AN APPROACH TO ROBOT MOTION FOR CONVEYOR TRACKING USING NEURAL NETWORK

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Key words: Conveyor Tracking, Robotic, ANN

ABSTRACT

In this study a robotic system collecting a given region of a surface automatically and in a systematic pattern at high rates and achieving these results are considered as scanning instruments. This paper introduces an approach to design and control a 6-degres freedom (DOF) multi purpose industrial. The robot control was achieved by PID fuzzy logic (FL) and neural network (NN) simulation results presented in this study. More data means better analysis to improve quality and shorter reaction time in a running production line. The production methods were improved to lean production techniques to catch the problem. So we have to improve our control methods to maintain the quality

I. INTRODUCTION

Robots can be designed for different purpose. An industrial robot is specific complex parameters that must be determined. There are many closely related design parameters that must be determined for proper design[1]. It needs six spatial parameters such as x, y, z, in translation and roll, pitch, yaw in rotation to fully describe the dimensional position and orientation of a rigid body. In this paper the criteria for the robot design are first specified an industrial robot is implemented for various tasks selected. According to tasks the simulations are presented.

The rest of this paper is organized as follows. In section 2, general automatic synchronization with moving objects is explained. The mathematical model of dc motor is expressed in section 3 kinematics and dynamics equations of the robot based on PID controller is expressed. In section 4 the simulation results are given. Final section provides conclusion on this study.

II. AUTOMATIC SYNCHRONIZATION WITH MOVING OBJECTS

To increase the flexibility of the robot, an adaptive algorithm for an unknown environment should be designed. For example if it is decided to integrate robots into old production lines utilizing existing conveyors not controlled by the robot, we need to implement conveyor tracking algorithm. With in this algorithm robot programs should be executed correctly in relation to the work object, regardless of how the conveyor moves[2]. Jobs should be executed with great accuracy independent of conveyor speed including stop and reverse motion. That algorithm should give a position synchronization feature to the system.

The robot has 6-DOF. The construction and electronic hardware of the robot is shown figure1. Cartesian coordinate was found to be suitable for the pre-specified tasks: however robot must be capable of being used for various applications on different geometries.

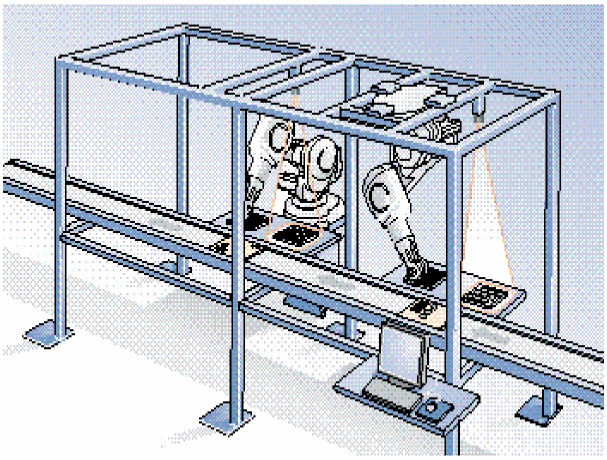


Figure 1. Schematic of Conveyor Tracking

PRINCIPLES OF CONVEYOR TRACKING

For the robot controller, conveyor is a mechanical unit with all features of mechanical unit except that is not under control of the robot controller. For conveyor tracking, the robot movements are coordinated to the movements of a user frame connected to the conveyor mechanic unit. User frame is placed on the conveyor and connected to its movements. A work object is used for this purpose and it is marked with the name of the conveyor mechanical unit and that the work object is moveable.

The conveyor tracking coordination will be active if the mechanical unit is active as seen figure 2. And the conveyor coordinated work object is active. When the conveyor coordinated work object is used, in jogging or in a move instruction, the data in the user frame component will be ignored and the location of the user coordinate system will only depend on the movements of the conveyor mechanical unit.

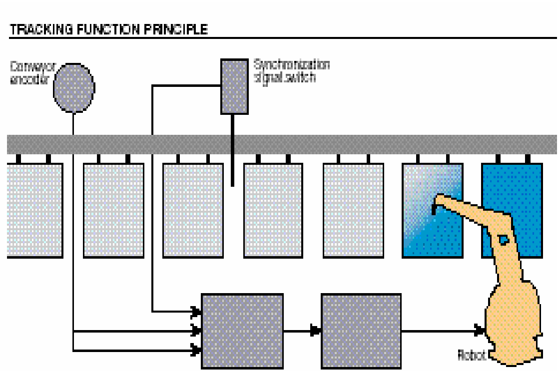


Figure 2. Tracking Function Principle

The aim of the controller is to reach or maintain a process in a specific state, by monitoring a set of variables and selecting the adequate control actions.The robot introduced here is controlled by PID controller independently acting atb each of six joints. The robot control system is given figure 3.

For a six DOF manipulator with a spherical wrist we should find first position of the intersection of the wrist axes and then the orientation of the wrist[3,5,6]. Assumption of a spherical wrist means that the axes z_4, z_5, z_6 intersect at o. To find an angles which correspond to desired end-effector configuration we need to solve the inverse kinematic equations we will decouple the inverse kinematics problem into two simpler problems, as inverse position kinematics and inverse orientation kinematics.

If the process is only picking the objects then robot wrist orientation may be choosen in z direction perpendicular to conveyor which is aligned in base coordinates.and required orientation can easily be performed by sixth axis which will be in relation with both conveyor and first axis.

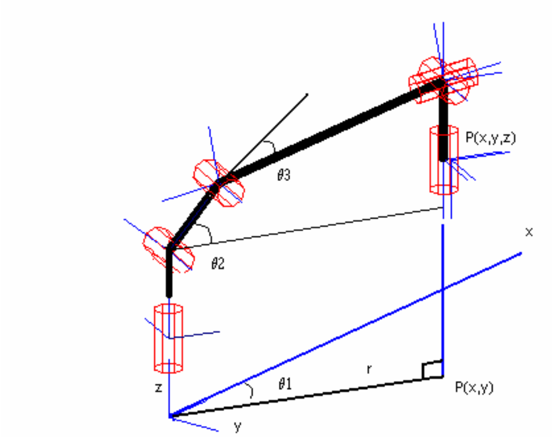


Figure 3. Six.DOF Manipulator

$$\theta_1 = A\tan(p_x, p_y) \qquad (1)$$

$$D = \frac{p_X^2 + p_y^2 + p_z^2 - a_2^2 - a_3^2}{2a_2 a_3} \qquad (2)$$

$$\theta_3 = A\tan\left(D, \pm\sqrt{1 - D^2}\right) \qquad (3)$$

$$\theta_2 = A\tan\left(\sqrt{p_X^2 + p_y^2}, p_z^2\right) - A\tan(a_2 + a_3\cos\theta_3, a_3\sin\theta_3) \qquad (4)$$

$$P_x = f(v_{con}, t) \qquad (5)$$

After converting the encoder value to angular displacement result will be set point for θ_1

The first step to kinematic modeling is the proper assignment of coordinate frames to each link. Each coordinate system here is orthogonal, and the axes obey right-hand rule[4-7-8].

Basically in forward kinematic we would like to know the position and orientation of each link as the mechanism moves. This can be done by attaching frames t each link and computing how the frame changes as the robot moves. For this we need to know how the frame changes with the mechanism parameters. To move from one link to another we should parametrize the relationship between two adjacent links (frames). Thus we will have a table of parameters that defines the relationship between two adjacent frames.

A commonly used convention for selecting frames of reference in robotic applications is the Denavit-Hartenberg, or D-H convention[Rivin]. In this convention, each homogenous transformation A_i is represented as a product of four basic transformations

$$A_i = Rot_{z'\theta} Trans_{z,d} Trans_{x,a} Rot_{x,\alpha}, \qquad (6)$$

$$=\begin{bmatrix}\cos\theta & -\sin\theta & 0 & 0\\ \sin\theta & \cos\theta & 0 & 0\\ 0&0&1&0\\ 0&0&0&1\end{bmatrix}\begin{bmatrix}1&0&0&0\\ 0&1&0&0\\ 0&0&1&d\\ 0&0&0&1\end{bmatrix}\begin{bmatrix}1&0&0&a\\ 0&1&0&0\\ 0&0&1&0\\ 0&0&0&1\end{bmatrix}\begin{bmatrix}1&0&0&0\\ 0&\cos\alpha&-\sin\alpha&0\\ 0&\sin\alpha&\cos\alpha&0\\ 0&0&0&1\end{bmatrix}$$

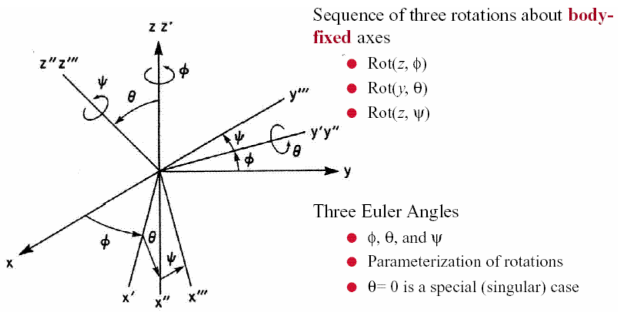
$$=\begin{bmatrix}\cos\theta & -\sin\theta\cdot\cos\alpha & \sin\theta\cdot\sin\alpha & a\cdot\cos\theta\\ \sin\theta & \cos\theta\cdot\cos\alpha & -\cos\theta\cdot\sin\alpha & a\cdot\sin\theta\\ 0 & \sin\alpha & \cos\alpha & d\\ 0&0&0&1\end{bmatrix}$$

$$\text{so; } {}^{N-1}_{N}A = F(a_{N-1}, \alpha_{N-1}, \theta_{N-1}, d_{N-1}) \qquad (7)$$

The D-H parameters in our system are:

Link	Alpha	a	d	Theta
1	0.0	0.0	200.0	200.0
2	90.0	200.0	0.0	90.0
3	0.0	200.0	0.0	0.0
4	90.0	200.0	200.0	0.0
5	-90.0	0.0	0.0	0.0
6	90.0	0.0	200.0	0.0

This geometric approach gives the value of the first three joint variables, now to find the final three angles for a given orientation we should determine the Euler angles corresponding to a rotation matrix R



$$R = Rot(z,\phi)xRot(y,\theta)xRot(z,\psi)$$

III. MATHEMATICAL MODEL OF 1ST AXIS WITH DC MOTOR

The center of the coordinate system is y direction which is perpendecilar to conveyor

3.1 Op-amp

The relationship between the outputs of the op-amp and the currents $i_a(t)$and $i_b(t)$ is

$$e_o(t) = -R_F[i_a(t) - i_b(t)] \qquad (8)$$

3.2 Servo amplifier

The gain of the servoamplifier is –K. The output of the servoamplifier is expressed as

$$e_a(t) = -K[e_o(t) + e_t(t)] = -Ke_s(t) \qquad (9)$$

3.3 Tachometer

The output voltage of the tachometer, e_t is related to the angular velocity of the motor through the tachometer constant K_t:

The angular position of the output gear is related to the motor position through the gear ratio, 1/n.

Thus $$\theta_o = \frac{1}{n}\theta_m \qquad (10)$$

3.4 DC Motor

The DC motor has been modeled with equations are

$$e_a(t) = R_a i_a(t) + e_b(t) \qquad (11)$$

$$e_b(t) = K_b\omega_m(t) \qquad (12)$$

$$T_m(t) = J\frac{\partial\omega_m(t)}{\partial t} + B\omega_m(t) \qquad (13)$$

where J and B are the inertia and viscous friction coefficients seen at the motor shaft. The inductance of the motor is neglected.

IV. SIMULATION RESULTS

A Six DOF manipulator for conveyor tracking is performed three approximations. Firstly, classical control method which to apply for conveyor tracking of 1st axis is PID. A DC motor using six DOF manipulator is modeled simulink for Matlab 6.0. PID result is seen figure 4. The PID parameters have selected emprically. Second of approximations is fuzzy logic (FL). Rule table of FL is given Figure 5. DC motor of convey tracking for FL outputs are given in figure 6 and 7.

And finally solution of conveyor tracking is Artificial Neural Network (ANN). Network structure is 1x8x1 and one input one output. Sigmoid are used as Net's activate function. ANN result is shown in figure 8

V. CONCLUSION

A 3-DOF industrial robot is designed and controlled successfully. The materials used for the robot are selected accordingly with optimum economy ratio. The difficulty faced in this implementation was to obtain the appropriate PID parameters for moderate control, FL and Neural network. This robot is mainly used in industrial and research purpose.In the future work, this study will be retried by using Fuzzy –PID and its different applications.

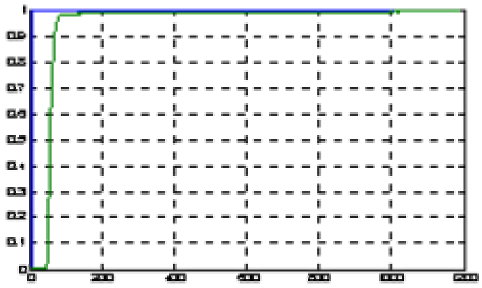


Figure 4. PID output of DC motor via step input

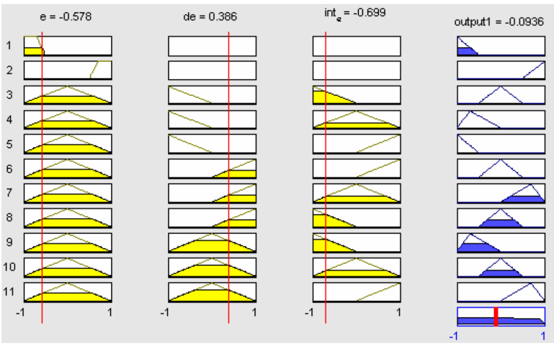


Figure 5. FL. Rule Table

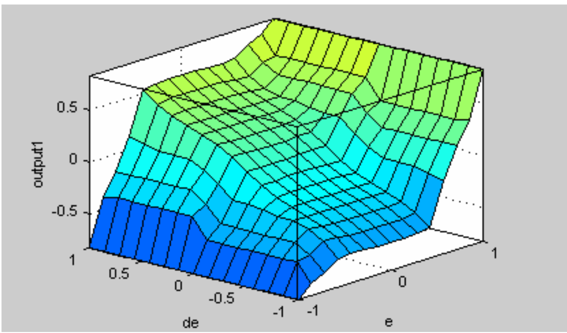


Figure 6. DC Motor of Convey Tracking for FL Output

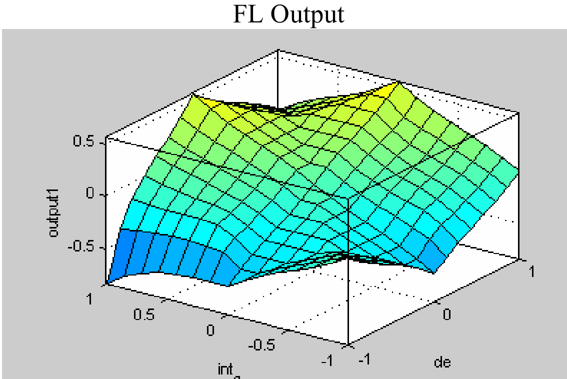


Figure 7. DC Motor of Convey Tacking for FL Output

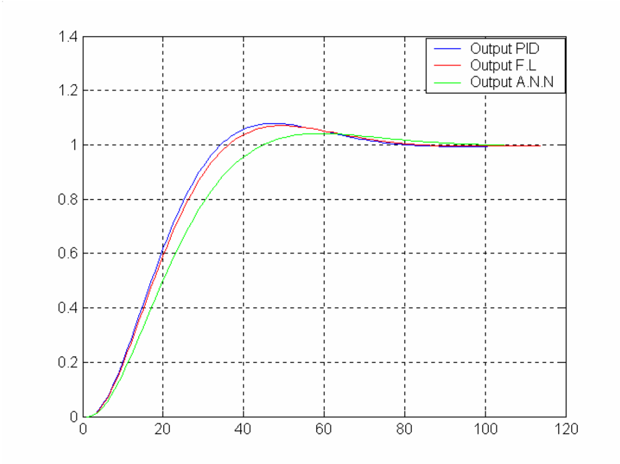


Figure 8. DC Motor Control Signal of Convey Tracking for PID, F.L. and ANN. output via step input

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