INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
MATERIALS MANAGEMENT DIVISION
Powai, Mumbai - 400076

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Technical Specification

VIRTUAL PRODUCTION SYSTEM SETUP FOR SMART MANUFACTURING

The Virtual Machine Lab Set Up for Smart Manufacturing should provide a perfect platform to facilitate advance research, training, process analysis and understanding of the smart technologies. The system should be capable to simulate a real industrial manufacturing environment on a virtual setup which includes leading Industry 4.0 technologies.

The system should have the following capabilities as a minimum:

1. Automated raw material storage and feeding
2. Automated raw material loading/unloading and transfer
3. Virtual Machining
4. Automated quality inspection and segregation
5. Centralized (SCADA) and decentralized control (through local controller)
6. Machine to Machine communication
7. Programmable controllers and professional HMI tools with easy interfacing with external applications written in Python, C++, C# etc.
8. IoT gateways for connecting external sensors.
9. Ease of assembly, disassembly and maintenance of system.
10. Compressed air supply for the required operations through a silent compressor (noise level < 60 db).

Important Note: All the hardware elements of the system should be of industrial grade from reputed manufacturers with high quality, long life and robustness.

Broad System Requirements

The system should consist of a six-station set-up for Study and Research Purpose. Each station of the system should be capable enough to perform in centralized & individual mode (decentralized).

Among the 6 stations, first station to perform as a Raw Material feeder and tracking station. The next 5 stations should perform like a virtual machine, each of which can be configured like any manufacturing machine on which work pieces can be automatically loaded from a conveyor, held for a programmed duration (representing processing operation) and unloaded on to the conveyor after processing the last station should perform inspection and storage of raw material.

The system and its components should be integrated with a manufacturing management HMI application for managing the production process.

A silent industry grade compressor should be a part of the system for compressed air supply.

Detailed system requirements

Station Type 1: Automated raw material storage and feeding

Quantity: 1

The main function of this station is to sense and feed the raw material with all related information written on its RFID tag into the next station.

This station should consist of a base feeder module to store work-pieces with integrated RFID tags to write manufacturing operation information and send it to the virtual machine station for simulating machine operations.

This station to be made of 850(H) x 720(W) x 1000(L) mm height-adjustable aluminum structure on which the system components used to perform the process will be mounted, which includes a touch enabled graphical user interface, control solenoid valves, feeder (metallic material and not plastic or Perspex) & conveyor assembly. The sides of the frame to be covered with aesthetically appealing panels.

The electrical controls to be mounted on the back face, from which the station will be controlled. It should also include the power control box, with the following buttons and indicator light: ON/OFF selector switch, power ON lamp and certified emergency stop button.

The station should be operated from a 14" industry grade graphical user interface monitor (mounted on a standard rugged metal arm attached to the station table for flexible orientation) controlled by a

Windows 10 based industrial controller with a provision for easy interfacing with external applications written in Python, C++, C# etc.

The station should have a RFID read/write device and a Windows 10 compatible UI based software that can be used to read from and write to the RFID tag.

Work pieces:

The work pieces should be of fixed shape but with feature variations to enable job variety.

The variety could be incorporated by having multiple features like for example, the number of holes on the workpiece and their sizes. The workpiece material should be chosen appropriately for the application but should be of good quality.

A minimum five numbers each of ten work piece variants should be provided with the system. The RFID tag should have enough capacity to hold required information such as job identity, date, batch size, priority etc.

User should be able to write the manufacturing process information manually to the workpiece RFID tag through the RFID read/write device using the GUI software.

Tracking of work-piece location during the manufacturing process should be made possible using appropriate and easy to integrate sensors.

This station should also have SCADA capabilities for centralized control of the stations.

Work-piece supply:

The supply should happen from a five column metallic gravity feeder which stores work-pieces with integrated RFID tag.

The work-piece feeding operation is to be carried out by means of a pneumatic mechanism which extracts work-pieces from the gravity feeder pushes them onto the conveyor. The mechanism should be implemented using a double acting dual rod cylinder with speed controllers and controlled by a solenoid valve. Wherever applicable, a multistage ejector with 3 stage diffuser construction, release and supply valve with released flow rate adjustment needle should be used.

The minimum level and the absence of work-piece in the feeder to be detected using an optical sensor.

It should be possible to control feeding of the workpieces to the conveyor using a custom logic that can vary with time.

Conveyor:

The station to include a section with two conveyor belts, which rotate in opposite directions and are operated by two independent motors of variable speed. A provision to be provided for making the work piece wait in case the next station is busy or not ready.

The work station should be capable of working independently as well as in integrated mode with other stations. The controller through an HMI should allow the user to choose a mode according to which the operations of the station should be changed.

The self-contained conveyor assembly should be attached to the station such that the conveyor of one station can be easily connected to the conveyor of subsequent station when required. In an independent mode, a mechanism should be provided to enable the conveyor ends to be closed using a pneumatic mechanism in such a way that forms a closed loop to keep the job rotating on the conveyor of the same station.

Electric and pneumatic controls:

All the cables and pneumatic tubing to be properly identified and labeled at both ends. The hardware should satisfy the following.

All hardware should be industry grade.

They should be mounted on a 510(H) x 700(L) mm mesh.

Should have an accessible electrical connection terminal box with power input and coded I/O.

Should have a 240VAC/24VDC power supply.

The Industrial Controller should be wired and programmable to operate the module with digital/analog inputs and outputs connected to the hardware.

An IO-link master device with Ethernet standard connection should be installed.

A 14" industry grade graphical user interface monitor with touch control should be provided.

The hardware should support industrial communication via standard Ethernet/Wi-Fi for communication with the other modules.

Controller PC (Industrial grade) specifications:

Operating System: Windows 10 IoT Enterprise

Processor: 6th generation Intel® Core™ i3-6100, 3.7 GHz, 2 cores, 8 GB RAM (TC3: 60)

Ports: 4 USB ports, 1 Display port, 2 Ethernet ports

SSD: 160 GB M2 SSD

Networking: 802.11ac 2.4/5 GHz Wireless Adapter

SCADA:

This station should have a GUI based SCADA software that can connect with all the stations and have the capability to receive data and send instructions to all the station controllers through Ethernet and Wi-Fi.

It should also be possible to easily interface with the SCADA software through external applications developed in Python, C++, C# etc and send the required instructions to the station controllers.

Power consumption Data receiver:

The station should have provision for energy monitoring screen for electricity and compressed air consumption. Energy efficient valves should be used for pneumatic actuators.

This should be done through an EDR (Energy Data Receptor) which receives the electricity consumption data from each of the stations as well as the flow of compressed air consumed in the system.

The measurement of the system's compressed air consumption should be done using a flow meter with a measuring range of 2-200 l/min.

An air treatment group with a regulator, filter, pressure gauge and 3/2 shut-off valve, power supply 110-240 VAC / 24VDC should be a part of the system.

The measurement of the system's air pressure should be done using a digital pressure switch with a measuring range of 0-10 bar.

The consumption data gathered for each station should be available to the system and accessible via each station's monitoring screen as well as the central controller screen.

Digital Data management:

The station must be able to capture & record/store logs for all desired process parameters for future analysis. The station should allow a connected data flow & visualization in an integrated form throughout the process. The devices and the station controller should be able to communicate using Ethercat. The station should be able to communicate with controllers of other stations through its controller using TCP IP via ethernet cable as well as Wi-Fi. The communication between stations and external devices should be made possible by using OPC UA for data collection in future.

Station Type 2: Virtual Machining Station

Quantity: 5

This station should perform like an automatic virtual machine in the sense that a work-piece should get automatically loaded from a conveyor, held on the virtual machine for a programmed duration and unload to the conveyor for further processing if the quality is acceptable. If the workpiece is defective, it should be removed from the station and placed in a rejection bin.
The quality of the work-piece is to be assessed using a vision-based system mounted alongside the machine. The vision system should be able to capture the image of work-piece and compare critical dimensions with the master data/drawing available on the station controller PC. If the product is OK then it should be placed on the conveyor, otherwise an alert should pop up for rejection and work-piece should be removed from the station to a rejection bin.
The virtual machine should emulate an actual machine. This is to be achieved by having a machine-like structure on the station with a front cover that opens or gets lifted during positioning and removal of work-piece from the machine table.

This station to be made of 850(H) x 720(W) x 1000(L)mm height-adjustable aluminum structure on which the system components used to perform the process will be mounted, which includes a touch enabled graphical user interface, control solenoid valves & conveyor assembly. The sides of the frame to be covered with aesthetically appealing panels.
The electrical controls to be mounted on the back face, from which the station will be controlled. It should also include the power control box, with the following buttons and indicator light: ON/OFF selector switch, power ON lamp and certified emergency stop button.
The station should be operated from a 14" industry grade graphical user interface monitor (mounted on a standard rugged metal arm attached to the station table for flexible orientation) controlled by a Windows 10 based industrial controller.
Along with the necessary sensing devices, the station should have a RFID read/write device and a Windows 10 compatible UI based software that can be used to read from and write to the RFID tag.
On the back face of the station there should be an air treatment unit comprising a 5❍m filter with a pressure controller, digital pressure switch and manual 3/2 shut-off valve.

Work piece supply:

The work piece feeding is to be carried out by means of a conveyor attached to the previous station. The presence of work-piece on conveyor is to be detected using an RFID reader present at the

entrance. RFID reader should read the tag and provide the tag information to the PC based station controller so that the station can perform the required operation as per the information available on the tag.

Work-piece Handling:

The handler should perform double function.

To position the work piece for the virtual operations (for a programmable duration) to be performed at the station using a dual rod cylinder equipped with auto switches for position detection.

To transfer the work-piece on to the machine from conveyor & vice versa by means of a rotary actuator which has an attachment of vacuum cups for work piece handling, geometry of which is suited to the profile of the work-piece. Multistage ejector with 3 stage diffuser construction, release and supply valve with released flow rate adjustment needle should be used.

The movement is to be achieved through a rotary actuator capable of 180 deg rotation, which is to be controlled with speed controllers and a double acting center closed solenoid valve.

The movement of the front cover of the virtual machine to be controlled by a double acting dual rod cylinder with speed controllers and controlled by a double acting solenoid valve.

To locate the work-piece on the machine, a double acting dual rod cylinder with speed controllers and controlled by a solenoid valve is to be used.

Machine Operation:

Machine operation is to be emulated using an electrical actuator to emulate feed control and one brushless DC motor as a spindle emulator.

This station should have a provision to be configured to emulate machining operation by controlling spindle speed, feed rate & rotational direction.

The electrical actuator should be vertically mounted and controlled by dedicated controller on standard communication.

A brushless DC motor should be used as a spindle. Provision to be provided for the user to emulate the rotational direction, torque and RPM of the spindle motor from the graphical user interface or the station controller.

Vision System:

An artificial vision-based system should be mounted alongside of the machine, which includes 0.3 Mega pixel Smart Camera with 2X Magnification and Electronic Shutter Speed of 0.001 to

1000ms.The vision system should be able to capture the image of work-piece and compare critical dimensions with the master data/drawing as per the command given by controller. If the product is OK then it should be placed on conveyor, otherwise it should be removed from station to rejection bin. The station controller and vision system should be able to communicate using MODBUS TCP protocol via Ethernet cable.

Conveyor:

The station to include a section with two conveyor belts, which rotate in opposite directions and are operated by two independent motors of variable speed. A provision to be provided for making the work-piece wait in case the next station is busy or not ready.

The work station should be capable of working independently as well as in integrated mode with other stations. The controller through an HMI should allow the user to choose a mode according to which the operations of the station should be changed.

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The station should have a Siemens IoT 2040 gateway with Arduino shield for connecting external sensors. The gateway should be connected to the station controller for further data analysis.

Other mandatory requirements

1. Equipment mentioned in the Bill of material should be compatible with each other in terms of configuration, specifications and size.
2. Delivery period of machine/items should not exceed 16 Weeks from the date of placement of Purchase Order.
3. Bidders should offer the minimum warranty of 1 year
4. Bidders should offer a minimum of 1-year AMC after the warranty period that includes a free-replacement warranty on all components. A detailed AMC and warranty offer document should be submitted by the bidder.
5. The bidder should have :
    a) A total turnover of Rs.20 Crore average in last 03 years in equipment supply & lab setup related to pneumatics/electrical device-based automation and IOT Lab.
    b) Experience of providing training in the field of Pneumatics lab to students / faculty.
    c) Executed at least one supply order of a similar Virtual Machine set up at an Institute of National Importance in India in the last three years.
    d) Experience of Manufacturing, Training and supplying similar equipment for minimum 5 Years and should have their own service and training centers in India. Details of Training and Service centers and information on service support facilities should be submitted along with the bid.
    e) The capability to provide extensive training on the system in terms of assembly and disassembly of various components, basic trouble shooting, operating and programming the station controllers, interfacing with external applications developed in Python, C++, C# etc.

Instructions to the bidders

1. No prices should be included in the technical bid.
2. A detailed document (Catalogue) along with Technical Description of the quoted model duly signed by the principals must accompany the quotation in the Technical bid.
3. Firm should share Schematic Diagram along with Technical Bid.
4. During the bid evaluation, IITB may at its discretion, ask the bidder for a clarification of its bid. The request of clarification and the response shall be through the online mode only. And no change in the price or substance of the bid shall be sought, offered or permitted.

5. Bidders should submit documents strictly as per the tender requirement only.. If documents as per the tender requirement are not submitted, IITB reserves the right whether or not to obtain clarifications.
6. Page No. of the catalogue where tendered specification is available to be mentioned and to be submitted along with deviation statement.
7. Submission of Audited Financial Statement of last three years.
8. The tender should NOT be SUBLET to any other service provider and must be executed at Bidders unit having all equipment & infrastructure owned by the company.
9. Bidders having quality certification like ISO9001:2015, ISO14001:2015 and OHSAS18001:2007 to please attach relevant certificates as a part of the bid.