

**Indian Institute of Technology Delhi  
Electrical Engineering Department**

21-10-2011.

**Sub: NIQ for Robotic Manipulator with Accessories and Simulation Software**

On behalf of duly constituted purchase committee, sealed quotations are invited from the dealers for the supply of **Robotic Manipulator with Accessories and Simulation Software**, to be used as a platform for Robotic operations projects/ modern control experiments as per specifications given below.

**Robotic Manipulator:**

Mechanical Structure of Robot should be vertically articulated; open frame, where Transmission Gears, timing belts, lead screw and motors are visible.

The Training robot should be compatible for Material Handling.

The robot should be supported by 3D graphic software that lets students design, create and control simulated industrial workcells.

The Robot should be operated directly from the Computer or by the hand held terminal provided along with the setup..

The Robot should be supplied with Multi-purpose gripper attachment capable of handling rectangular objects.

**Mechanical Arm**

Degrees of Freedom : 5 (Articulated R  $\perp$  R || R || R  $\perp$  R)

Payload Capacity : 2 kg or above

**Axis Range**

Axis 1 : Base rotation above 300 degree

Axis 2 : Shoulder rotation minimum -30 to +110 degree

Axis 3 : Elbow rotation at least +120 degree

Axis 4 : Wrist pitch least +120 degree

Axis 5 : Wrist roll above  $\pm 550$  degree

Reach : 600 mm or above with gripper

Speed : 600 - 700 mm/sec

Repeatability : Max  $\pm 0.20$  mm

Standard gripper : Servo motor, parallel fingers

Homing: Each axis should have mechanism for homing.

Actuators: Each axis should be actuated by servo motor.

S &

## **Controller**

Axis control : Real-time; PID; PWM

Communication : USB type cable connection to Computer; Plug and play without rebooting; 2 integrated RS232 channels: one for hand held terminal; one for controller I/O card.

Inputs/Outputs : 8-10 digital inputs; 4-6 analog inputs; 6-8 digital outputs; 2-3 analog outputs.

Microcontroller : Full featured, 32-bit microcontroller

Servo axis drivers : min. 6 for robot & min 2 for peripherals

User Memory : Unlimited programs, program lines and variables, positions.

Position Definition : XYZ coordinates, Joint coordinates (degrees), Absolute, Relative, Cartesian, Joints, Encoder counts

Trajectory Control : Joint, Linear, Circular.

Speed Definition (software) : 8 or above speed settings; travel time definition

Servo control; PID, speed, velocity profile, smoothing; axis position error; gripper operation; thermic, impact, limit protection; homing; Cartesian calculations.

Safety Features : Emergency switches; short-circuit protection; automatic shut-down upon detection of impact, overheating, PC failure or communication error.

**Programming Tool** : Robotic programming and operation tool.

## **Accessories and Simulation Software:**

### **1. Hand Held Terminal**

Functions:

- Should control up to 8 axes connected to the robot controller.
- Should have movement according to encoder coordinates (Joint mode) and Cartesian coordinates (XYZ mode)
- Should have manual movement of axes
- Should have move to position commands
- Should have position recording
- Should have position insertion and deletion
- Should have speed settings

Interface:

- LCD display with more than 75 characters
- Multi-function keys
- Cable and connections

*Handwritten signature*

- Coiled connector cable length minimum 4m
- Emergency by-pass plug, for use when teach pendant is not present

**Safety:**

- Certified for CE safety compliance.

**2. Linear Conveyor**

The linear conveyor belt serves to transport parts to and from the robot work area.

The conveyor should be normally driven by the robot controller as a servo axis, but should also be directly operatable in open-loop by connecting to power supply.

**Design**

- Metal base, heavy duty PVC belt
- Dimensions: L=800 to 900 mm, W=90 to 120 mm, H=90 to 110 mm
- Belt width: minimum 80 mm
- Adjustable side supports enable tilting of conveyor up to 5° angle
- Predrilled holes to enable sensor attachment to conveyor and conveyor attachment to workbench

**Drive and control**

- Motor with high resolution optical encoder
- Controlled by axis driver in robot controller via software
- Variable travel speed
- The necessary cable with connector for connecting to axis driver in controller should be supplied.

**3. Proximity sensor for linear conveyor**

A cylindrical photoelectric sensor with built-in amplifier for use as an optical proximity switch. The sensor unit should include a mounting bracket for attachment to the conveyor. The sensor should be powered by the robot controller's power supply and monitored by any one of the controller inputs.

**Design**

- Cylindrical photoelectric sensor
- Built-in amplifier
- Detection method: Diffuse reflective
- Detection distance: minimum 80 mm
- Response time: 2.5 ms max.
- Mounting bracket for attaching sensor to conveyor
- Cable for connection to controller input

S-J

#### 4. Gravity parts feeder with microswitch sensor

##### Design

- Table-top mounting

##### Dimensions

- Feeder plate: 2-5 mm x 140-160 mm x 280-330 mm
- Adjustable front leg support: 140 mm – 215 mm
- Adjustable rear leg support: 215 mm – 300 mm

##### Slide

- Angle: adjustable, 0 – 40°
- Width: adjustable, 25 mm – 100mm
- 2 guide rails: 10-15 mm x 280-320 mm
- Adjustable end stops on guide rails
- Part-sensing microswitch with I/O connecting leads.

#### 5. I/O experiment table

The I/O experiment table should demonstrate the concept and uses of inputs and outputs.

The table should contain a lamp, a buzzer and minimum four micro switches, which should be connected to the robot controller. The table should allow students to practice operation and programming of controller inputs and outputs. The table should be usable as stand-alone lab accessory, or integrated in a robotic workcell.

##### Design

- Dimensions: L=150-200 mm, W=300-350 mm, H=50-100 mm

##### Inputs

- Minimum 4 micro switches

##### Outputs

- Lamp
- Buzzer
- Two batteries, mounted internally
- Set of wooden cubes and plastic cylinders, of various size

#### 6. Parts Bin

##### Design

8.8

- Dimensions: 150-180 x 150-180 x 80-130 mm

## 7. Robotic Simulation Software

### a. Robotic workcell setup:

- Interactive graphic setup should enable creation of virtual robotic workcells.
- Simple point and click manipulation of object for placement and definition.
- Peripheral axis placement and connection: conveyor belts, XY tables, rotary tables, linear slide bases.
- Part definitions and properties: color, size, position.
- Definition and connection of sensors and I/O devices.
- Definition of parts in storage devices and feeders; feeders can supply any quantity of any part.
- Definition of CNC machines, control of machine doors and machine cycle time.
- Predefined welding cell; which the user has option to modify.
- CAD files import utility for user-defined parts and objects.

**b. Programming and control:** Fully integrated with robotics software for programming and operating robotic workcells.

### c. Dynamic 3D simulator:

- Fully functional 3D graphic display module to provide dynamic simulation and tracking of the robot and devices in the workcell.
- Simulation of robot movements and gripper part manipulation.
- Simulation of peripheral axes: conveyor belts, XY tables, rotary tables, linear slidebases
- Simulation of CNC mills and lathes: moveable machine parts such as door, chuck and spindle; user-definable machine cycle-time; CNC processing reflected in shape of virtual parts.
- Simulation of parts: objects fall according to laws of gravity; stacked objects move together when lower object is moved; feeders supply parts according to user-defined properties and quantities.
- Simulation of different types of sensors.
- Detection and response to impact conditions and axis limits.
- Point and click on screen to move the robot and teach position.
- Display of robot origin, work envelope and gripper position.
- Display of coordinates of workcell objects and devices: absolute positions or positions relative to robot origin.
- Display of names of robot, workcell objects and devices.
- Various viewing and display controls; zoom, rotate, pan, drag, redirect, continuous follow-me camera, shading and lighting.
- Display of gripper path during robot movement.

S.T

- Simultaneous display of 3 different 3D views of robotic cell.

**Terms and Conditions:-**

1. Please submit the TECHNICAL and FINANCIAL bids in separate sealed envelopes. Mark the two envelopes clearly as "Technical Bid" and "Financial Bid". Both the sealed envelopes should be sent in a single sealed envelope, with clearly marked as Quotation for "Robotic Workcell with tools and Accessories". The quote should reach the following address on or before 11/11/2011 up to 5.00PM.

**Name : Dr. S. Janardhanan**

**Address : Control Lab,**

**Room No. II-214,**

**Department of Electrical Engineering,**

**IIT Delhi, New-Delhi – 110016 ( India )**

**NB: Lab Technical staff Mr Jaipal Singh is authorized to**

**collect the same on behalf of Dr. S. Janardhanan**

2. Please quote the price at FOB / CIF New- Delhi, inclusive of installation charges.
3. For imported products, Quote should be in foreign currency and to be valid for at least three months.
4. Attached all technical literature and list of similar installation done in India.
5. If the quote is being submitted by the representative of the principals/manufactures themselves, a valid Agency ship/ Dealership certificate authorizing the agent to quote to IIT Delhi on behalf of the Principals should be enclosed.
6. The institute reserves the rights to accept/reject any/all quotations without assigning any reasons thereof.
7. Complete set of manuals for the operation of the equipment should be given. All circuit diagrams, other mechanical and electrical schematics must be provided to main unit, sub systems and accessories.
8. Delivery as early as possible in weeks on receipt of PO.
9. Clearly specify the installation requirements – Such as space, power, frequency, environment( Temperature and Humidity)
10. If the item quoted are proprietary in nature, please enclose proprietary certificate from the principals stating "certificate that ----- is proprietary item of M/s ----- and no other manufacture make these items".
11. If the bidder is Indian agent, the agency certificate should be enclosed.
12. Please produce compliance certificate for the specification.
13. Please ensure that the Indian agent has been enlisted with the Department of Expenditure, evidence may please be attached.

**Dr. S. Janardhanan**

*S. Janardhanan*  
*21/10/11*  
**(Buyer)**