Annexure-I

1. REQUIREMENT OVERVIEW

This section briefs the high-level requirement for supply and operation / programming training of a human-sized, programmable, anthropomorphic robotic hand (left handed) at CSIR - CMERI, Durgapur.

The robotic hand comprises a central body (palm) from which five fingers spread out in an anthropomorphic fashion. The wrist end of the hand allows mechanical attachment to the wrist of a robotic arm.

The robotic hand should be able to able to grasp a variety of objects and to sense them through multiple force and position sensors. The hand is to be used as slave for dexterous remote handling tasks in both controlled and preprogrammed mode in a force feedback setup. The detailed specifications of the hand are mentioned in Sl. No. 3.

2. SCOPE OF SUPPLY

The following Products and Services are to be provided by the vendor:

Products:

- 5 Fingered anthropomorphic robotic hand
- SDK, Tendon force sensing kit (if not embedded with the hand) and accessories

Services:

- Product documentation including usage and programming manuals and operation and troubleshooting guides.
- Training to the CSIR - CMERI team for Operation, programming and user level maintenance of the system.

3. ROBOTIC HAND SPECIFICATIONS

1.	Fingers		
a.	Count	5 human-sized fingers including one opposing finger (thumb)	

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b.	Degrees of Freedom	• Fingers: At least two DOFs (1 MCP and 1 PIP) in each finger • Thumb: At least three DOFs (2 MCP and 1 PIP) in thumb • Total: at least 11 DOFs	Middle and distal phalanxes may be coupled together using compliant silicone rubber (if no DOF at DIP)
c.	Degrees of Actuation	• Independent Flexion/extension and adduction/abduction in opposing finger (thumb) • Independent flexion/extension of thumb, index and middle fingers, • Independent or simultaneous flexion/extension of ring and little fingers • Total: at least 5 DOAs	The open and close of ring and little fingers may be coupled together, but each finger should adapt on the object
d.	Range of motion	MCP joint: 90 deg PIP joint: 110 deg	
e.	Fingers automatically wrap around objects		
f.	Adjustable joint stiffness		
g.	Under actuated, self adaptive		
h.	Actuation type	Brushed DC motors with non-back-drivable mechanism	Failsafe, object should remain secure without power
i.	Transmission	Steel tendons and Bowden cables	
j.	Speed	Full flexion from full extension : ~ 1 sec Full abduction from full adduction : ~ 1 sec	
2.	**Features**		
a.	Payloads	Tendon max active force : 40 N Cylindrical power grasp : 35 N Lifting : 1 kg or more	
b.	Weight	Up to 1 kg	Including all sensors, mechanics and electronics.
c.	Self contained	All the mechanics and electronics should be embedded within the hand.	For compactness and mobility.
d.	Dexterity	Ability to grasp variety of objects.	
3.	**Communication / Interfacing**		
a.	USB compatible RS232 protocol based communication		
b.	Plug and play robot, controllable by all kind of PC or microcontroller based devices		
4.	**Sensory system**		

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a.	Position	Position sensing on each active axis	Type: Digital encoder Resolution: 1000 pulses/deg or better
b.	Motor current	Motor current sensing on each active axis	Type: Analog Resolution: ~200mN (10 bit) or better
c.	Grasp force	Tendon force sensing on thumb, index, middle and ring fingers.	Type: Analog Resolution: 1mA (10 bit) or better
d.	Limit switch	Two limit switch sensors on each active axis	Type: Digital
5.	**Embedded Controller**		
a.	Implemented control loops	Position, Current, force for each axis, 1kHz	
b.	Sensor reading delays	< 1 ms	
c.	Total preset grasps	10, Should be programmable by the non-expert user	
d.	Security	Logic electronics protected with fuses, continuous motor over-current monitoring and shut-off	

4. ACCEPTANCE TEST

- Successful preliminary operation of preprogrammed tasks and completion of training.

5. WARRANTY AND SUPPORT

- 6 months of free support, including parts and labor (return to base excluded), unlimited email, Skype, and phone support.
- After 6 months, unlimited email support.

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