A REPORT

ON

PW1: ONLINE PROGRAMMING OF UR ROBOT

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1.0 Introduction

In this practical laboratory report, we present our theoretical and experimental study of the UR5 industrial robot which is a flexible lightweight collaborative arm that lets to automate repetitive and dangerous tasks with payloads of up to 5kg. During the laboratory, we focused on the study of the two (2) programming modes of the robot which are robot programming through the pendant (teach) and robot programming through a specific computer interface. A theoretical study of the system was carried out, and subsequently experimental validation was done through careful observation a of the robot's collaborative working processes and conditions in order to validate our theoretical assumptions.

1.1 Objectives

Specifically, the objectives of this Practical Work (PW) are:

- Master the manual control of the robot through the pendent.
- Achieve a basic pick and place operation (manually then automatically).
- Associate frames to the working areas.
- Achieve a pick and place program relative to those frames

1.2 The General Presentation of the Practical Work (PW)

Figure 1 below describes the experimental setup of the UR5 collaborative industrial robots suitable for the optimization of low-weight collaborative processes like pick and place or test. The diameter of the robot working area is about 850mm and its repeatability is about 0,01mm. The robot can be programmed directly through the pendant or a V+ language via a specific computer interface.

The robot and all its components are interconnected as shown in the figure below.

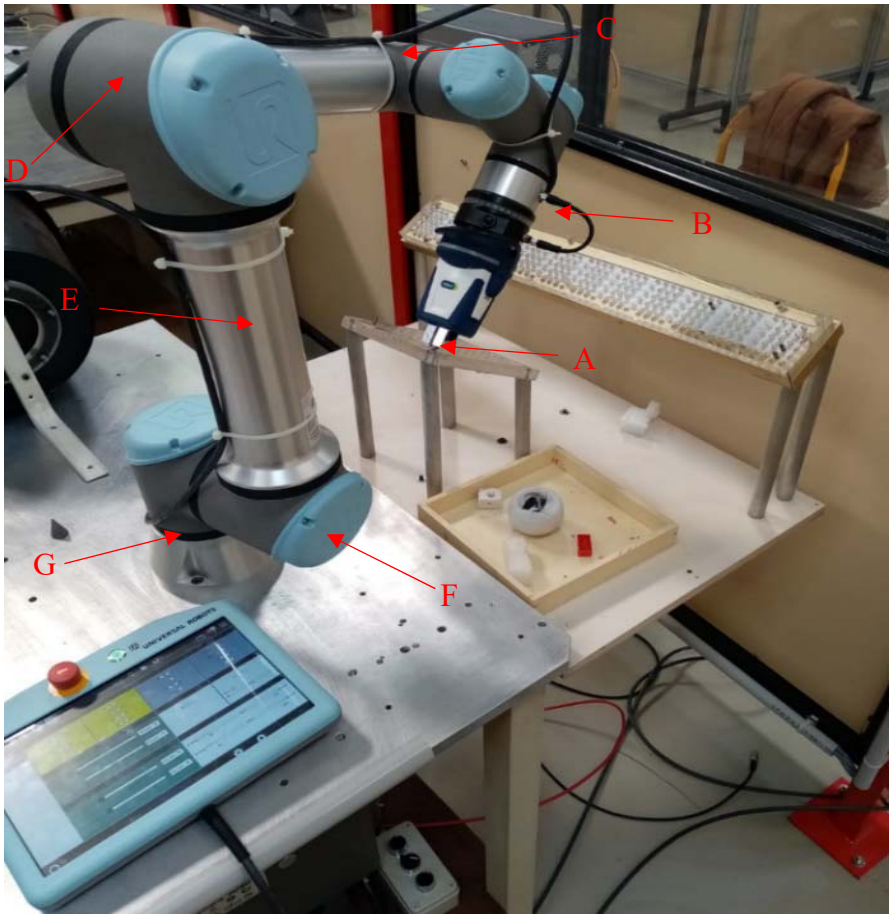

Figure 1: The experiment model setup of a UR5 collaborative robot

Where:

A: Gripper
B: Wrist
C: Lower arm
D: Elbow
E: Upper arm
F: Shoulder
G: Waist

The key components of the experimental set-up include the robot itself, a teach pendant, voltage source, the end effector and the rack where the pick and place operation takes place.

2.0 UR5 Robot Programming

In this technical project, we are going to master the software and the material of the UR5 robot. To this end we begin by programming a basic pick and place task using the robot pendant and also using V+ code.

2.1 Pick and Place Task Programming

The robot pendant incorporates a lightweight touch screen display, enabling easy handling when programming. It offers a variety of different features and functionalities including but not limited to the choice of working mode, program access area (fig. 2) etc. These features collectively enhance the robot's ability to be tailored to the needs of the application through simple, menu-driven steps. The robot also has enhanced process reliability features such as faster brake release after an emergency stop and protected PC power supply.

Figure 2: Program access area of UR5 collaborative robot

Before starting, a transformation was introduced in order to take into account the tool of the robot. Then the free movement option of the robot was utilized to approach the targeted pick and place point. A button placed on the robot wrist was used to set this working mode.

However, due to the nature of our working area, the picking and placement of the pins in and out of the appropriate holes require a high level of accuracy and precision so as to avoid damaging the robot or the work area. Hence, we always placed the robot tool at a minimum safe distance in front of the holes and used a solitary movement in the z-axis to insert or extract the pins form the holes. This was done through the manual mode (fig. 3).

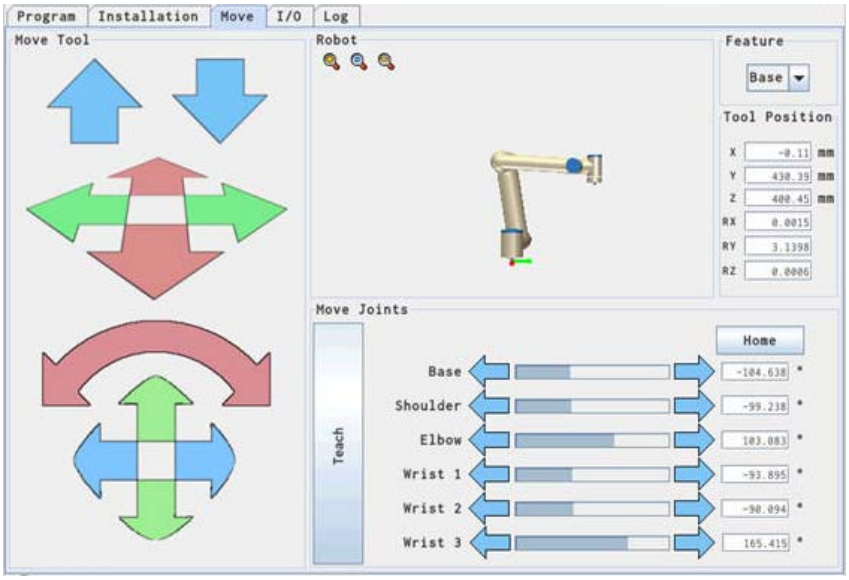

Figure 3: Manual mode section of the UR5 collaborative robot

The robot program in itself is simple, intuitive and accessible via the program access area of the pendant. Each desired position of the robot tool simply has to be noted and saved using the teach button. By so doing, the robot is able to memorize and run the sequence of code saved in its memory whenever the run command is given. Figure 4 below shows the generated code at the end of our teach sequence.

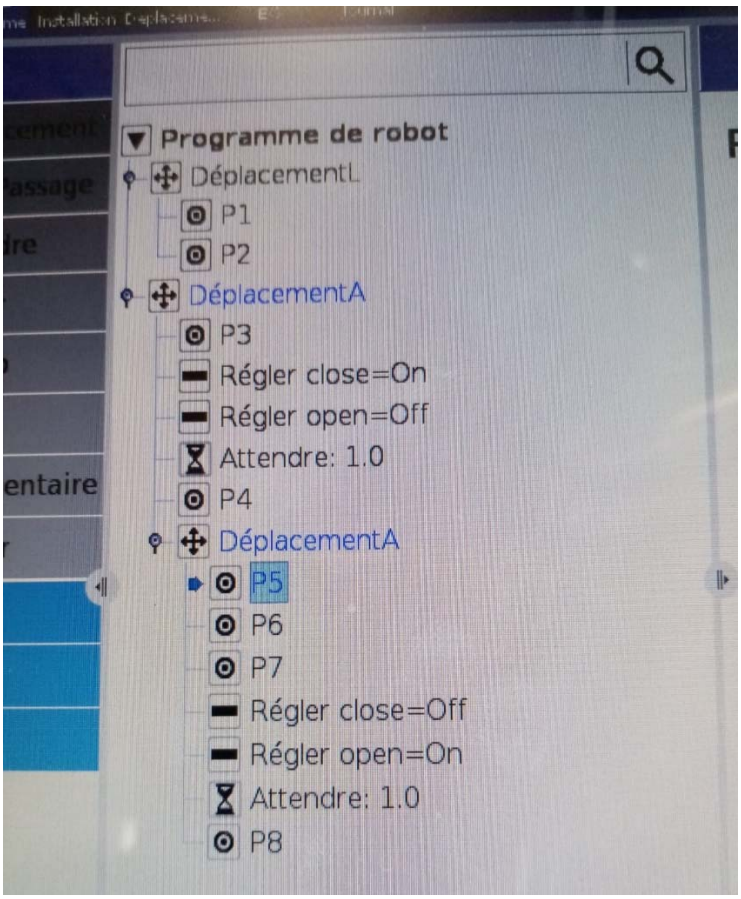

Figure 4: Teach pendant code of the UR5 collaborative robot

Next, we executed the program generated by teach sequence above and noted with keen interest as the robot executed program. The results are given in the figures 5a-f below.

Figure 5a: Robot picks the pin

Figure 5b: Robot approching minimum safe zone

Figure 5c: Robot exiting minimum safe zone

Figure 5d: Robot in transition to place the pin

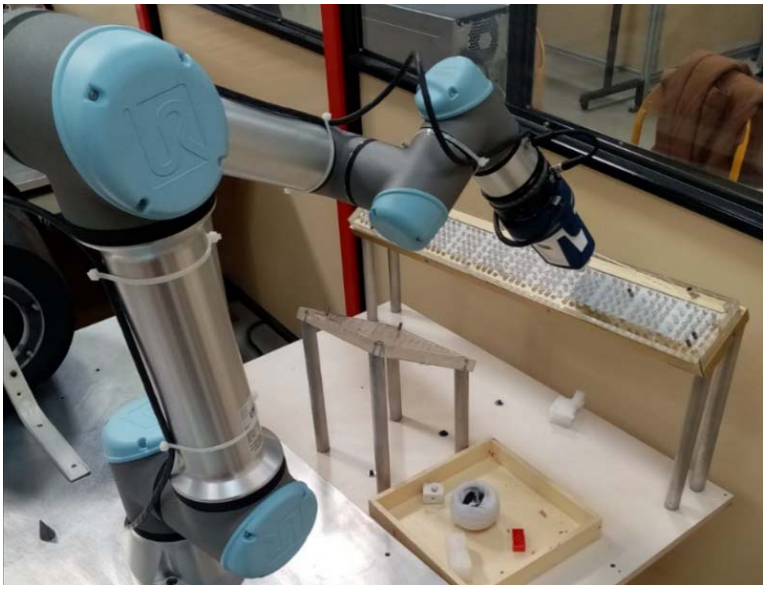

Figure 5e: Robot approaches minimum safe position

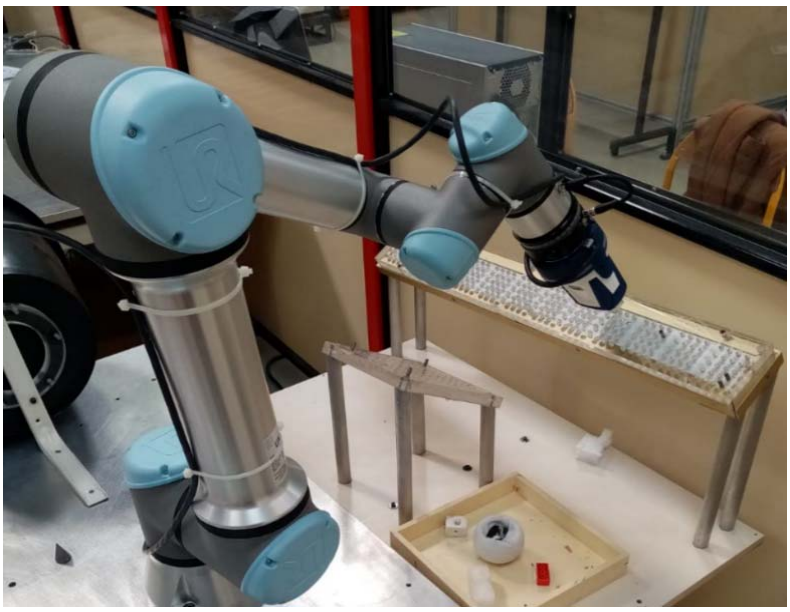

Figure 5f: Robot places the pin

Observation: We observed that the UR5 robot from Universal Robots is easy to program, cost-effective, safe, flexible to deploy, offers fast set-up, is collaborative and safe, and much like other collaborative robots.

2.2 Pick and Place Task Programming Relative to the Working Area Frame

In this section we created and attached a frame to the working area and then adapted the previous program to achieve the same pick and place operation within the frame. This is necessary in order to combat the limitation posed by the robot pendant interface (despite its intuitiveness) when it comes to programming complex tasks that require for example several frames.

We used V+ (code) language to create and attach the frames to the working area. The setup window for the program is shown in figure 6.

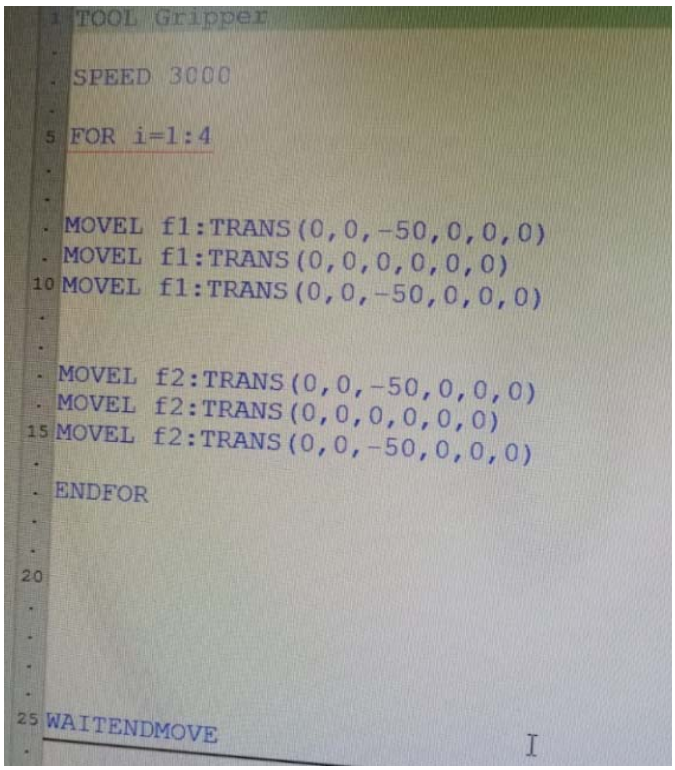

Figure 6: Relative programming of the UR5 collaborative robot

Observation and Conclusion: We observed that the program developed through the V+ code functioned in the same way as the one programmed using the pendant interface. However, the attached frames to this program is an added advantage as it allows to adapt the program to different working areas and environments without having to create the entire program afresh.

3.0 Conclusion

So far in this laboratory project, we have demonstrated collaborative process of a low-weight industrial robot UR5 suitable for optimization of processes such as picking, placing, and testing. In particular, we focused on the two programming modes of the robot which are robot programming through pendant (teach) and through a specific computer interface. As a result, we acquired the basic notion of the online programming of the collaborative UR5 robot via the implementation of a pick and place task which the robot completed with ease and utmost accuracy. The relative programming allows to adapt a given frame to different working areas and is perfect for the execution of complex task unlike the teach pendant whose program is only valid for a specific working area. In addendum, UR5 robot is easy to program, cost-effective, safe, flexible to deploy, offers fast set-up, is collaborative and safe, and much like other collaborative robots, offers one of the fastest payback times in industries. Its industrial applications include but not limited to industries that deal with flexible automation, manufacturing of various sizes, assembly, painting, screw-driving, polishing, as well as injection and welding. Collaborative robots with innovative grippers, computer vision and machine-learning systems can pick up a wide range of objects even in unstructured environments such as a bins or totes making them the perfect tool for packaging and palletizing applications.