ROBOT MANIPULATORS: MODELING CONTROL & PROGRAMMING

Assignment-2

Group-18
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Task 1. Welding routine

For this task, IRB 1520 4kg 1.5meter robotic arc welder model is used as the structure of this manipulator supports executing the required welding task.

- External and internal paths are created using *Autopath* command
- Before starting the welding path, the tooltip should come from the top, therefore, an offset point is created to do that.
- For precise welding, z0 command is taken for every target.
- After finishing the welding task, the tooltip should leave vertically. Therefore, the same offset point is used in that.
- *WaitTime* command is used to make the robot wait for 3 seconds.
- For repeating the welding on another workpiece, the previously created inner and outer path are copied and move 90mm along the Z axis using *Translate path* command.

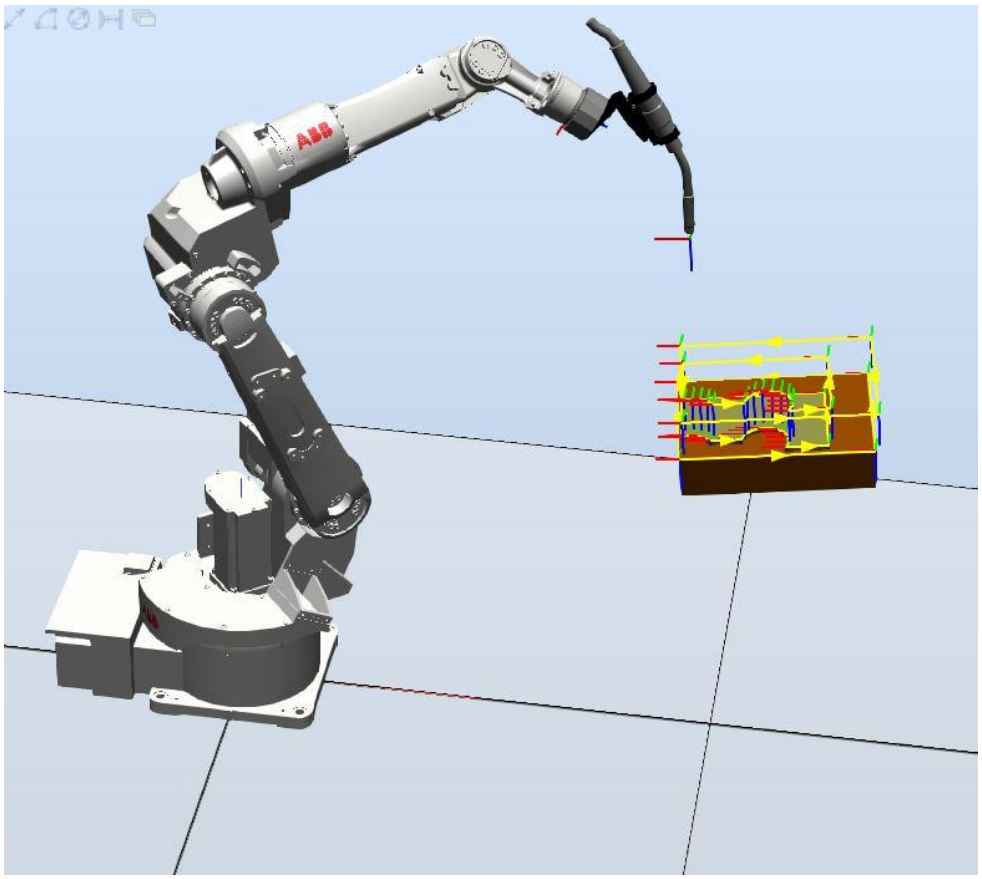

Figure: Welding routine

Task 2: Pick and place

In this pick and place routine, ABB IRB 140 robot is used which required the RobotWire 5.15.14. At first, codes are written and tested offline and later it is tested on real equipment.

- Only three target points are created for doing this routine. Those are via point, Pick and Place.
- Also, two functions are created for opening and closing gripper.
- For defining the pre-pick and pre-place target on top of the pick and place target, offsets are created.
- According to given instruction, *MoveJ* command is used between via point and pre-pick targets, between via point and pre-place targets for free movement with the speed of V500.
- Command *MoveL* is used for linear movement between pre-pick, pre-place targets and the actual pick and place targets.
- After opening and closing the gripper, a wait command *WaitRob\ZeroSpeed* and *WaitTime* are used so that robot can wait for a moment before executing the next move.

In the demo, we had to change the robot number because we are simulating robot 1, but in the lab, we worked with robot 2. While working with the practical robot we defined the pick, place and via point using the 'teach pendant'. The code was tested at first with no object before working with a real object in order to avoid collision.

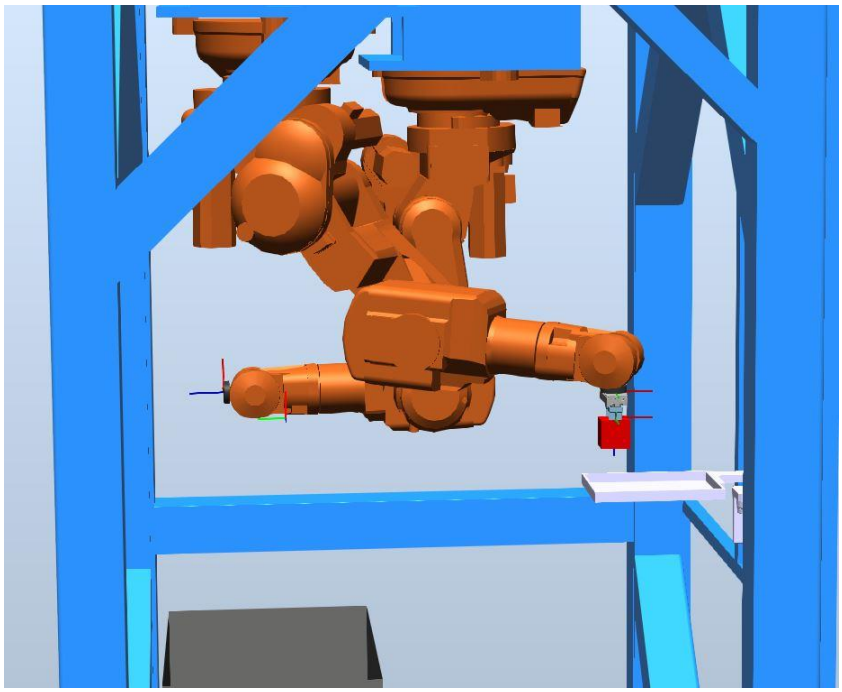

Figure 2: Pick and place

Appendix:

Task 1. Welding routine: RAPID CODE:

```
PROC main()
  !for 1st workpice
  Outer_path;
  Inner_path;

  WaitTime 3;

  !for another workpice
  Outer_path_another_piece;
  Inner_path_another_piece;


ENDPROC

        PROC Outer_path()

  VAR robtarget vertical_point; !declearing variable for offset
  vertical_point:=Offs(Target_10, 0, 0, 300); !creating the offset 300mm above of the starting point

  MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0; !as the welding should be precise, z0 is taken for every target
          MoveL Target_10,v500,z0,AW_Gun\WObj:=wobj0; !welding start point
          MoveL Target_20,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_30,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_40,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_10,v500,z0,AW_Gun\WObj:=wobj0; !welding end point
  MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0;
        ENDPROC

        PROC Inner_path()

  VAR robtarget vertical_point; !declearing variable for offset
  vertical_point:=Offs(Target_60, 0, 0, 300); !creating the offset 300mm above of the starting point

  MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0;!as the welding should be precise, z0 is taken for every target
          MoveL Target_60,v500,z0,AW_Gun\WObj:=wobj0; !welding start point
          MoveL Target_70,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_80,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_90,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_100,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_110,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_120,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_130,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_140,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_150,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_160,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_170,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_180,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_190,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_200,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_210,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_220,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_230,v500,z0,AW_Gun\WObj:=wobj0;
          MoveL Target_60,v500,z0,AW_Gun\WObj:=wobj0; !welding end point
  MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0;
        ENDPROC


PROC Inner_path_another_piece()

  VAR robtarget vertical_point;
  vertical_point:=Offs(Target_60_3, 0, 0, 300);

  MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0;
  MoveL Target_60_3,v500,z0,AW_Gun\WObj:=wobj0; !welding start point
  MoveL Target_70_3,v500,z0,AW_Gun\WObj:=wobj0;
  MoveL Target_80_3,v500,z0,AW_Gun\WObj:=wobj0;
```

```
        MoveL Target_90_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_100_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_110_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_120_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_130_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_140_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_150_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_160_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_170_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_180_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_190_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_200_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_210_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_220_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_230_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_60_3,v500,z0,AW_Gun\WObj:=wobj0; !welding end point
        MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0;
        ENDPROC

    PROC Outer_path_another_piece()

        VAR robtarget vertical_point;
        vertical_point:=Offs(Target_10_3, 0, 0, 300);

        MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_10_3,v500,z0,AW_Gun\WObj:=wobj0; !welding start point
        MoveL Target_20_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_30_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_40_3,v500,z0,AW_Gun\WObj:=wobj0;
        MoveL Target_10_3,v500,z0,AW_Gun\WObj:=wobj0; !welding end point
        MoveL vertical_point,v500,z0,AW_Gun\WObj:=wobj0;
    ENDPROC
ENDMODULE
```

Task 2: Pick and place: RAPID CODE:

```
MODULE MainModule
    CONST robtarget via_point:=[[419.99,-377.933,712],[0.707106781,0,0,-0.707106781],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Pick:=[[275.502,-630.736,852.224],[0.707106781,0,0,-0.707106781],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Place:=[[214.792273259,38.46617002,1125.252179854],[0.707106922,0.000000191,0.000000183,-
0.70710664],[0,2,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];

    PROC main()
        HomePosition;
        Path_10;          !routinre for pick and place
        HomePosition;

    ENDPROC


    PROC HomePosition()
                        MoveAbsJ [[0,0,0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]]\NoEOffs,v200,z50,tool0;
              ENDPROC

    !Function for closing gripper
    PROC CloseGripper()
        SetDO Rob1_Gripper_Reset,0;
        SetDO Rob1_Gripper_Set,1;
        WaitDO Rob1_Gripper_Set,1;
        WaitTime 1;
    ENDPROC

    !Function for opening gripper
    PROC OpenGripper()
        SetDO Rob1_Gripper_Set,0;
        SetDO Rob1_Gripper_Reset,1;
        WaitDO Rob1_Gripper_Reset,1;
        WaitTime 1;
    ENDPROC

    PROC Path_10()
        VAR robtarget PrePick; !declearing variable for creating offset
        VAR robtarget PrePlace; !declearing variable for creating offset

        PrePick:=Offs(Pick, 0, 0, -100); ! creating offset from the pick point
        PrePlace:=Offs(Place, 0, 0,-100); ! creating offset from the place point


        OpenGripper;

        !via point
        MoveJ via_point,v500,z0,Fingers\WObj:=wobj0;

        ! going to the pick point
        MoveJ PrePick,v500,z0,Fingers\WObj:=wobj0;
        MoveL Pick,v50,fine,Fingers\WObj:=wobj0;
        WaitRob \ZeroSpeed;

        CloseGripper;

        MoveL PrePick,v50,fine,Fingers\WObj:=wobj0;

        !via point
        MoveJ via_point,v500,z0,Fingers\WObj:=wobj0;

        ! going to the place point
        MoveJ PrePlace,v500,z0,Fingers\WObj:=wobj0;
        MoveL Place,v50,fine,Fingers\WObj:=wobj0;
        WaitRob \ZeroSpeed;
        OpenGripper;


    ENDPROC

ENDMODULE
```

Task 2: Pick and place : RAPID CODE:Used for Demo.

```
MODULE MainModule
   CONST robtarget via_point:=[[419.99,-377.933,712],[0.707106781,0,0,-0.707106781],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
   CONST robtarget Pick:=[[275.502,-630.736,852.224],[0.707106781,0,0,-0.707106781],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
   CONST robtarget Place:=[[214.792273259,38.46617002,1125.252179854],[0.707106922,0.000000191,0.000000183,-
0.70710664],[0,2,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];

   PROC main()
      HomePosition;
      Path_10;          !routinre for pick and place
      HomePosition;

   ENDPROC

   PROC HomePosition()
                        MoveAbsJ [[0,0,0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]]\NoEOffs,v200,z50,tool0;
            ENDPROC

   !Function for closing gripper
   PROC CloseGripper()
      SetDO Rob2_Gripper_Reset,0;
      SetDO Rob2_Gripper_Set,1;
      WaitDO Rob2_Gripper_Set,1;
      WaitTime 1;
   ENDPROC

   !Function for opening gripper
   PROC OpenGripper()
      SetDO Rob2_Gripper_Set,0;
      SetDO Rob2_Gripper_Reset,1;
      WaitDO Rob2_Gripper_Reset,1;
      WaitTime 1;
   ENDPROC

   PROC Path_10()
      VAR robtarget PrePick; !declearing variable for creating offset
      VAR robtarget PrePlace; !declearing variable for creating offset

      PrePick:=Offs(Pick, 0, 0, -100); ! creating offset from the pick point
      PrePlace:=Offs(Place, 0, 0,-100); ! creating offset from the place point


      OpenGripper;

      !via point
      !MoveJ via_point,v500,z0,Fingers\WObj:=wobj0;

      ! going to the pick point
      MoveJ PrePick,v500,z0,Fingers\WObj:=wobj0;
      MoveL Pick,v50,fine,Fingers\WObj:=wobj0;
      WaitRob \ZeroSpeed;

      CloseGripper;

      MoveL PrePick,v50,fine,Fingers\WObj:=wobj0;

      !via point
      !MoveJ via_point,v500,z0,Fingers\WObj:=wobj0;

      ! going to the place point
      MoveJ PrePlace,v500,z0,Fingers\WObj:=wobj0;
      MoveL Place,v50,fine,Fingers\WObj:=wobj0;
      WaitRob \ZeroSpeed;
      OpenGripper
   ENDPROC

ENDMODULE
```