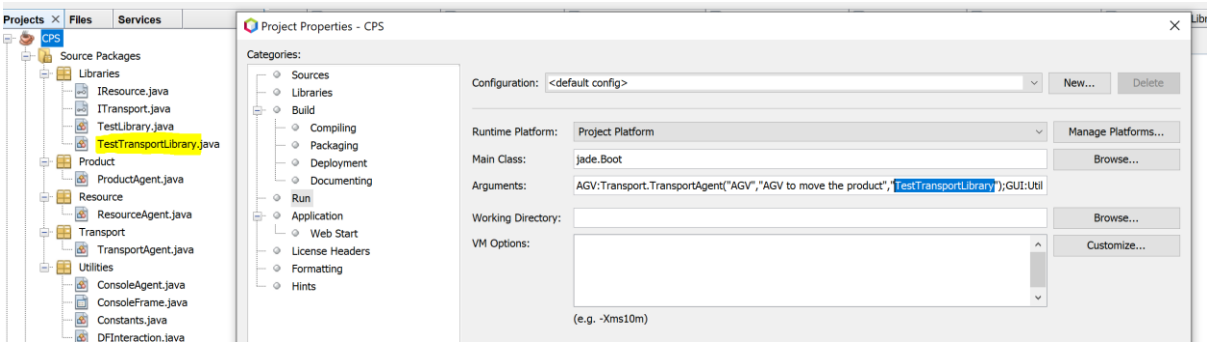


Figure 2 - Configuring the project to launch a TransportAgent with the TestTransportLibrary.

While the RAs and TAs should be launched as illustrated in Figure 2, the PAs abstracting the different product variables should be launched via the ConsoleAgent's graphical user interface, as shown in Figure 3.

Upon launching a new PA of a specific product type through the GUI, the execution process should be triggered by it, checking the necessary steps of its execution list and initiating the negotiation with the appropriate RAs.

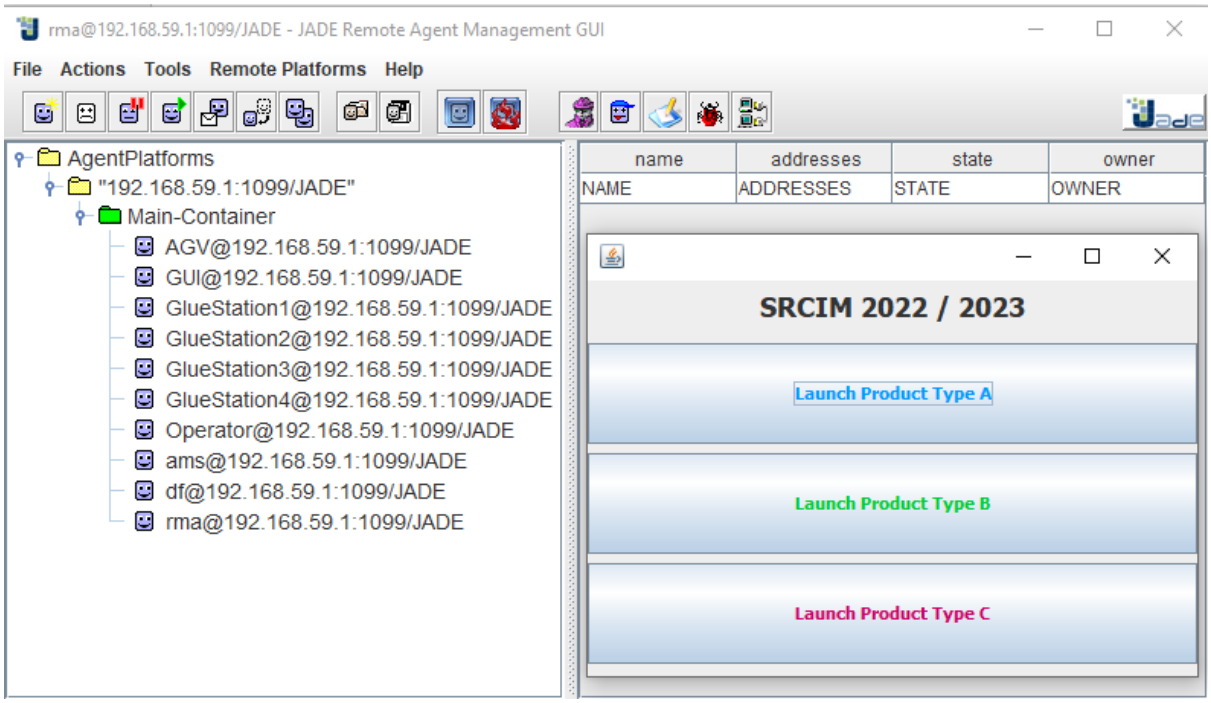


Figure 3 - JADE Remote Agent-Management GUI and the ConsoleAgent's GUI to launch new products of a given variant.

3. Evaluation

In addition to the submission on Moodle, the result of this assignment will be discussed during the final presentation/evaluation of Lab 1. The evaluation of this assignment will take the following points into consideration:

- Correct implementation of the different agent types, following the guidelines provided during the lab classes;
- Correct implementation of the different behaviours and communication protocols required by the agents;
- Integration and validation with the test libraries;
- Quality and clarity of the presentation and discussion during the evaluation;
- Development of additional (extra) functionalities.

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