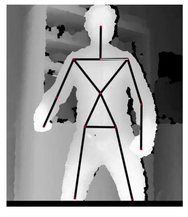
Human Arm Imitation

The Inverse Kinematics Problem

[3]



Joint Angles

Human-robot skeleton mapping

Robot Joint Angles

D-H Parameters

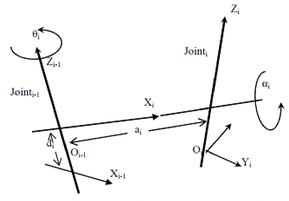


FIGURE 1. The relation between two consecutive coordinates

[2]

Human Arm

Robot Arm

TABLE.1 Numeric Value for D-H Parameters

Frame (joint)	α_i(rad)	d_i(cm)	a_i(cm)	α_i(rad)
1	q_1	0	0	π/2
2	q_2+ π/2	0	0	π/2
3	q_3	0	0	-π/2
4	q_4	0	L4	π/2
5	q_5	0	L5	-π/2
6	q_6- π/2	0	0	-π/2
7	q_7	0	0	-π/2

[2]

Table I. D-H Parameters of PowerCube manipulator.

Link	a_i	d_i	α_i	θ_i
1	0	d_1	−90°	θ_1
2	0	0	90°	θ_2
3	0	d_3	−90°	θ_3
4	0	0	90°	θ_4
5	0	d_5	−90°	θ_5
6	0	0	90°	θ_6
7	0	d_7	0°	θ_7

[4]

Amtec PowerCube Manipulator

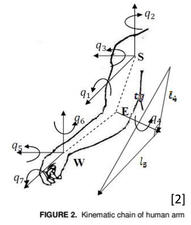
Serial Manipulator (8-DOF) – interfaced using RS232 (SERIAL) Cable

Microsoft RGBD Camera

Interfaced using OpenNI Library

Kinect

[1]



[2]

FIGURE 2. Kinematic chain of human arm

Inverse Kinematics

Use of D-H Parameters to calculate joint angles

Algorithm

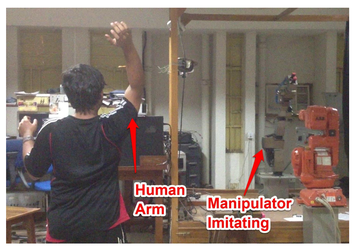
Solution of IK Problem using the Jacobian Pseudo Inverse Method.

$$\begin{vmatrix} d\theta_1 \\ d\theta_2 \\ d\theta_3 \\ d\theta_4 \\ d\theta_5 \\ d\theta_6 \\ d\theta_7 \end{vmatrix} = J^{+} \begin{vmatrix} dx \\ dy \\ dz \end{vmatrix}$$

dθ's are changes in the joint angles and dx, dy and dz – change in the end-effector position and J^{+} pseudo inverse of Jacobian Matrix

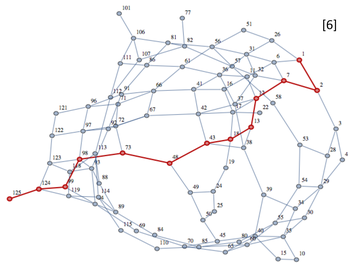
Results

- Achieved Human arm imitation to some extent
- Slight Lag in the imitation because of the speed limits of the Manipulator



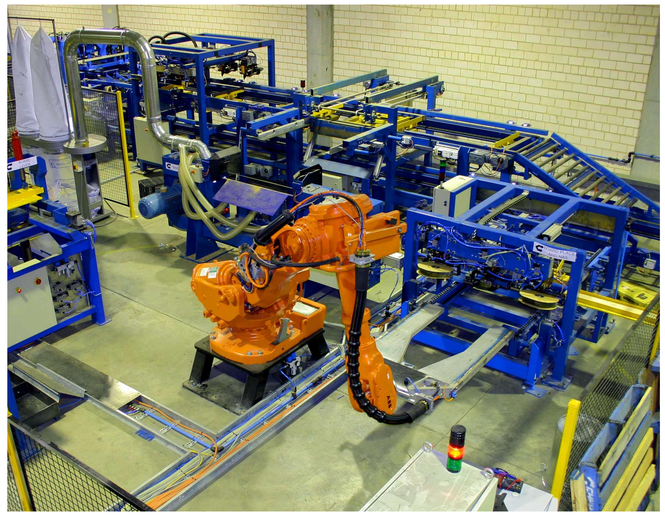
Future Work

Local Optimization – Store Configurations as nodes in a graph and find the shortest path to complete the task.



[6]

Industrial Robots can now be trained and controlled easily



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[6] From http://mathematica.stackexchange.com/questions/4084/finding-a-not-shortest-path-between-two-vertices [2013]

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