Playing Chess with the Assistance of an Industrial Robot

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Abstract — **In the first part of this paper the simulation of the industrial robot as an assistance robot for playing chess and the realisation of the real idea is presented. The simulation part of the project has been realised with the software KUKA Sim Pro in version 2.2.2. The software KUKA Sim Pro is an application used for design of 3D-layouts of a plant components including KUKA-robots. With it, any plans and concept designs can be virtually projected and be analysed. Industrial robot used in the project is of the type KR6 R900 sixx (Agilus), which counts to be a quickest industrial robot worldwide. Further part of the system is PLC controlled conveyor belt, connected with the robot control unit. In the second part of the paper, the practical realisation of the simulation is presented. Especially the construction of the chess board and the pawns has been explained. For it aluminium has been used as a material for the "white" pawns and graphite for the "black" pawns. In order to pick up the paws, the Vacuum cup with Venturi nozzle has been designed. The project can be applied for educational purposes as a form of an interesting example how to learn to program and simulate the industrial robots.**

Keywords – Chess, Industrial Robot, Simulation, KUKA Sim Pro, Pick-and-Place, Education

I. INTRODUCTION

There are many attractive ideas and possibilities to arrange a university lecture in the field of robotics. One possibility of many, is to use an industrial robot for playing chess game. With the help of this idea, both, simulation with the help of robot software, as well as the real programming of the industrial robot can be practiced. Using simulation application is one of the most effective way, to save a costs and to get suitable ideas of the practical programming of the plant or to design it [1]. The same applies to conceptualize an instal-lation, to optimize, to perfect the system and to test it above all, without to buy an implemented component, mounting and equipment. With simulation, every desired working step can be carried out and it can considered from the most different perspectives. Process adaptations can be, at very short notice, as long carried out, till the optimum result is available. After the simulation part, the real construction of the arrangement, including the fine adjustments are necessary, in order to test the system under the real conditions. Such real realization of the system, is carried out during the design of the chess game with the help of an industrial robot. In addition to it, the constructed chess board with suitable chess figures are presented in this paper, as a part of the whole arrangement.

II. SIMULATION OF THE ARRANGEMENT

In this chapter, the simulation equipment and the simulated construction of the agreement are explicated. The simulation of the robot movement as well as the simulation of the periphery, are carried out with the programme KUKA Sim Pro in version 2.2. The used industrial robot is of type KUKA KR 6 R900 sixx. It counts to the quickest in the world at the moment. Core information about the simulation software as well as the used industrial robot used, can be found in [2]. The subject of the simulation is, as mentioned, the chess game. The idea is already patented and used in different manner [3]. According to the target project the industrial robot should be able, on command, to move the chess figures. The first components of the simulation are inserted by means of the click-and drop function, directly in the user window of the simulation. About the so-called catch functions of the simu-lation software, these components are tied together with each other, so that these are also connected firmly with each other in the simulation [4].

A. Simulation of the Industrial Robot

According to the available robot selection in the simulation database, the suitable robot (KR KUKA 6 R900 sixx) is selected for the simulation. By using of the simulation library, this robot arm is selected directly and is inserted by click-and drop function into the simulation workspace [5]. After the robot arm is aimed and fixed, it can be manipulated. A fixation is necessary, because in the simulation, neither gravitation nor other limitative characteristics are implemented. The manipulation of the robot is explained in the later chapter.

B. The Gripper and Signal Connection

A simulation must, in the best case, allow all functions of the system close to real requirements [6, 7].Therefore, in order to simulate the system, using of manipulators is necessary. In the case of this simulation, a gripper is used as a manipulator. With the insertion of the gripper, it must be noticed, that it disposes of a so called simulative “blue zone”.

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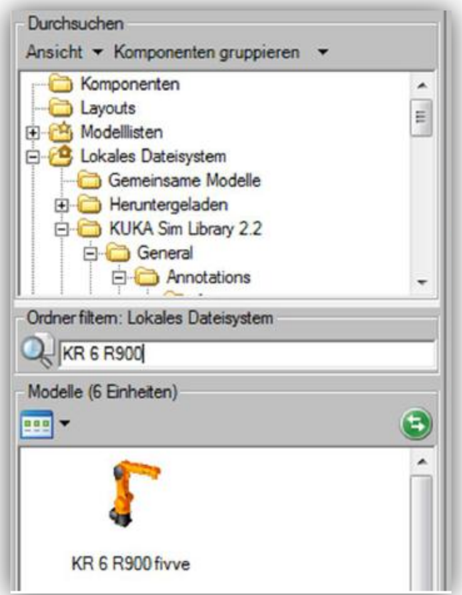

Figure 1. Robot selection

This “blue zone” describes an area of the gripper, which can interoperate with others components and is marked with a blue field. In this project the so called "shift gripper" was selected and adapted in regard of the characteristics in his magnitude.

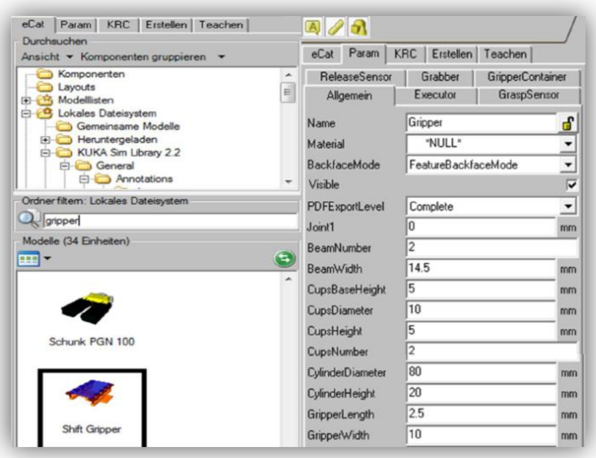

Figure 2. Gripper characterisation

In order to connect the gripper with the robot, the assignment of the signals and their interconnection is important [8]. Besides, it is mandatory, to assign a certain out-signal in the simulation to the gripper. In this project, the out-signal for the gripper is assigned to the number 105. The figure 3 shows more exactly the suitable settings, which were met. Without this allocation, it is not possible, to move the gripper during the simulation, in order to move an object, or to manipulate or grasp it. In this case, if the signal 105, is switched on "True", it causes the closure of the gripper. The figure 3 shows also, how the industrial robot is tied together with the gripper. Without this and similar settings, it is not possible to open the gripper or to close him by robot.

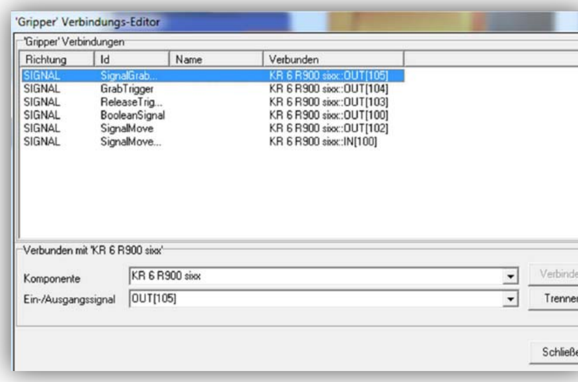

Figure 3. Assignment of the signals

Besides, it is necessary during the process, to hold the conveyor belt at a certain time, in order to prevent the (theoretical) falling down of the workpieces. This is reached by means of sensors. Sensors are mounted and integrated in the particular place of the conveyor belts, and they dispose of the possibility to change the logical output state of the conveyor to "False"- state, and with it, to stop the belt and the workpiece on it accordingly.

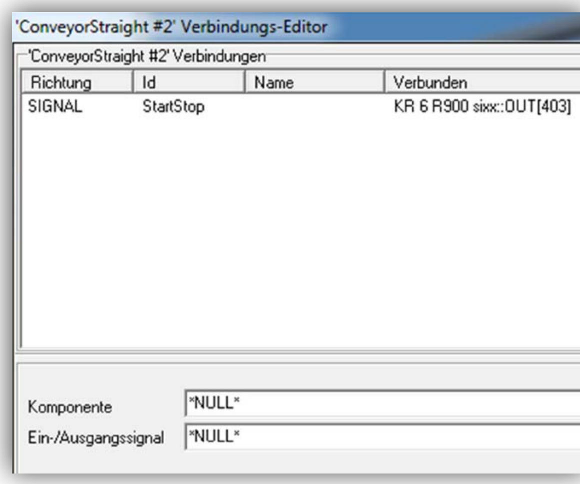

Figure 4. Conveyer signal assignment

In the library, the most different kinds of sensors are to be found. In this project, the horizontally sensor was used. This sensor is fixed at the end of the conveyer belt. As soon as the trans-ported workpiece reaches the sensor, this will stop the belt, with the suitable signal linking procedure. The linking of the sensor with the conveyer belt is realised in the signal linking editor. This is presented in the figure 4. In this case the conveyer is switched on and off actively by the robot. It is clear to recognise that the out signal 403 is responsible for it. Exactly like the conveyor belt, the so called creator, which creates the workpieces, is also actively steered by the robot and gets the respective processing instruction by him.

III. The Main and Subroutines

After placement and connecting of all necessary components the basis for the simulation is to be created. For this purpose, the so called teaching of the robot, as a basic tool is used. With the help of the teaching process, the robot can be positioned in the desired position, which becomes stored and then separately, frequently recalled in the later program. As soon as a position is recalled, the robot moves according to defined movement instructions (e.g., point to point or linearly) on this position and waits for the next command, or sends the command to periphery. It is possible, to interoperate by different displacement options. This means, that the robot can be steered either axis for axis, or with the help of the Cartesian coordinate systems, along the axes or over the mounted tools.

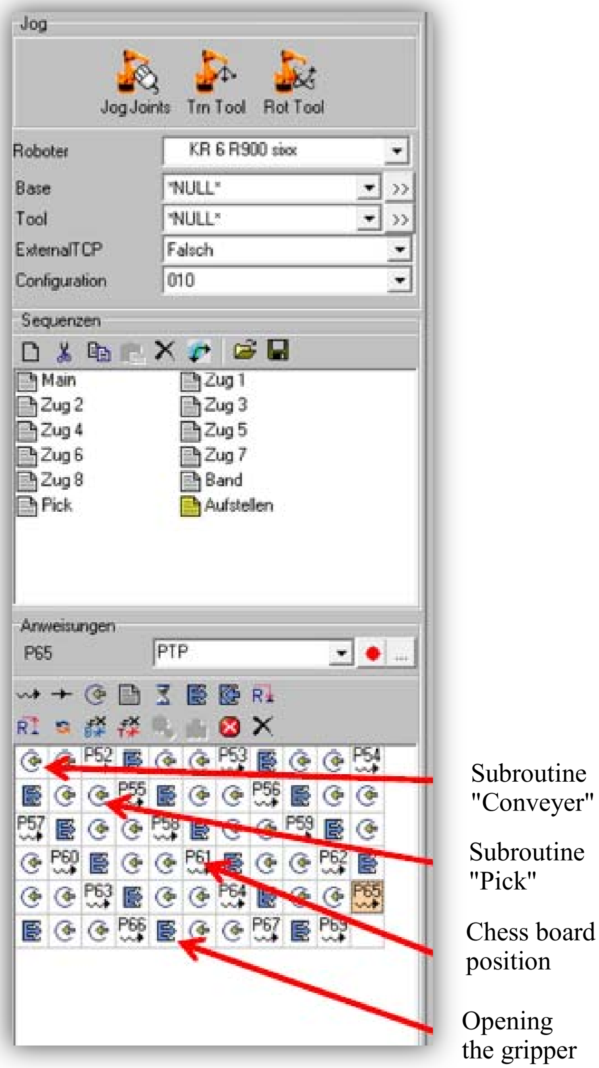

Figure 5. Programming of main and subroutines

If every required position is stored, and perhaps also accordingly named, it is inevitably to write the suitable program, in that the single positions are recalled and approached. In the figure 5, the programming sequences of different sub-routines and the main routine are presented. For the programming of this project, the whole program was divided into several subroutines, in order to guarantee an optimum overview of the main program. It includes subroutines: "Conveyer (Band)", "Pick, "Putting up (Aufstellen)", "Chess move (Zug) 1-8", as well as the main program. In the subroutine "Conveyer", the robot is instructed, to move itself to the issue position, over the conveyor belt and to release orders. In the subroutine "Pick", the robot is instructed to pick up the pawns from the conveyor belt and to place them afterwards, on the respective position. The sub-routine "Putting up" relies essentially in returning order on both subroutines "Conveyer" and "Pick". The main program is the actual “heart” of the whole programming. In this program, all program parts and subroutines are brought together to a whole. The result of the programming is shown in the following picture. To show the finalization of this project part, the following stopped view of the simulation is presented.

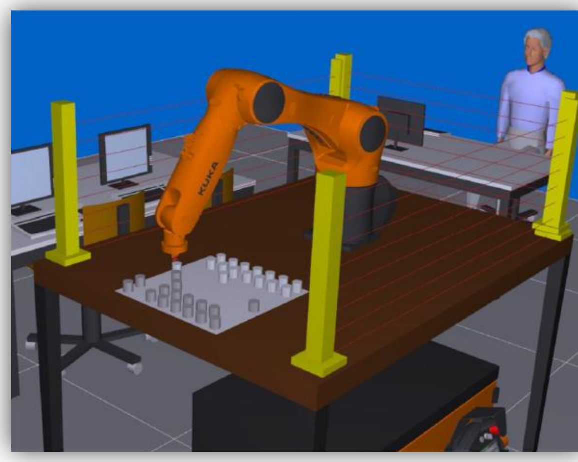

Figure 6. Final simulation

IV. Practical Realisation of the Simulation

In this part of the paper, practical realisation of the simulation is presented end explained. It's the nature of the beast that the practical realisation deviate from the simulation. The practical part consist of the construction of the chess board and the pawns. The chess board on which later the pawns are put on, has been made of aluminium as a material, and has the following mass: 400 x 400 x 10. The final realisation is presented in the next figure.

Figure 7. Chess board

The chess pieces (pawns) were produced of two different materials. For it aluminium has been used for the "white" pawns and graphite for the "black" pawns. The diameter of all figures amounts to 40 mm. This is important, in order that they can be grasped and easily moved by the gripper. The final realisation of the king pawn is presented in the next figure.

Figure 8. The king pawn

In the following, the whole construction is briefly presented and explained. The robot is in a so-called “park position”. That means, after every gambit that was carried out, the robot goes back again in this position, in order to allow a quick new gambit again. In the figure 9, all implemented components, which are necessary for the realisation of the whole project, are presented. These are conveyor belt, industrial robot used, vacuum cup with Venturi nozzle [9] and chess board with figures. The chess board is placed in the margin of the robot. In the presented case, all figures are on their respective positions and are ready to be used for a chess game.

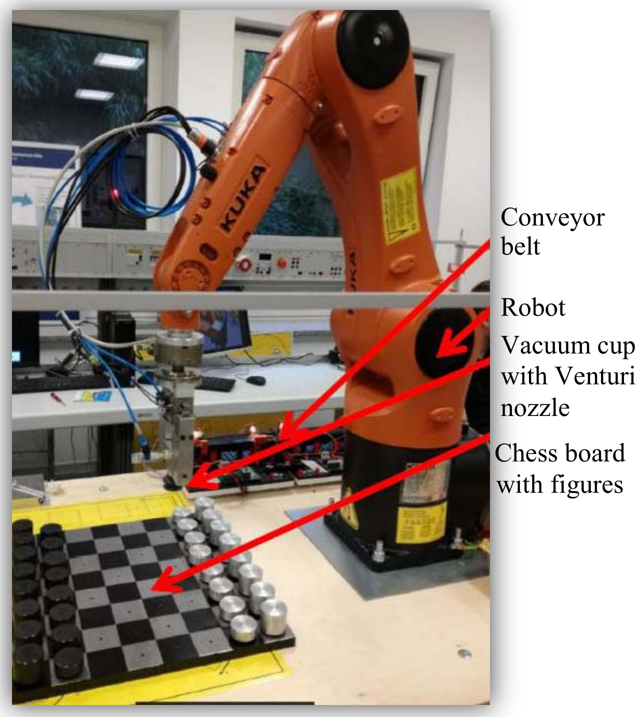

Figure 9. The final realisation

The geometrical difference between the small pawns and the other active chess figures which are placed in the first raw, can be clearly recognised. The time used for the realisation of the simulation part and the construction part of the project was about 3 months.

V. CONCLUSION

This paper presents an idea how to use the industrial robot as an assistance tool in order to play chess. The first part of the paper explains the simulation of the whole arrangement by the software KUKS SIM Pro, explaining the necessary signal connections as well as the settings required. It is mainly presented the realisation way, less the didactical background and the methodology behind. On those, appropriate references are used. After the realisation of the simulation, a practical example of the realisation of the real environment is presented. It takes into account different necessary proce-dures, as the production of the chess figures or chess board, colour requirements on the pawns and board, material used and combination of the components tight together into the whole functional project. The idea of the playing chess with the robot is of an educational character, and can be used as a possible project for scholars and students. By reason of the scale, in this work, the operational part of the robot programming and the codes used in the control unit of the robot, are not presented.

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