Smarter. Greener. Together.

Seeking Smart Manufacturing Talents

The 6th Delta Advanced Automation Contest

Project Proposal

Team Number:

<table>
<tr><td>Proposal Name</td><td colspan="4">Smart Manufacturing using Cloud Computing</td></tr>
<tr><td>Team Name</td><td colspan="2">Exterminators</td><td>University/ Affiliation</td><td>K. J. Somaiya College of Engg ,Vidyavihar</td></tr>
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Team Building

1. Husain Shabbir Khamerawala, Age 23

B. Tech Mechanical

Role : Mechanical System Design, Communication, Machine Learning

C.G.P.A : 7.32 / 10 (Up to 7th Semester)

Diploma:87.4%

Class 12 : 84%

Class 10 : 74%

Area of Interest : Robotics, Artificial Intelligence, Industrial Automation, Designing, RAC, Heat & Mass Transfer, Supply Chain Management

- Software Program: SolidWorks, Ansys, Autocad MATLAB, Arduino IDE,
- Programming Language: Java, C, C++, MATLAB, Robot Operating System, PLC Coding
- Hardware: Arduino, Sensors and Actuators, Motors and Drives, PLC
- Key Technical Skills: Robotics, Machine Learning, Natural language Processing, Microcontrollers, Programming

2. Jugal Jagdesh Panchal, Age 22

B.Tech Mechanical Engineering

Role: Mechanical System Design, Communication, Machine Learning

C.G.P.A: 8.224 / 10 (Up to 7th Semester)

Diploma: 89.80%

Class 10: 88.80%

Area of Interest: Simulation, Supply Chain Management, Industrial Automation, Data Analysis, Robotics

- Software Program: SolidWorks, Ansys, Autocad
- Programming Language: PLC Coding
- Hardware: Lath Machine, Arduino, Motors, Drivers, PLC,

3. Rounak Hitendra Nayee

B.Tech Electronics and Telecommunication Engineering

Role: Warehouse Simulation and Analysis, PLC and HMI Programming

C.G.P.A: 7.36 / 10 (Up to 7th Semester)

Class 12: 79.23%

Class 10: 94.00%

Area of Interest: Simulation, Supply Chain Management, Industrial Automation, Data Analysis, Robotics

- Software Program: SolidWorks, Arena Rockwell Automation, FlexSim, Simio, Minitab, Factory i/o
- Programming Language: Embedded C, Matlab & Simulink, C, C++, Django, Python, Ladder Logic Programming.
- Hardware: Lath Machine, Arduino, Raspberry pi, Motors, Drivers

Motivation and Design Concept:

Problem Insight:

In 21st Century smart technology holds key for future in all sectors. Many interdisciplinary beneficial aspects of smart manufacturing paradigm, research and development in manufacturing field have been increased substantially. However smart manufacturing application for subtractive manufacturing challenging. Hence in order to meet the demand of the increasing manufacturing unit's requirement a cloud computing CNC machine can be made use of in order to stabilize the requirement ensuring an increased production unit at an effective cost and as per the demanded dimensions.

Technology Background :

The term ‗smart manufacturing' has inspired from the term ‗intelligent manufacturing'. Intelligent manufacturing term was coined around 1990 by Kusiak. In 1995 Japan established Intelligent Manufacturing System (IMS) Programme. USA started Next Generation Manufacturing Systems (NGMS) Programme in 1995. Kurzweil R., Director of Engineering at Google in 2001 predicted that the 21st century may experience 20,000 years of progress. Manufacturing is a key element in the global economy. Recent progress in computer particularly in cloud computing (CC), Internet of Things (IoT) has taken automation in manufacturing to next level.

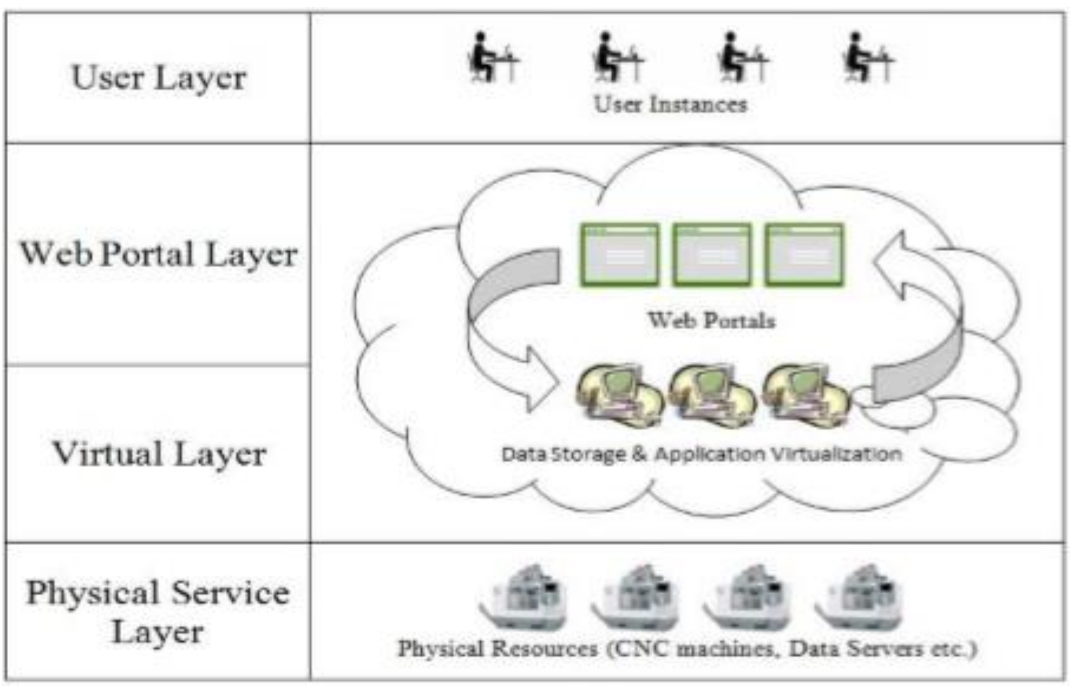
Smart Manufacturing Leadership Coalition (SMLC) in 2012 has proposed Smart manufacturing (SM) terminology to shape future manufacturing with advanced sensing, platform technologies, control and modeling. Various initiatives like Industry 4.0 by Germany, Factories of Future (FoF) by European Commission, Future of Manufacturing by UK, and Made-in-China 2025 by China are to achieve smart SM systems. There is no universally accepted definition of SM, various institutes; authors defined it in their own way. According to the National Institute of Standards and Technology (NIST) defined SM as ―fully integrated, collaborative manufacturing system that responds in real time to meet changing demands and conditions in the factory, in the supply network and in customer needs. Davis et al. defined SM as "the use of data-driven manufacturing intelligence in multiple real-time applications deployed throughout all operating layers across the factory and supply chain"

According to Kang et al SM system is ―a collection and a paradigm of various technologies that can promote a strategic innovation of the existing manufacturing industry through the convergence of humans, technology, and information‖. SM utilises sensor networks, cyber-physical systems (CPS), artificial intelligence (AI), IoT, CC, service-oriented architecture, and data analytics. CC for manufacturing is gaining at popularity towards various industrial sectors due to its features like efficiency, flexibility, sustainability, and interoperability .

Project Idea:

As there is commonality between Computer Integrated manufacturing (CIM), CC for manufacturing and Cyber Physical System (CPS) in the ways IT is used and helped different stages of industrial revolution. Use of IoT and big data analytics in SM is helping in advancement of technology but also imposing new challenges. SM is an enabler for new computer aided process and being successfully implemented for processes like additive manufacturing, sheet metal forming, robotic applications etc. However SM applications for machining particularly in subtractive manufacturing are not as popular as additive manufacturing. All over the world, majority of manufacturers use CNCs and special purpose tooling machines. Direct application of Cloud technology for CNC is little tricky. Basically its how Cloud technology can be incorporated in subtractive manufacturing and its benefits from manufacturer‘s point of view.

Flow Diagram:



Enabling Technologies for SM

Development in last two decades particularly in information and communication technologies (ICT) has helped to achieve SM in reality. This section briefs about important key technologies as follows. IoT term was coined by Kevin Ashton in 1999. IoT is a massive network of connected things and it has been estimated that by 2020, almost 20.8 billion devices will be connected using IoT . It is one of the important enabling technologies in Industry 4.0 and SM. IoT is a network of the things like software, sensors, and electricity or physical objects .

In 2012 General Electrical introduced the Industrial IoT (IIoT). IIoT applies IoT to manufacturing by incorporating machine learning and big data, harnessing sensor data and automation. CC term was introduced in 2006, which delivers computing service like servers, storage, databases, networking, software, analytics and more over the internet . CC offers benefits such as adaptability, multi-tenancy, reliability, scalability, etc. to companies .The term ‗Cloud Manufacturing' (CM) was coined in 2009 in China by Professor Bo Hu Li. CM is CC for manufacturing.

CM is a customer centric manufacturing process which gives you on demand access to the shared pool of manufacturing resources to enhance the efficiency, decrease the product lifecycle cost in response to the variable demands of the customers . In CM, all the manufacturing resources are sensed and connected to the cloud. For the sharing and exchanging the data automatically, IoT technologies like RFID tags and barcodes can be used . Cyber-physical System (CPS) term was coined by National Science Foundation in 2006 in USA. IoT deals with the internet connected physical objects, CPS is concerned with the nature and system characteristics of the software controlled systems [16]. Most of the studies related to the CPS are linked to SM. Lee et al. has given 5C architecture of CPS for SM with 5 levels: smart connection level, data-to-information conversion level, cyber level, cognition level, and configuration.

SM and Related Issues

The SMLC definition states, "Smart Manufacturing is the ability to solve existing and future problems via an open infrastructure that allows solutions to be implemented at the speed of business while creating advantaged value". Lu et al. [16] discussed the SM Ecosystem, SM capabilities (productivity, agility, quality and sustainability), and standards opportunities for SM. Tao et al. [18] has given a data-driven approach for SM by proposing the framework of four modules (manufacturing module, data driver module, real time monitor module and the problem-solving module). Data driven approach provides full range of services to manufacturing and it increases the efficiency of manufacturing with improvement in products performance [18]. In last decade or so, world has slowly shifted from SM. Because of many interdisciplinary beneficial aspects of SM, research and development in manufacturing field using applications of CC and IoT have been increased substantially. Most of the research work on SM is focused on one particular aspect of manufacturing and development was around it. Some of the researchers created framework, while some of them have put forward architecture of possible SM system. From implementation point of view many successful ventures were attempted on prototype levels.

Based on literature survey identified research gaps are as follows:

- Industrial application of SM is in initial stage and it needs to be tested large-scale environment.
- The awareness of SM is steadily increased but it is only for SMEs. Application range and geographic area are crucial for SM service. Interoperability and portability are also concerns of manufacturers.
- Additive manufacturing sector considered to be more suitable for adopting SM than subtractive manufacturing. To address the issues of SM for subtractive manufacturing author proposed four layer framework.
- Case study implementation on CNC Lathe machine application used to validate proposed framework.

PROPOSED FRAMEWORK

Majority of manufactures around the world still use CNC machines, special purpose machines along with traditional NC machines and lathes. Many researchers around the world have been trying to integrate Cloud technology with manufacturing field. It has been successful venture on additive manufacturing level but not so on subtractive manufacturing. As per discussion in literature survey, reason behind it is interoperability, which is nothing but the ability of computer systems to exchange and make use of information. In manufacturing field, different organisation use different software for their work. To address this problem a generic Cloud based system approach is proposed. In this system information is supposed to be taken in the form of text/numerical format in first layer, i.e. user layer. Based on information feed a CAD file or assembly sequence or Bill of Material etc. for required job will get generated automatically. This application can be operated on virtual level, i.e., on web portal level. This virtual level is operated using Cloud technology. Cloud Based layer is primarily used for virtualization of resources or applications. Then on physical service layer actual operations and controls can happen.

Cloud based application is developed which generates the CAD file of required job. This application takes information from user in text format and using that information part file gets generated automatically. This CAD will then goes to physical service provider where tool selection and tool-path generation can be done. This system mainly consists of three parts, namely Cloud system, CAD-CAM system and CNC or physical hardware system. Cloud portal is created using _Microsoft Azure' cloud services. Microsoft Azure is hybrid Cloud platform. Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) features of Cloud technology is utilized. For automatic CAD file generation _Solidworks' software and Visual Basic (VB) as scripting language are used. For tool selection and tool-path generation _Mastercam for Solidworks' is incorporated in system. For actual implementation work an application is created for automatic generation and saving of CAD file using VB coding. In this application a Graphical User Interface (GUI) is given which enables user to input the dimensions, generate the CAD file and save the completed part file on desktop. Different GUIs are shown in Figure 2 and 3

Fig. 2 User Input Window

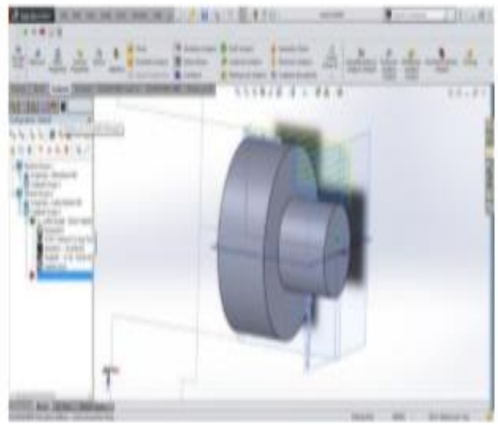


Fig. 3 Tool Path Simulation

Cloud Computing

Cloud computing and the IoT both serve to increase efficiency in everyday tasks and both have a complementary relationship. The IoT generates massive amounts of data, and cloud computing provides a pathway for this data to travel. Many Cloud providers charge on a pay per use model, which means that you only pay for the computer resources that you use and not more. Economies of scale is another way in which cloud providers can benefit smaller IoT start-ups and reduce overall costs to IoT companies.

Another benefit of Cloud Computing for the IoT is that Cloud Computing enables better collaboration which is essential for developers today. By allowing developers to store and access data remotely, developers can access data immediately and work on projects without delay. Finally by storing data in the Cloud, this enables IoT companies to change directly quickly and allocate resources in different areas. Big Data has emerged in the past couple of years and with such emergence the cloud has become the architecture of choice. Most companies find it feasible to access the massive quantities of Big Data via the cloud.

Hence using such cloud computing the production unit can be made to easy to operate as well as a lot of manufacturing time can be reduced for better consumer satisfaction.

Application:

Customer Requirement:

A customer has a complex machine part design in a batch of 1000 pieces or more

Solution:

The manufacturer only needs to upload the part design in the cloud software, the coding along with the final product will be made available using smart manufacturing simulation software which is connected to the input panel of the CNC machine which will take command using IoT (anywhere in the world) ultimately the required product will be manufactured without any skilled operator, only a consultant for loading and unloading of raw material and finish product is required.

Innovative Planning and Value

- The old manufacturing unit can be automated using such manufacturing software
- It decreases the demand of a skilled worker as well as the errors inputted while coding a part to be machined on a CNC machine
- Manufacturing time can be reduced using such software as well as the mobility of the operator increases
- Even a sudden outbreak won't affect the manufacturing part as the IoT will recall as the data and no point of error is possible
- No human error

Uncertain Error Handling:

- The machine input control panel has to connected to the internet as it is working over the IoT and cloud computing, thus has to be connected via a driving mechanism hence if internet is not available it will notify its user using an alarm or emergency light.
- Massage notification will be visible on HMI and will also be uploaded on cloud.
- Data will be logged in the mainframe storage for future use

- A command will be further needed to resume operations as a sudden breakdown or after solving the problem

Cost Analysis, Reasonability and Feasibility

As we are using all parts according to the industrial standards, we are having very cost-effective structure. Only cloud computing license permit is required as well as the input modular of the CNC machine would be required to manufacture the complete unit thus the project is very cost effective and cheap.

Components Specification & Bill of Materials

CNC machine
input unit: 1
Operator output
unit: 1
Mainframe System for Monitoring with cloud computing

Serial Number	Product Name	Delta Product Code	Quantity	Description
	DELTA PRODUCTS			
1	Wireless Module	DVW-W02W2-E2	4	To connect with internet
2	Power Supply (24V Output)	PMC Panel Mount Power Supply (24V Output)	4	To provide 24V to the PLC
3	Motor Driver	ASD A2 Servo Drives	2	To drive all Axes motors
4	Motor Driver	ASD MR Servo Drive	2	To drive all Axes motors
5	Servo Motor with Encoder (750W)	ASDA20721U	12	To move all Axes
6	Linear Motion Product (400W Linear Motor)	LU46214	3	For Z-Axis
7	Delta cloud computing software	-	-	To command the input panel of the CNC and control CNC operations