Conceptual Design of a Virtual Pick and Place Operation Using an Articulated Robot Arms.

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Abstract−*With the development of rising technology every year, automation and robotics is essential to meet the needs of modern life. Nowadays, the technology of virtual design is considered as one of the most important thing for the process of overall design in engineering. In this paper, an articulated robot arms was virtually design for a virtual pick and place operations. 3D-CAD system software has been used. SolidWorks software has been introduced. In this project, each of every part of the robot and whole system has been created. Then, all of it has simulated in the software. Motion and force has created to make an appropriate system. The six axes articulated robot arms was created which using a concept of industrial automation robot. Simulation results of the articulated robot arms are presented to demonstrate the assembly robot in the system.*

Keywords*: virtual design, SolidWorks, 3D-CAD system software.*

1.0 INTRODUCTION

The power of technology is dramatically change the design world today. As combining the technology of design and technology of robotic, the process of making a robot will be more easily. Furthermore, the industrial robots are important components of today's factory and even more in future, beside, the demand of using robot is high lately. According to specialty of robot which is has potential for flexibility and intelligent in performing tasks in repetitive manner, and at acceptable cost and level of quality [1]. According to specialty of robot and automation, the system is virtually design to model a real-world object into three dimensions model design. A virtual design can be simply defined as 'design in the computer' [1]. It appeal is due to appropriate and economical aspect and the important thing is everything can be done on the computer before build the real one [1, 2].This paper proposes a 3D-CAD robot and automation design based on SolidWorks software. A virtual pick and place operation system was assembled after each of all part has been created by defining all the parameter for well-matched combination to make the whole system may be assembled correctly. This system was developed for picking bottles and placing it into a box and then palletizing the boxes.

The development of technology virtual design has played a main role in the design software and hardware technology of computer now, such as virtual modeling, virtual assembly, virtual control, motion simulation and etc [2]. The three dimension design software was chosen because it can reduce design period, cut design cost and improve design quality. Furthermore, virtual design may saving assembly cost effectively and also improve assembly efficiency [3]. So, that is why the SolidWorks software was chosen in designing an articulated robot arms for pick and place operation through the computer aided design.

From literature reviewed, robot helps to increase production rate, therefore we propose to design a virtual an articulated robot arms for pick and place operation in manufacturing industry. The example of academic journal that is creates design as it idea for project such as, "Virtual Design of Multi-axis Positioning for Robotic Application" [1]. This project is to design the robot arm using CAD system, they used robot Fanuc M-6iB has been chosen for reference, and using finite element (FE) to analyses the joints and manipulation movement. The application for the robot has not been created for robot task. Another is "Design, Simulation and Control in Virtual Reality of a RV-2AJ robot" [4]. This journal also using CAD software to develop geometric model, it solves the kinematic and schematic of robot arms by using calculations and presents the equations. Simulate it with Matlab software, which is geometrical model exported into Matlab.

2.0 METHODOLOGY

I. Concept design.

A robot can be defined as a re-programmable multifunctional manipulator design to move material, parts or device through variable programmed motion. A robot is extraordinary has capability compared to human such as it may work in hazardous environment, reduce production cost, improve product quality, and etc [5]. So, robot has high demand in industry. This operation was used an articulated robot arms. Two robot arms have been placed in the system. Using the concept of industrial automation robot arm, the six degree of freedom of robot was chosen, which robot joint can move in six directions, so that the working envelops of this robot much wider [6]. The translation and rotation motion of degree of freedom was shown in figure 1. Robot's manipulator consists of an assembly of links and joints. The joints were located at specific places of robot which is waist, shoulder, elbow, and wrist. The manipulator divided into three sections which are body (consist of waist joint and the body), arm (consist of shoulder joint, upper arm, elbow joint and fore arm) and wrist (consist of wrist joint). The manipulators were located in relative to the ground in fixed base [5, 6]. The robot manipulator was illustrating in figure 2. The wrist produce joint between the manipulator and end-effector, it enables the end-effector to be in proper orientation. The wrist extends the mobility of robot manipulator, it has three rotational axes dimension, which is yaw (angular movement from left to right side), pitch (rotational movement up and down) and roll (rotational movement around the end of wrist). Robot also has hand, but robot's hand is not part of the manipulator, it is called end-effector. The end-effector may be changed for suitable difference kind of jobs [5]. This robot was used two different types of end-effectors, one for pick and place bottles and another one for pick and pallet the boxes. The vacuum cup and gripper were chosen for these tasks.

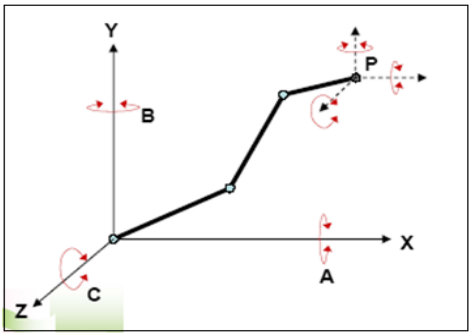

Fig.1. Translation and rotation motion of six degree of freedom on xyz coordinate. [6]

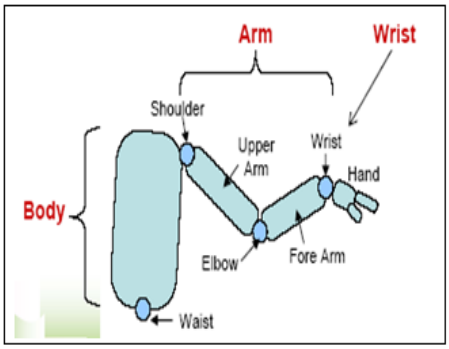

Fig.2. Component of robot manipulator. [6]

II. Design and simulation of pick and place robot.

The virtual geometry of modeling was built in the CAD system which is called SolidWorks software. The dimensions of each part was clearly define to make all part will be matched together. All of smallest parts that do not affect the dynamic motion and assembly of robot were ignored. The dimensions of each part was recorded for facilitate in the next component design. All of the robot arms elements were named to make easy for the next operations, as follows: base, waist, arm1, arm2, wrist, end-effector, and etc. Therefore, the 6 DOF of arm robot was build. After modeling, the individual components have been assembling into a single file. The rotation and movement of joints were set up in the model and the motion analysis for robot was introduced. Figure 3 shows the flow chart of process of a virtual pick and place operation using an articulated robot arms in SolidWorks.

SolidWorks Software also has been used to simulate the whole automation assembly system. Figure 4 shows the component of assembling robot arms. After assembled the robot arms, the other components for whole system that have been created were gathered into robot arms assembling file, as follows: conveyor belt, bottles, boxes, pallet tray of boxes, and etc. The motion of movement for each component was positioned carefully to get right speculation. . Figure 5 shows the assembled robot parts into a complete 6 DOF articulated robot, a motion for each part was created in this assembly file. The whole system model was shown in figure 6.

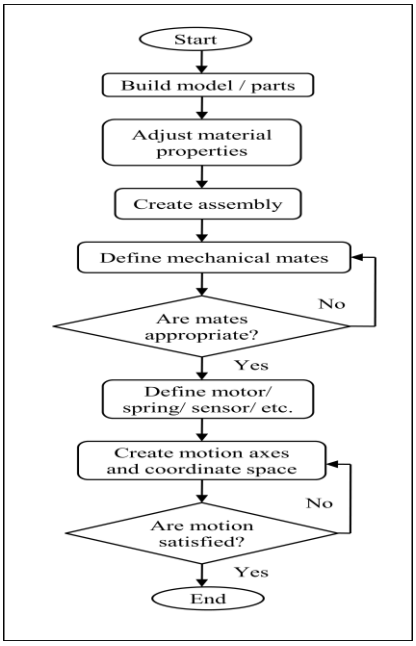

Fig.3. Flow chart of overall process in SolidWorks.

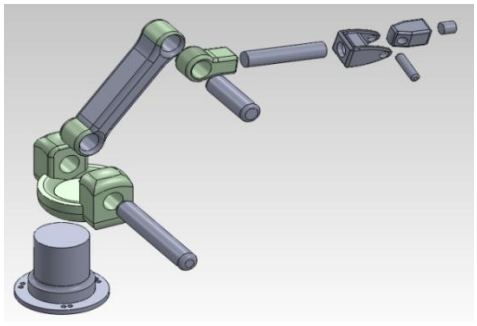

Fig.4. Component of robot arms.

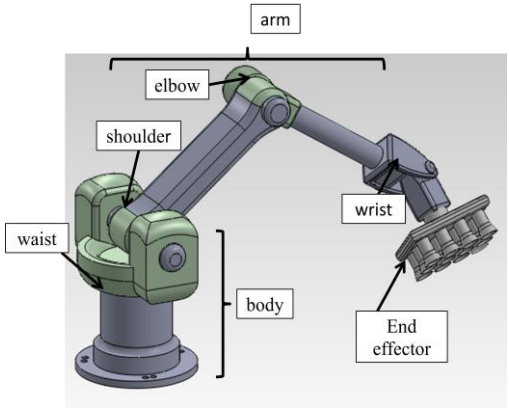

Fig.5. Virtual geometry model of robot arms.

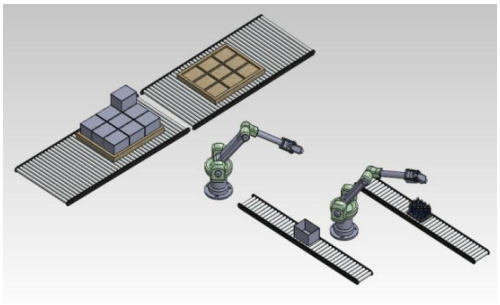

Fig.6. Pick and place and palletizing operation.

3.0 RESULT AND DISCUSSION

After accomplish this project, the 3D virtual model was obtained and the pick and place operation has been built by using an articulated robot arms. This successfully designs through 3D-CAD system software (SolidWorks). The results were have been looked is about the motion of this operation which is focusing on the articulated robot arms. Figure 6 shows the angular velocity of waist joint. This joint turn at 180˚ of it distance to positions manipulation to the bottles' conveyor belt. Figure 7 shows the angular motion of shoulder joint in term of velocity. This joint rotates in 90˚ for positioning the upper arm. Figure 8 shows the angular motion of elbow joint, this graph describe the movement of fore arms. All of result represent graph in term of angular velocity per second, it describes the velocity of robot move in five second to done. So, the movement for one task is cycle in every five second.

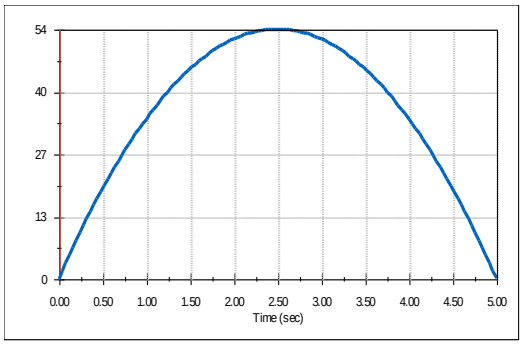

Fig.6. Angular motion of waist joint.

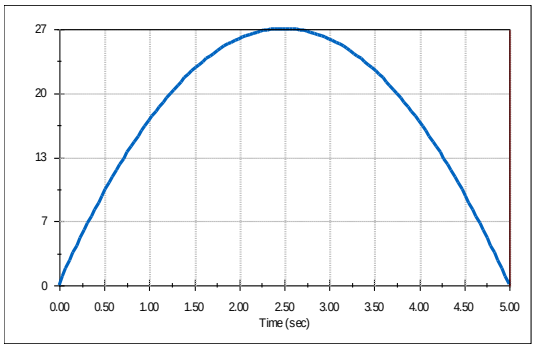

Fig.7. Angular motion of shoulder joint.

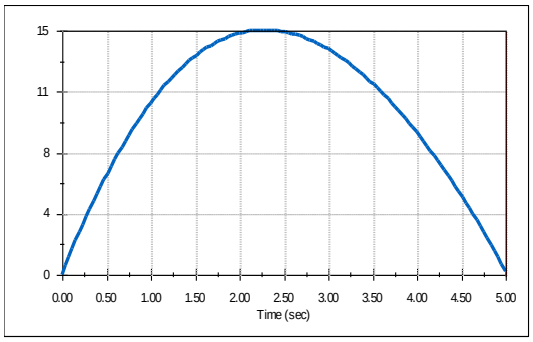

Fig.8. Angular motion of elbow joint.

4.0 CONCLUSION AND RECOMMENDATION.

SolidWorks software was used to design a virtual pick and place articulated robot arms, including three dimensions virtual modeling design of components, three dimensions virtual assembly and motion simulation. The simulation modeling and virtual assembly of robot parts and the whole system parts can detect problem on structure in design, and modification can be correct in time. The design details of components are observed at any angle. Combination and motion simulation ensure the appropriate movement of the robot. Simulation design shortens design period and enhances design efficiency. In the future, the material component used are mentions to get more practical virtual design, and also, the SolidWorks software must be simulate together with LabVIEW software to get more realistic control link for the system.

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