INDUSTRIAL INTERNET OF THINGS WITH AUGMENTED REALITY

An Internship Oriented report submitted in partial fulfillment of requirements for the award of degree of

BACHELOR OF TECHNOLOGY IN

MECHANICAL ENGINEERING (ROBOTICS)

by

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Under the esteemed guidance of

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GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING

(AUTONOMOUS)

Affiliated to J.N.T.U. KAKINADA

VISAKHAPATNAM-530048 , May, 2023

CERTIFICATE

This report on

“INDUSTRIAL INTERNET OF THINGS WITH AUGMENTED REALITY”

is a bonafide record of the Internship work submitted

by

B.PRAVALLIKA

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In their VII semester in partial fulfillment of the requirement
for the Award of Degree of

Bachelor of Technology in Mechanical Engineering (Robotics) of

the Gayatri Vidya Parishad College of Engineering (Autonomous)

Affiliated to JNTU(K) ,Visakhapatnam during the year 2022-2023

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Department of Mechanical Engineering

ACKNOWLEDGEMENT

We would like to express our deep sense of gratitude to our esteemed institute **Gayatri Vidya Parishad College of Engineering (Autonomous),** which has provided us an opportunity to fulfill our cherished desire.

We thank our Course coordinator and internship mentor **Dr. Sanjay.K.Darvekar Associate Professor, Mr.V.S.Siddharth Branch Coordinator, Department of Mechanical Engineering** for the kind suggestions and guidance for the successful completion of our internship.

We are highly indebted to **Dr. B.Govinda Rao, Professor and Head of the Department of Mechanical Engineering, Gayatri Vidya Parishad College of Engineering (Autonomous)**, for giving us an opportunity to do the internship in college.

We express our sincere thanks to our Principal **Dr. A.B. KOTESWARA RAO, Gayatri Vidya Parishad College of Engineering (Autonomous)** for his encouragement to us during this project, giving us a chance to explore and learn new technologies in the form of mini project.

We are also thankful and grateful to **Centre of Excellence of Maritime and Shipbuilding (CEMS)** for providing us with this opportunity. Finally, we are indebted to the teaching and non- teaching staff of the Mechanical Engineering Department for all their support in completion of our project.

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This is to certify that Mr/Ms ***BOLISETTY PRAVALLIKA NAGA SAI SRI***

Regd No ***20131A5308*** *from* ***GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING (Autonomous)***

branch has undergone ***Industrial Internship***

on the following technologies:

1. ***IIOT WITH AR***
2. ***Project - MATERIAL INSPECTION WITH IIOT AND AR***

Conducted by

Centre of Excellence in Maritime & Shipbuilding, Visakhapatnam

from ***25/05/2023*** *to* ***24/06/2023***

Certificate No:**AP/VTZ/4002/05-2023/0111**

Place: Visakhapatnam

Date: 24/06/2023

Centre of Excellence in Maritime & Shipbuilding (CEMS) Visakhapatnam

Authorized Signatory

Commander Gopikrishna Sivvam, IN (Retd.)

Chief Operating Officer - CEMS

NOTE FROM CHIEF OPERATING OFFICER, CEMS

Internship Training at CEMS for Students of Gayathri Vidya Parishad

College of Engineering (Autonomous), Visakhapatnam

1. Centre of Excellence in Maritime and Shipbuilding (CEMS) is a Section 8 Not for Profit Company started by Ministry of Ports, Shipping and Waterways, Govt. of India under its prestigious Sagarmala Project.

2. CEMS has been set up to provide skilled manpower as a crucial foundation to meet the goals of Sagarmala viz., Port Modernisation & New Port Development, Port Connectivity Enhancement, Port-linked Industrialisation and Coastal Community Development.

3. CEMS campus at Visakhapatnam is equipped with all the hardware and licensed software related to Industry 4.0 training courses imparted at CEMS. CEMS courses are highly subsidized to provide access to maximum number of students and youth across the country.

4. 7th Semester B.Tech , MRB student of Gayathri Vidya Parishad College of Engineering(A) Visakhapatnam underwent internship from 25 May 23 to 24 Jun 23 at CEMS Vizag campus. The training was designed in such a way to train the students on the trending and in-demand industry relevant skills (IIOT with AR) and also to give exposure to the students in Industry 4.0 technologies in the various labs at CEMS. The students have put in excellent efforts to understand the various trending technologies and they have also undertaken a very important project "MATERIAL INSPECTION WITH IIOT AND AUGMENTED REALITY"

5. We would like to express our sincere gratitude to Management and faculty of Gayathri Vidya Parishad College of Engineering (A), Visakhapatnam for giving us the opportunity to conduct the Industrial Internship for the students. We look forward to feedback on the Internship Program and opportunity to conduct further such courses.

Place: Visakhapatnam

Date: 24 Jun 23

Commander Gopikrishna Sivvam IN (Retd)

Chief Operating Officer

Centre of Excellence in Maritime & Shipbuilding

CONTENTS

CENTRE OF EXCELLENCE IN MARITIME AND SHIPBUILDING (CEMS)

- Centre of Excellence in Maritime & Shipbuilding (CEMS) is a high-end skill development centre set up by the Govt. of India, Ministry of Ports, Shipping and Waterways under Sagarmala Project with state-of-the-art laboratories at Visakhapatnam and Mumbai.

- CEMS aims to bridge the skill gap between industries and academic institutions by imparting hands-on-skills training on trending courses in Industry 4.0 relevant technologies.

- CEMS is equipped with a world-class infrastructure in its labs located at Visakhapatnam and Mumbai having a cyber-physical infrastructure involving the following labs in functional domains of learning: Product Design and Validation, Advanced Manufacturing, Test and Optimisation, Dimensional Accuracy Control System, Nesting Productivity Improvement, Hull Design, Research Machine Shop, Automation, Mechatronics, Robotics, Process Instrumentation, Electrical and Energy Saving, Pneumatics and Hydraulics, Pumps Training Systems, Piping Training Systems, Radars, Virtual Reality and Welding Technology.

- The training at CEMS is provided by experienced faculty and is complemented by guest lectures from industry and academic experts. Each lab in CEMS is industry relevant backed by an Industry leader specializing in that particular technology or domain contributing in subject matter and technology consulting expertise.

LABORATORIES PRESENT IN CEMS

S.NO	LABORATORIES
1.	Product Design & Validation Lab
2.	Advance Manufacturing Lab
3.	Test & Optimisation Lab
4.	Dimensional Accuracy Lab
5.	Nesting Productivity Lab
6.	Hull Design Lab
7.	Electrical & Energy Savings Lab
8.	Welding Lab
9.	Automation Lab
10.	Radar Lab
11.	Process Instrumentation Lab
12.	Mechatronics Lab
13.	CNC and CAM Lab
14.	Piping and Pumps Lab
15.	Virtual Reality and Augmented Reality Lab
16.	PLM Lab
17.	Pneumatics and Hydraulics Lab
18.	IOT Lab
19.	Additive Manufacturing lab
20.	Robotics Lab

INTERNSHIP SCHEDULE

IIOT with AR - INTERNSHIP SCHEDULE	
Day Wise	**Topic Covered**
Day 1	PLC Introduction, Hardware relay logic control, Hardware Details Of PLC, Powering And Wiring Of Modules With Addressing, Automation & System Overview
Day 2	Step7 Family Controller Details, Software: TIA Portal Overview, Digital Fundamentals, NC/NO, Set/Reset Instructions
Day 3	Bit Logic Operations Hands On Practice With Real Time Examples
Day 4	Timers Hands On Practice With Real Time Examples
Day 5	Counters Hands On Practice With Real Time Examples
Day 6	Comparators, Math Operations, Program Control Hands on Practice with Real Time Examples
Day 7	Conversions ,Analog Scaling Blocks Hands On Practice With Real Time Examples
Day 8	Program control operations, watch table, force table
Day 9	Introduction to Communication Protocols Communicating PLC to PLC.
Day 10	PLC to Cloud server integration.
Day 11	MODBUS protocol & Siemens TCP/IP Protocol.
	latest IC's Technologies , and designing Process
Day 12	Present trending companies using these latest technologies
	What is IOT? & Introduction to IOT
Day 13	Industry 4.0 and the fourth industrial revolution explanation
	Cloud server to IIOT Cloud integration.
Day 14	Cloud server installation.
	Getting started with the IIOT Cloud platform.
Day	Cloud users creation

15	Create an Application key (API Key)
Day 16	Getting data from industrial gateway & generic data.
	Connect and monitor industrial plant equipment.
Day 17	Creating thing and Thingshapes.
	Thing template and data shapes.
Day 18	Basic Mashup widgets.
	Display data in different charts.
Day Wise	**Topic Covered**
Day 19	Methods of data storages.
	Streams, Value streams, Data table & Infotable.
	Integration of two plc's & getting live data to IIOT Cloud
	Send message and calls with Twilio.
Day 20	Installing, configuring, and handling issues related to Twilio, IIOT Cloud.
	Multiple Mashup screens with menus navigations.
Day 21	Topic Introduction
	AR Software
	Immersive technologies
Day 22	Concept of realities
	Difference b/w AR,VR,MR
	XR Spectrum
	Exploring AR View app
	Hand's on with AR
Day 23	Authoring tools
	Publishing tools
	Experiencing tools
	SDK tool
	IOT platform
Day 24	Why AR Studio for developing Experience ?
	AR Studio Working Architecture
	Steps Involved in designing a experience

	Installation of AR Studio
	Exploring AR Studio
Day 25	Creating an AR Expereince
	Importing 3d model
	Sequence Creation
	Exporting & Publishing
	Creating an AR experience -1
	Creating an AR experience -2
Day 26 - Day30	PROJECT

INDUSTRY 4.0

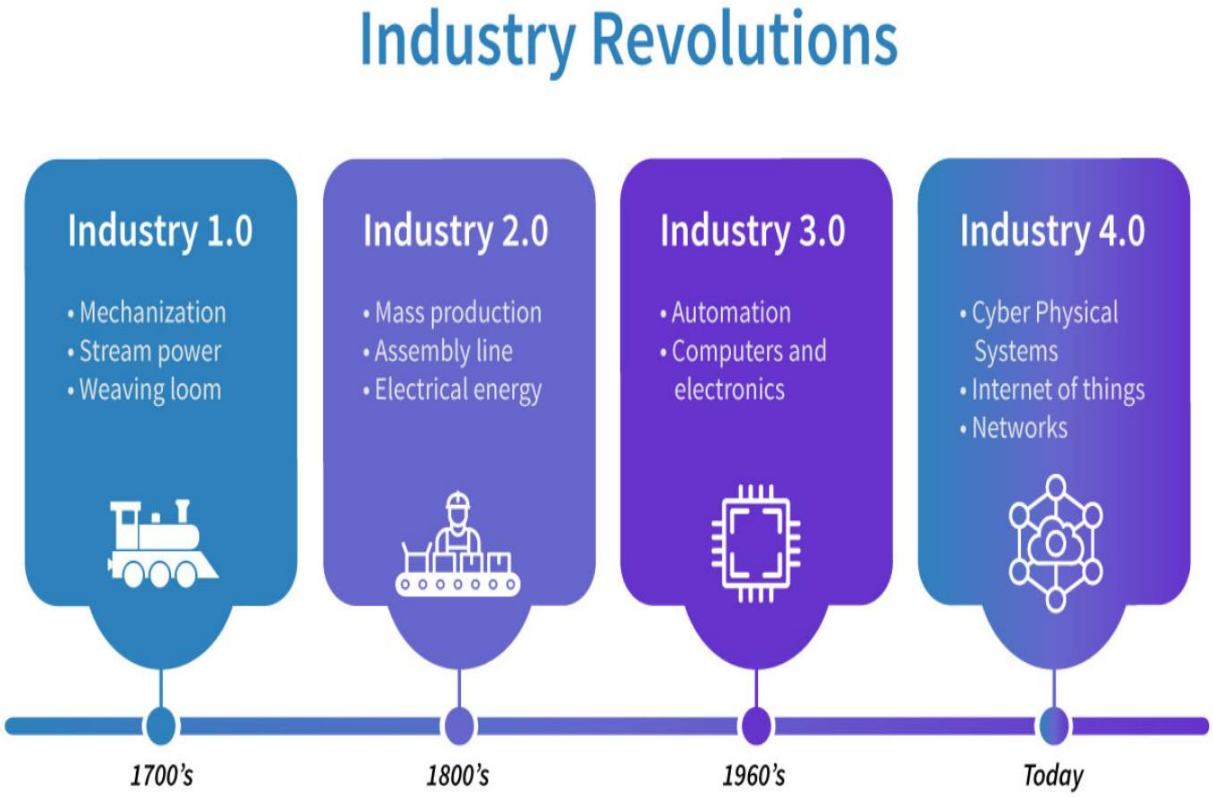

FIG:1.1

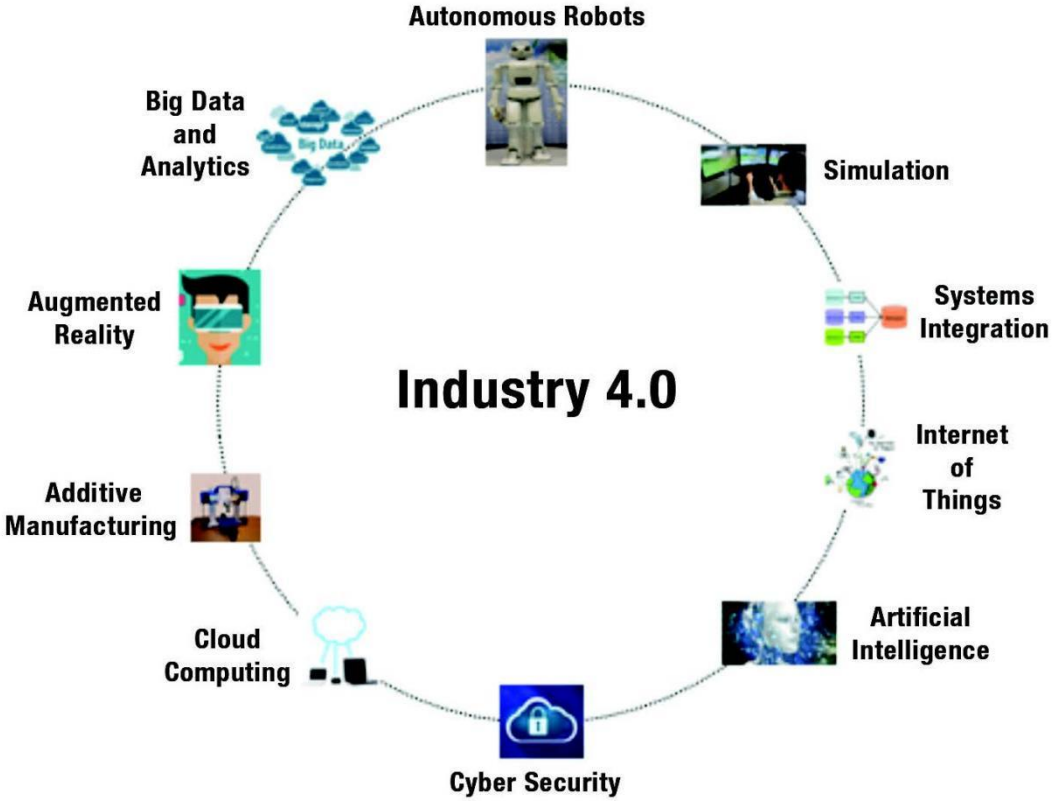

FIG:1.2

COMPONENTS OF INDUSTRY 4.0

- **Autonomous Robots :** It is a robot that acts without recourse to human control. They have the ability to gain information about their environments, and work for an extended period of time without human intervention.

- **Simulation :** It is a model that repeats the operation of an existing system by being able to test different process changes.

- **System Integration :** It is the process of creating a complex information system that may include designing a customized application, integrating it with new or existing hardware, software and communications.

- **IIOT :** The industrial internet of things refers to interconnected sensors, instruments and other devices networked together with computers, industrial applications, etc.

- **Cyber Security :** It is a practise of defending computers, servers, networks, electronic gadgets and data from malicious attacks.

- **Additive Manufacturing :** 3D printing or addictive manufacturing is the construction of a three dimensional objects from a CAD model or a digital 3D model.

- **Augmented Reality:** It is a technology that uses the existing real world environment and puts virtual information on top of it to enhance the experience.

- **Big Data Analysis :** It describes the process of uncovering trends, patterns and correlations in large amounts of raw data to help make data informed decisions.

- **The Cloud :** It is a term used to describe a global network of servers, each with a unique function. It is not a physical entity, but instead is a vast network of remote servers.

INTERNET OF THINGS (IOT)

- IOT stands for Internet of Things, which means accessing and controlling daily usable equipment and devices using Internet.
- The Internet of Things (IOT) describes the network of physical objects that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

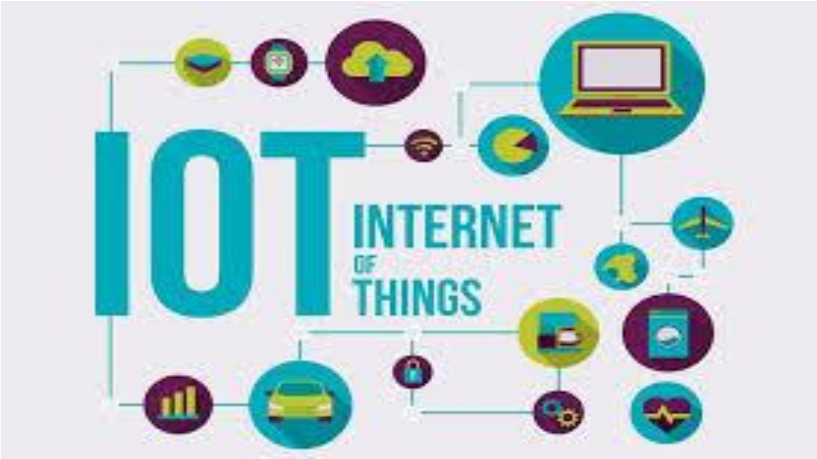

FIG:1.3

- The entire IOT process starts with the devices themselves like smart phones, smart watches and electronic appliances like TV, Washing Machine which helps you to communicate with the IOT platform.

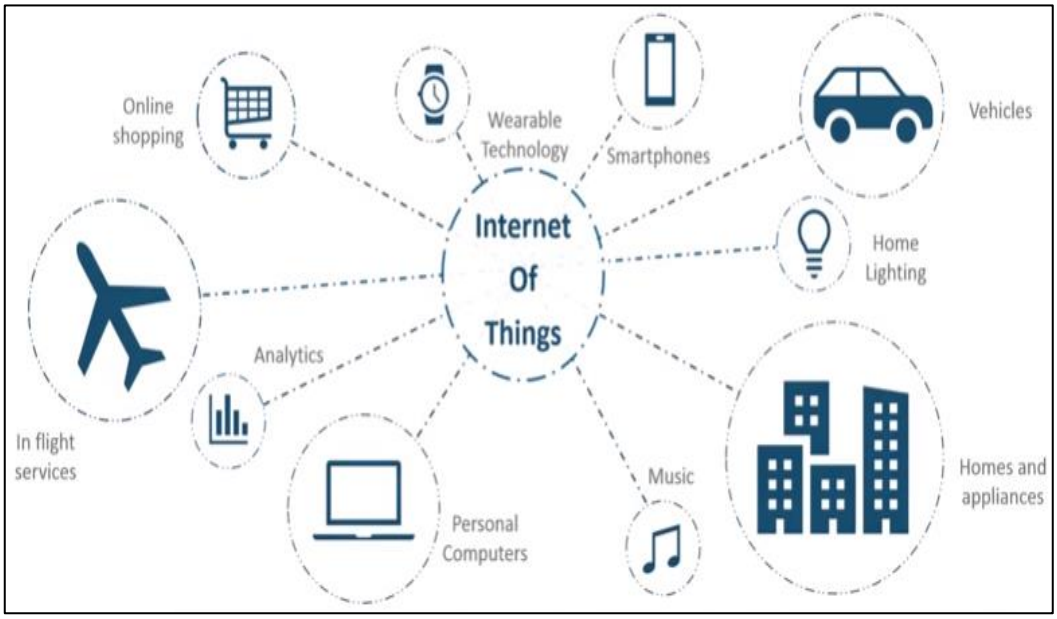

FIG:1.4

Advantages of IOT:

- Internet of things facilitates the several advantages in day-to-day life in the business sector.

Some of its benefits are given below:

- **Efficient resource utilization:** If we know the functionality and the way that how each device works, we definitely increase the efficient resource utilization as well as monitor natural resources.
- **Minimize human effort:** As the devices of IOT interact and communicate with each other and do lot of tasks for us, then they minimize the human effort.
- **Save time:** As it reduces the human effort then it definitely saves out time. Time is the primary factor which can save through IOT platform.
- **Improve security:** Now, if we have a system that all these things are interconnected then we can make the system more secure and efficient.

Disadvantages of IOT:

- As the Internet of things facilitates a set of benefits, it also creates a significant set of challenges.

Some of the IOT challenges are given below:

- **Security:** As the IOT systems are interconnected and communicate over networks. The system offers little control despite any security measures, and it can be lead the various kinds of network attacks.
- **Privacy:** Even without the active participation on the user, the IOT system provides substantial personal data in maximum detail.
- **Complexity:** The designing, developing, and maintaining and enabling the large technology to IOT system is quite complicated.

INDUSTRIAL INTERNET OF THINGS (IIOT)

- The industrial internet of things (IIOT) refers to the extension and use of the internet of things (IOT) in industrial sectors and applications.
- The IIOT encompasses industrial applications, including robotics, medical devices, and software-defined production processes.

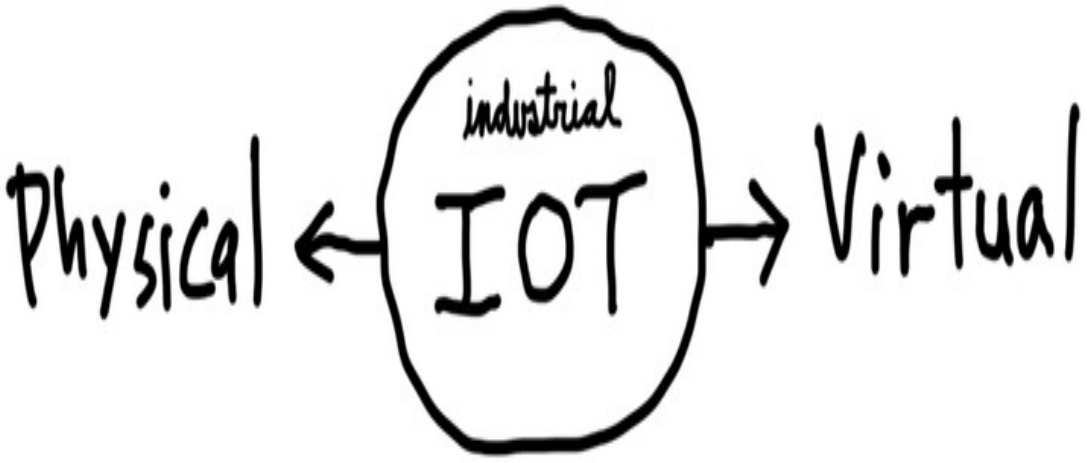

FIG:1.5

- The IIOT goes beyond the normal consumer devices and internet working of physical devices usually associated with the IOT.
- With IIOT implementations, three areas need to be focused on: availability, scalability, and security.
- IIOT is used across a range of industries from manufacturing logistics, oil and gas, transportation, mining, aviation, energy, and more.
- Its focus is to optimize operations,particularly the automation of processes and maintenance.
- Industrial IoT, or the Industrial Internet of Things (IIOT), is a vital element of Industry 4.0.

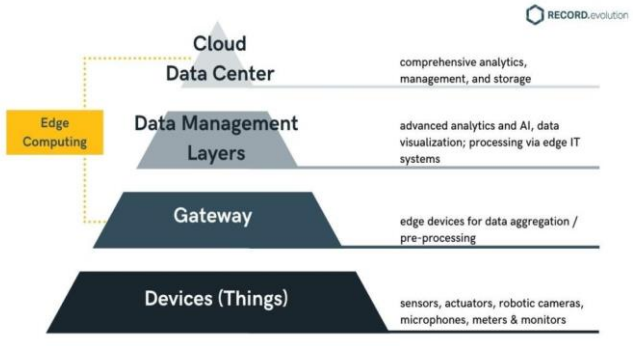

FIG:1.6

FIG:1.7

PROGRAMMABLE LOGIC CONTROLLER

- A Programmable Logic Controller (PLC) is an electronic device that takes input from the machine via sensors and transmitters, executes the logic programmed in its memory and generates the useful outputs on actuators to control machine.

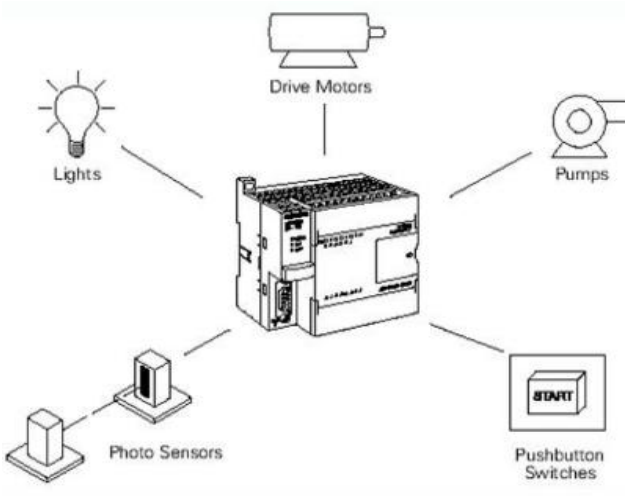

FIG:1.8

- Every PLC system has atleast one CPU.
- The digital and analog I/Os can easily be expanded without affecting the physical size of the controller by installing a signal board inside the front of the CPUs.
- The number of input/output pins can be increased by adding additional signal modules to the CPU.

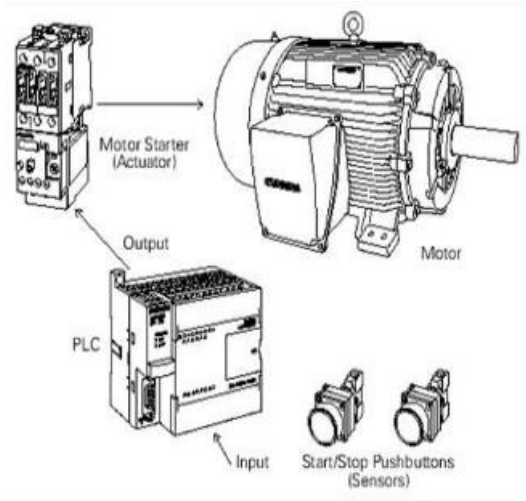

FIG:1.9

Block Diagram of PLC:

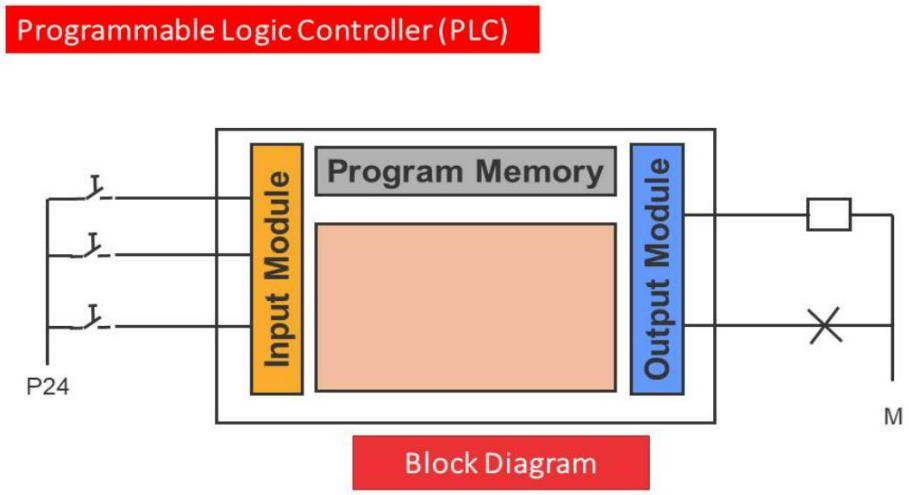

FIG:2.0

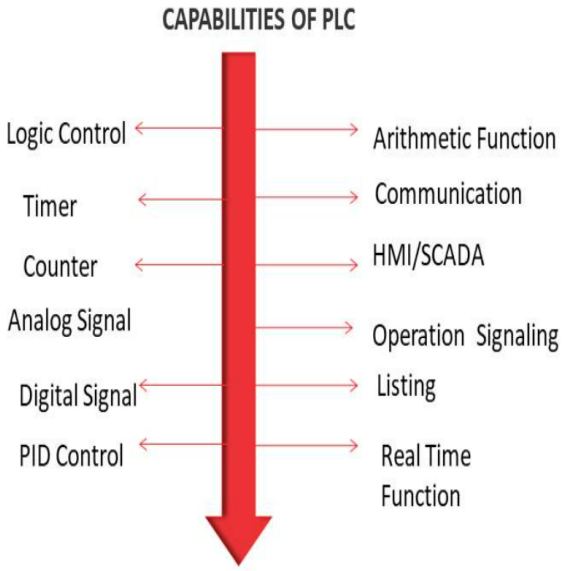

FIG:2.1

FIG:2.2

INTERFACING WITH PLC:

TIA PORTAL:

- The siemens TIA portal(Totally Integrated portal) is the programming environment where we can configure hardware and do the programming.
- Programming languages are
  1) Function block diagram(FBD)
  2) Statement list(STL)
  3) Ladder logic programming(LDR)
- Ladder logic is visual programming language.

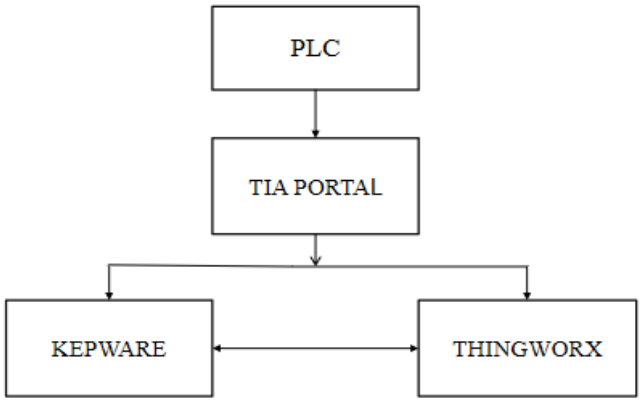

FIG:2.3

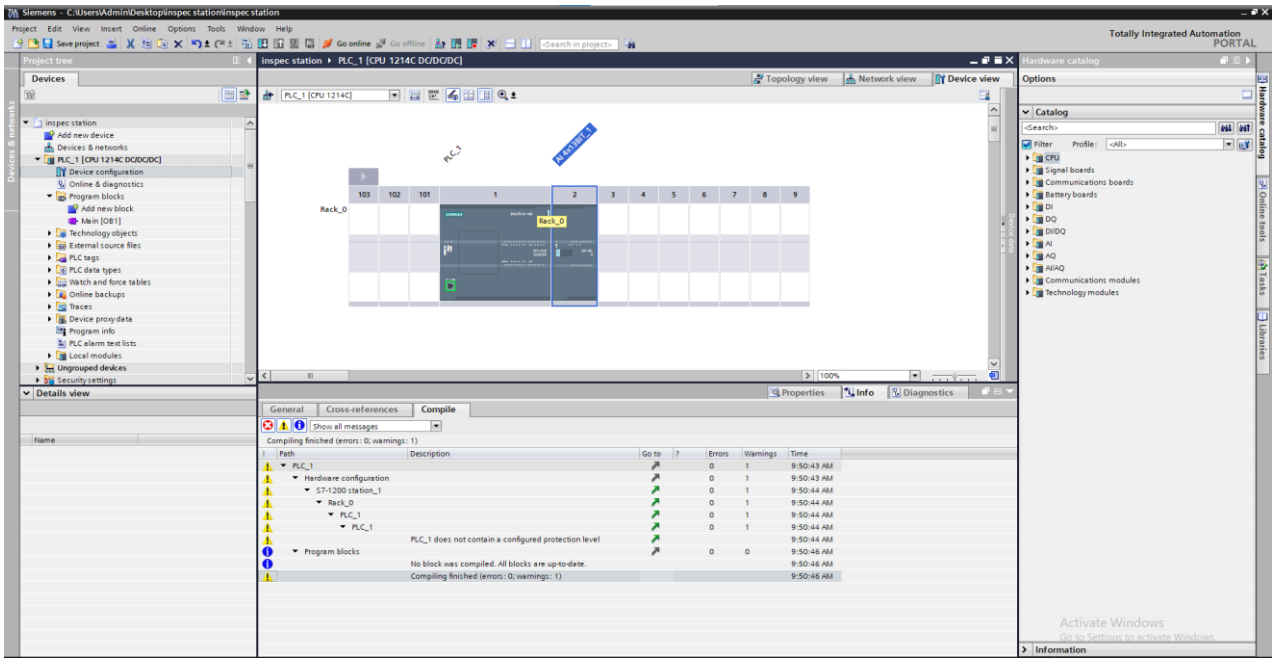

FIG:2.4

LADDER LOGIC PROGRAMMING

LADDER LOGIC PROGRAMMING:

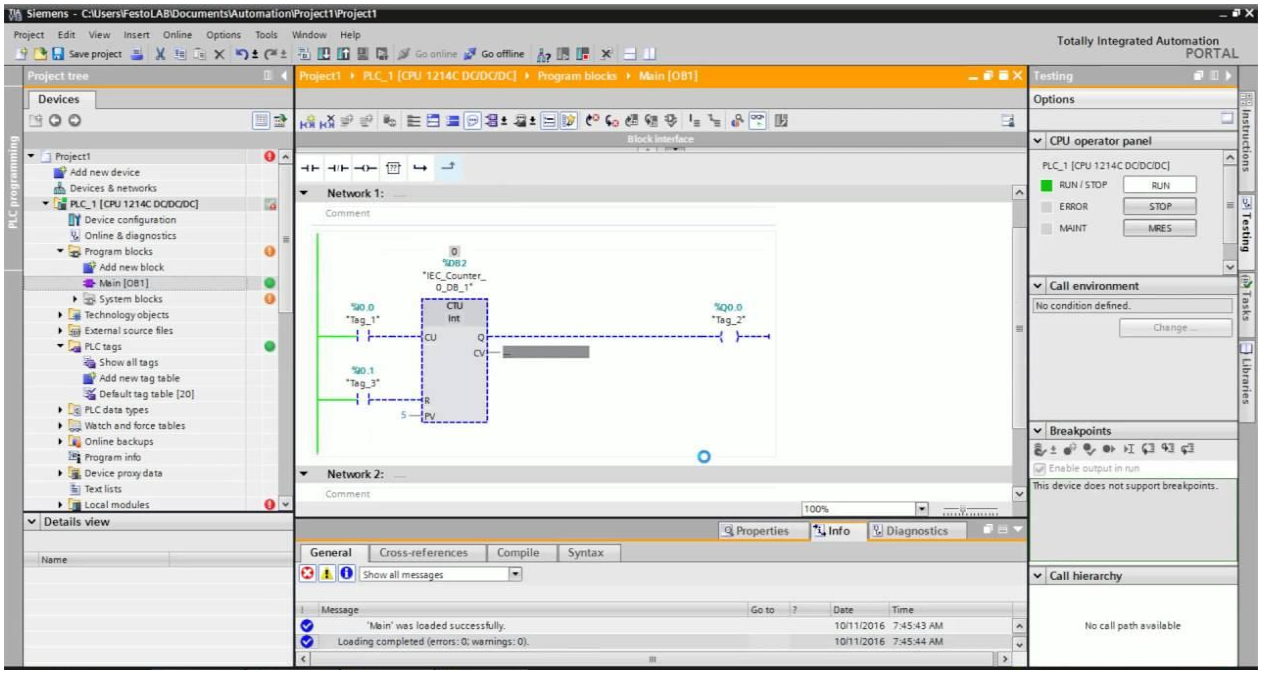

FIG:2.5

MONITORING OUTPUT:

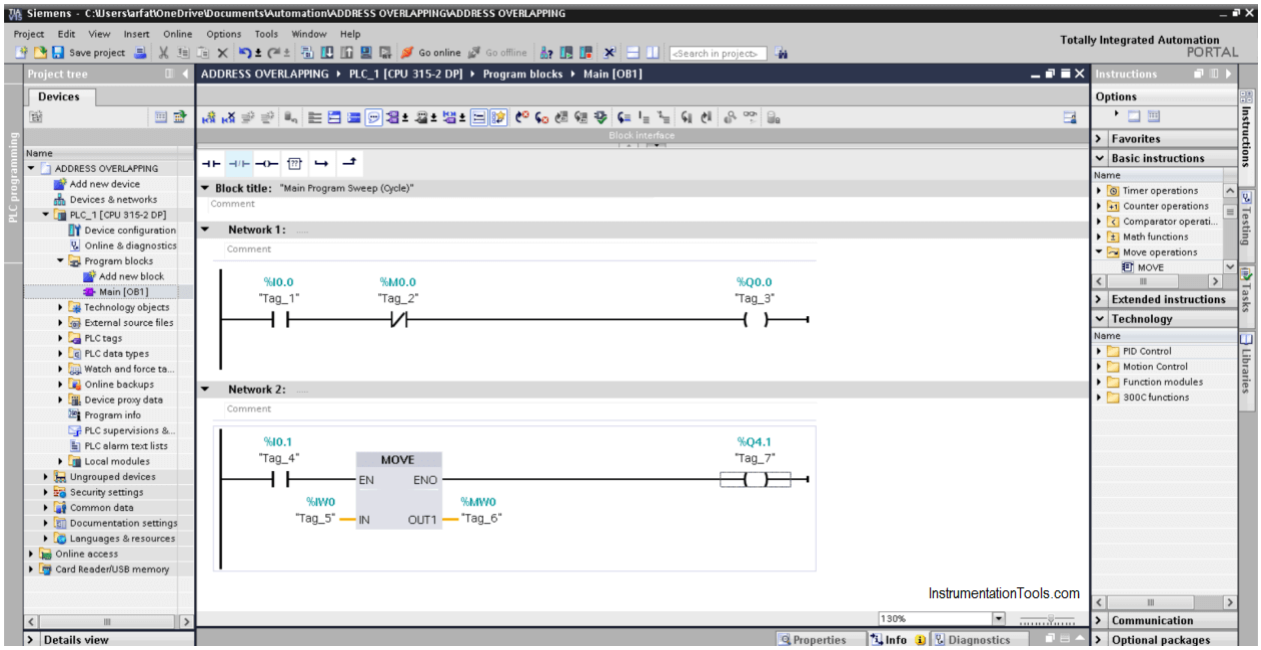

FIG:2.6

KEPWARE

- Kepware servers are industrial connectivity platforms that provide drivers for various controllers and protocols.
- They are used to connect, monitor, and troubleshoot industrial assets and applications.
- Similarly other software that can be used is Micro-Edge server.

FIG:2.7

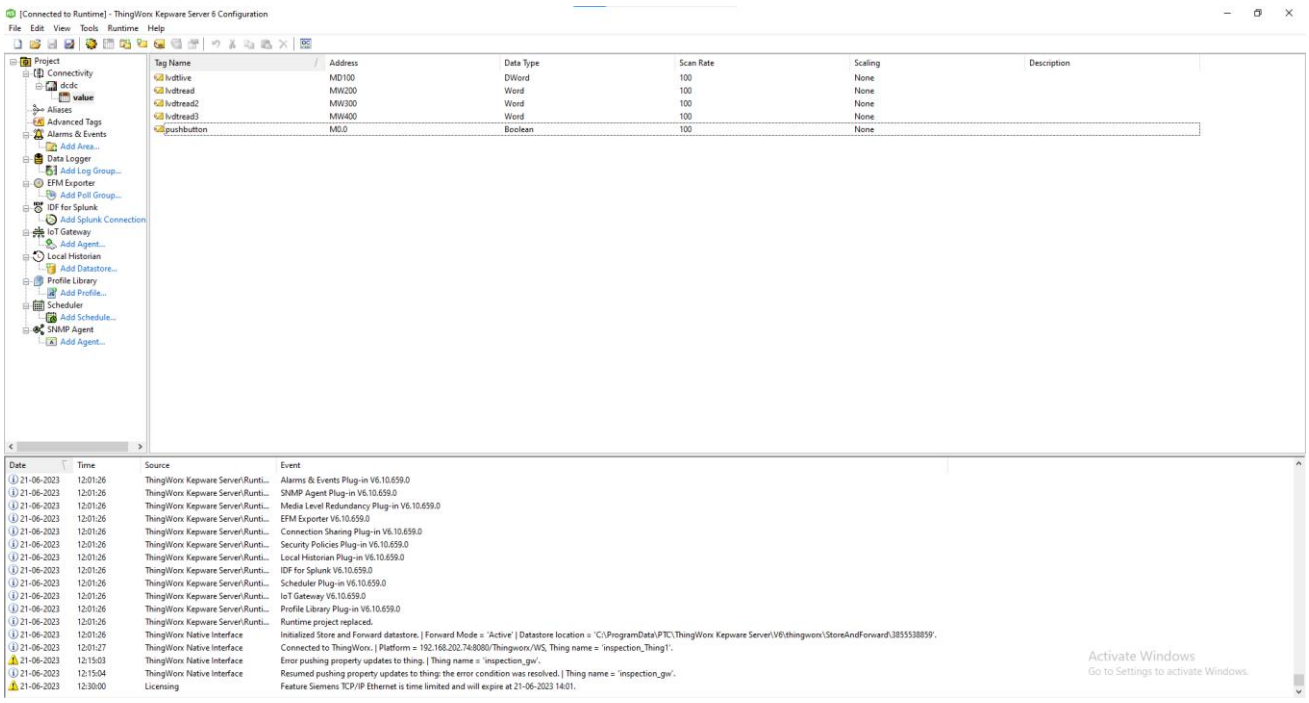

FIG:2.8

THINGWORX

- The Thingworx platform is a complete, end-to-end technology platform designed for the industrial Internet of Things (IIOT).
- It delivers tools and technologies that empower businesses to rapidly develop and deploy powerful applications and augmented reality (AR) experiences.

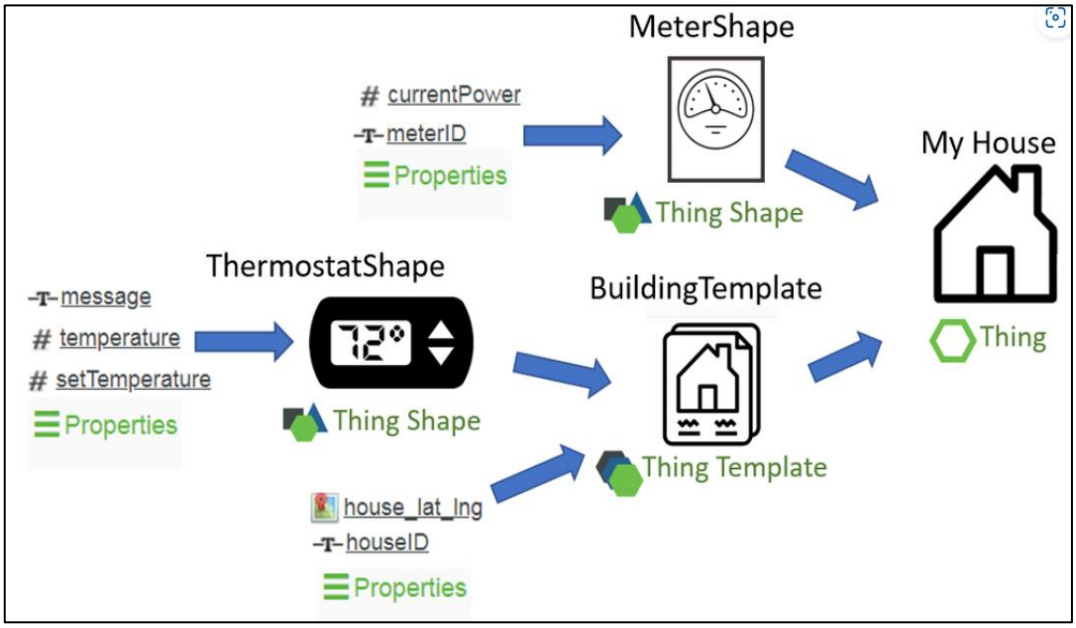

FIG:2.9

INTERFACING PLC TO KEPWARE :

FIG:3.0

THINGWORX MASHUP :

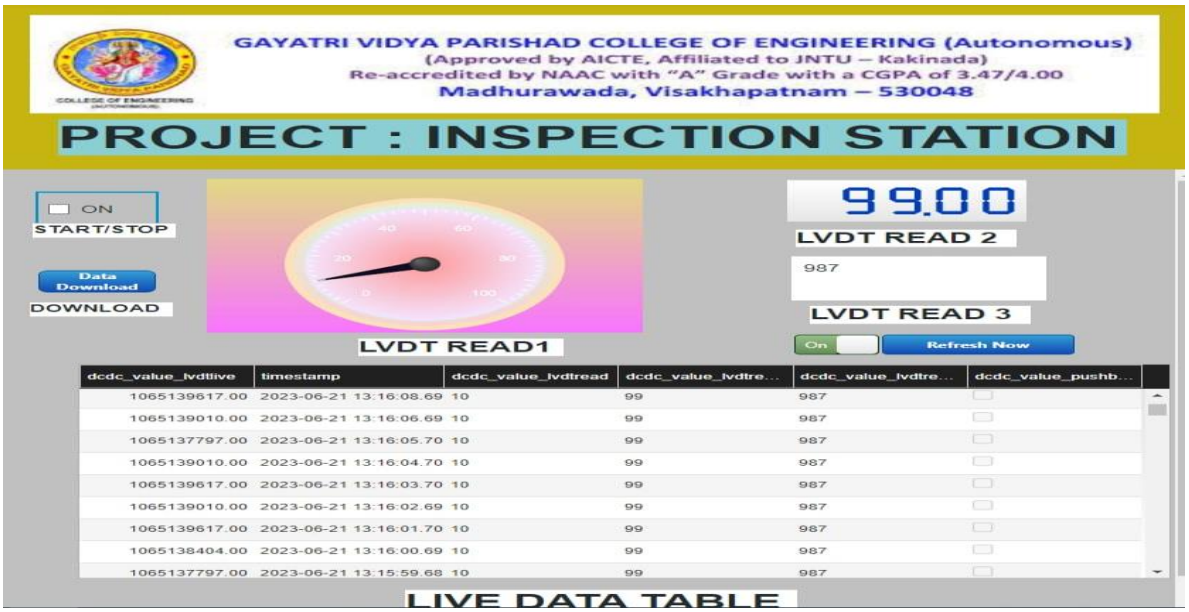

FIG:3.1

PROJECT : MATERIAL INSPECTION WITH IIOT AND AUGMENTED REALITY

PROBLEM STATEMENT : High-production outcome requires fast inspection cycles. Checking parts and objects manually without the right tools during an entire shift is very demanding for frontline workers. A worker must manually assess if parts are assembled correctly, wires are fully connected, or welding points are at the right location. Comparing real objects with paper-based manuals or 2D images is time-consuming, leading to slow inspection cycles and delays for customers

OBJECTIVES : Inspection is a critical part in the quality control process in manufacturing. Quality inspection ensures that product quality and work steps performed meet the defined standards. Raw materials and components are often checked prior to the assembly process; products can also be inspected during and post production. Frontline workers measure, examine, and test whether work steps were carried out correctly, and that products and their components were assembled or maintained according to specifications. AI-enhanced visual inspection detects false parts, and with AR, guides workers to improve quality control. Step Check helps frontline workers to perform end-of-line inspection cycles faster, with higher accuracy and less risk of errors. Step Check uses AR and AI to identify parts, classify the object's state, and automatically learn from pass/fail decisions.

INTRODUCTION TO PROPOSED SOLUTION

STEP-1: PLC(Programmable Logic Controller) is hardware device which takes input from machine or plant via sensors, transmitters and executes its logic, programmed in it's memory. Produces useful output vis actuators to control machine. PLC is been programmed in TIA PORTAL(Totally Integrated Automation) using logic ladder programming language.

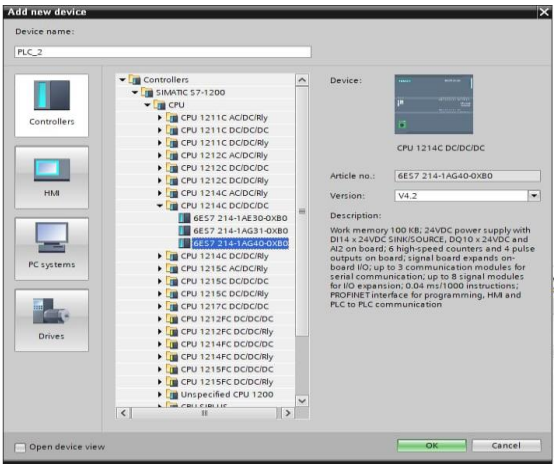

FIG:3.2 PLC configuration

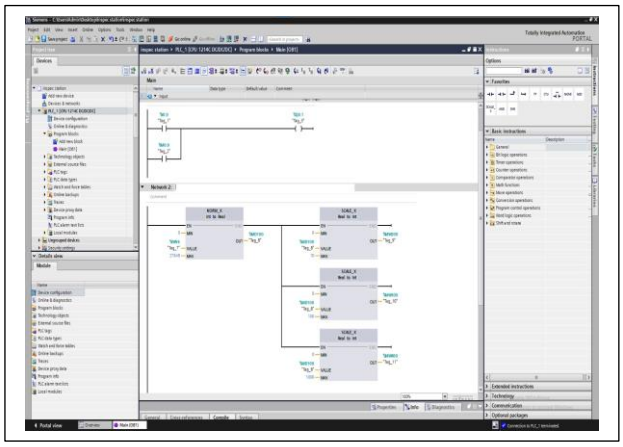

FIG:3.3 Ladder Logic

STEP-2: PLC is connected to Thingworx kepware server. kepware offers tools to control user server access, data source, or data values, regulate read/write access, connect or disconnect client applications, and configure secure data tunnels.

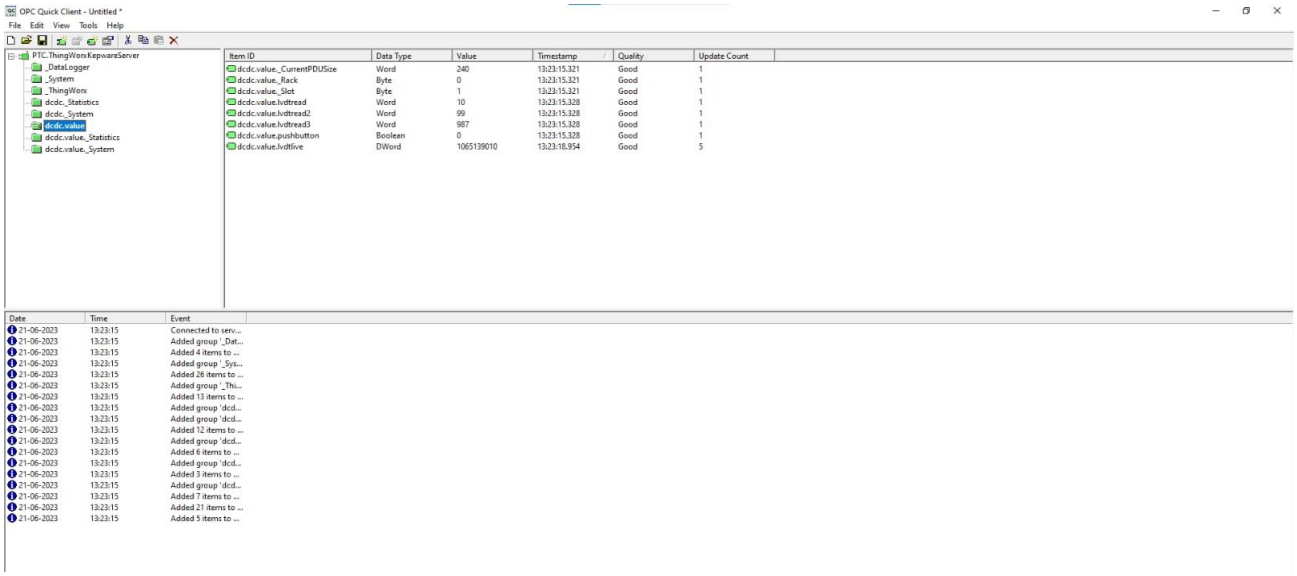

FIG:3.4 Live data of Analog and Ditigal Input/output of PLC are streaming in Kepware server

STEP-3: Kepware server is then integrated with Thingworx cloud platform. PLC can be controlled automatically via Thingworx Properties and Thingworx Mashups using memory addresses. Thingworx is the first platform that connects the people, systems, things, connection operations, connected products, connected applications, etc. Thingworx reduces the time, cost, and risk which are required to build the IoT applications. It deploys the application 10-time faster with model-based development.

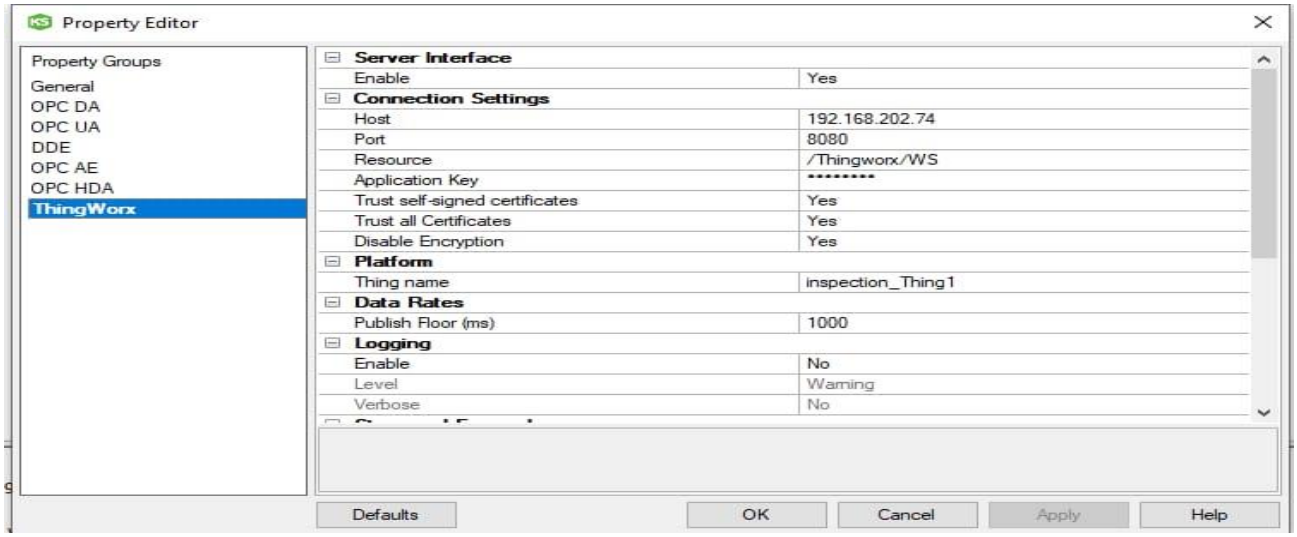

FIG:3.5 Integrating Kepware server with Thingworx

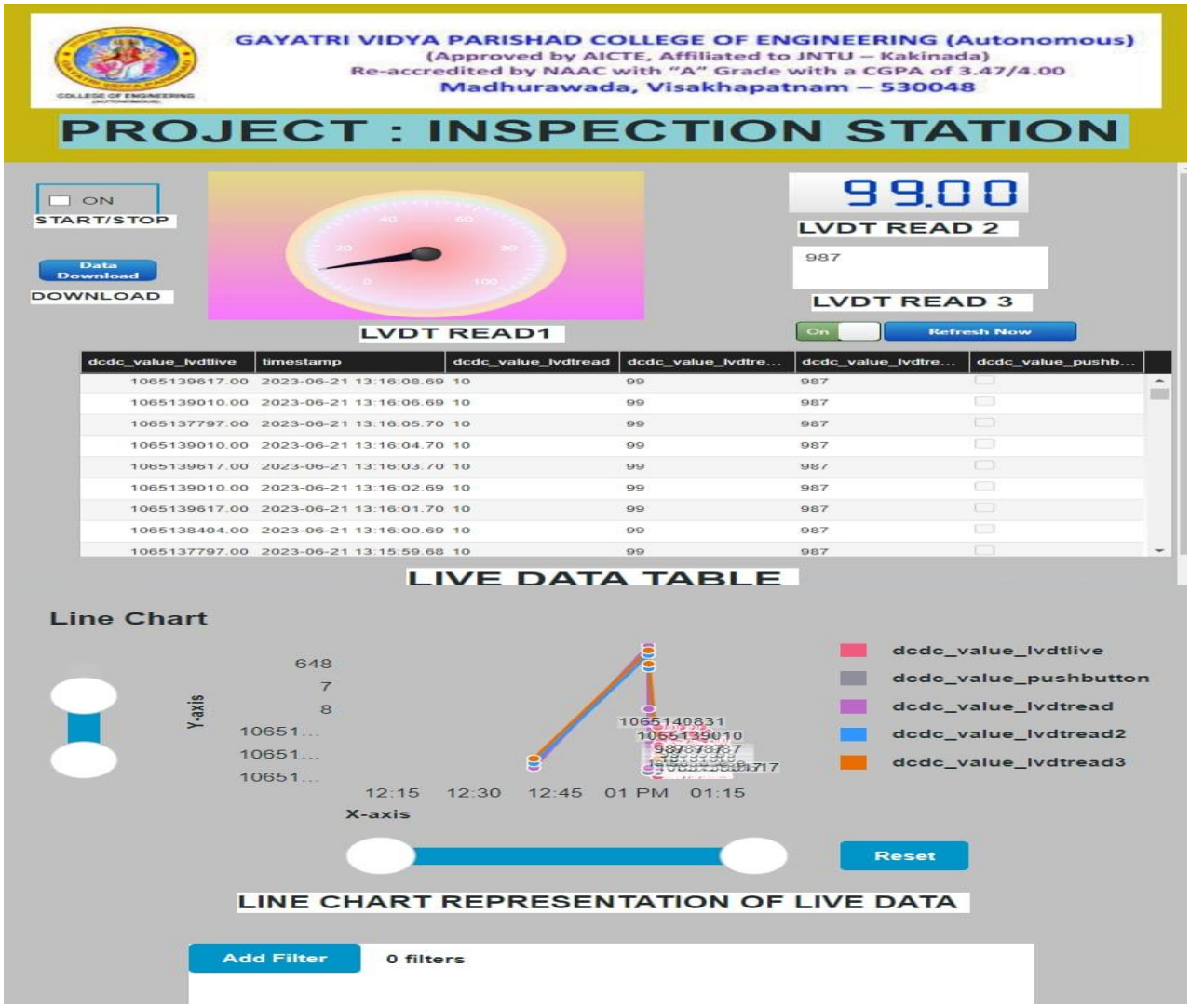

FIG:3.6 Monitoring and Controlling Analog Values in Thingworx Mashup

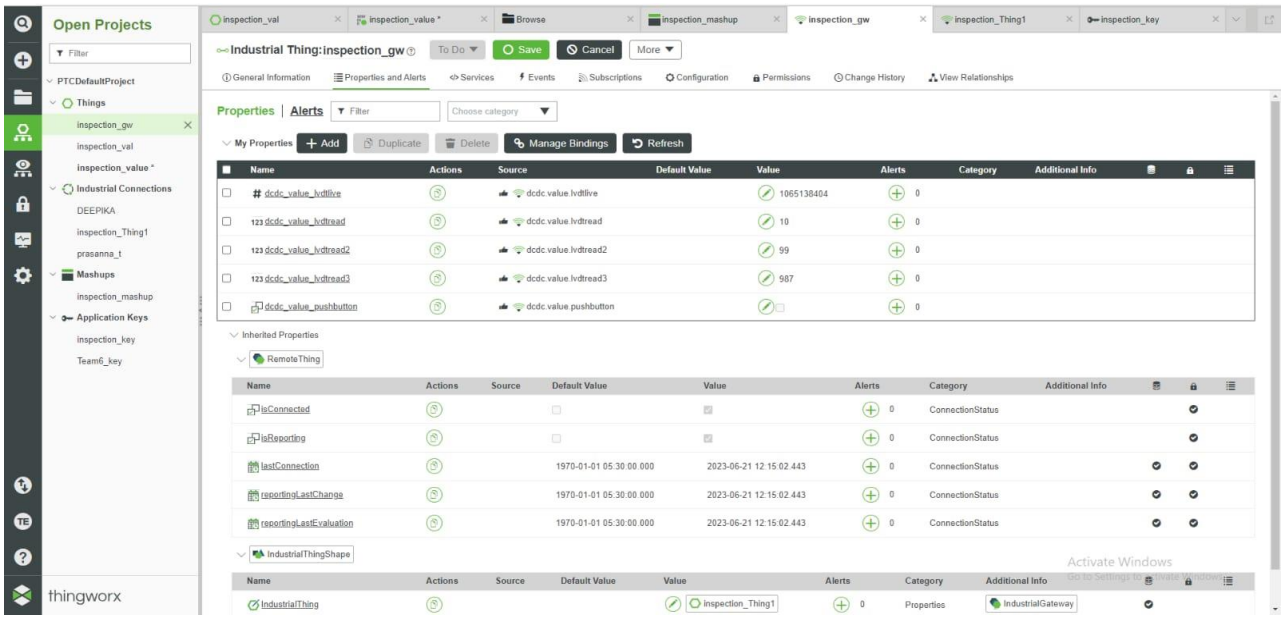

FIG:3.7 Monitoring and Controlling Analog Values in Thingworx

STEP-4: Thingworx is been further integrated with Augmented Reality(AR). Automated assessment using the mobile device camera and Vuforia's leading computer vision technology. AR overlays show the worker if an object passed the check or if something is wrong. A tool that guides through the process, checks that the right object is inspected, and whether the assessment has passed or failed in real time.

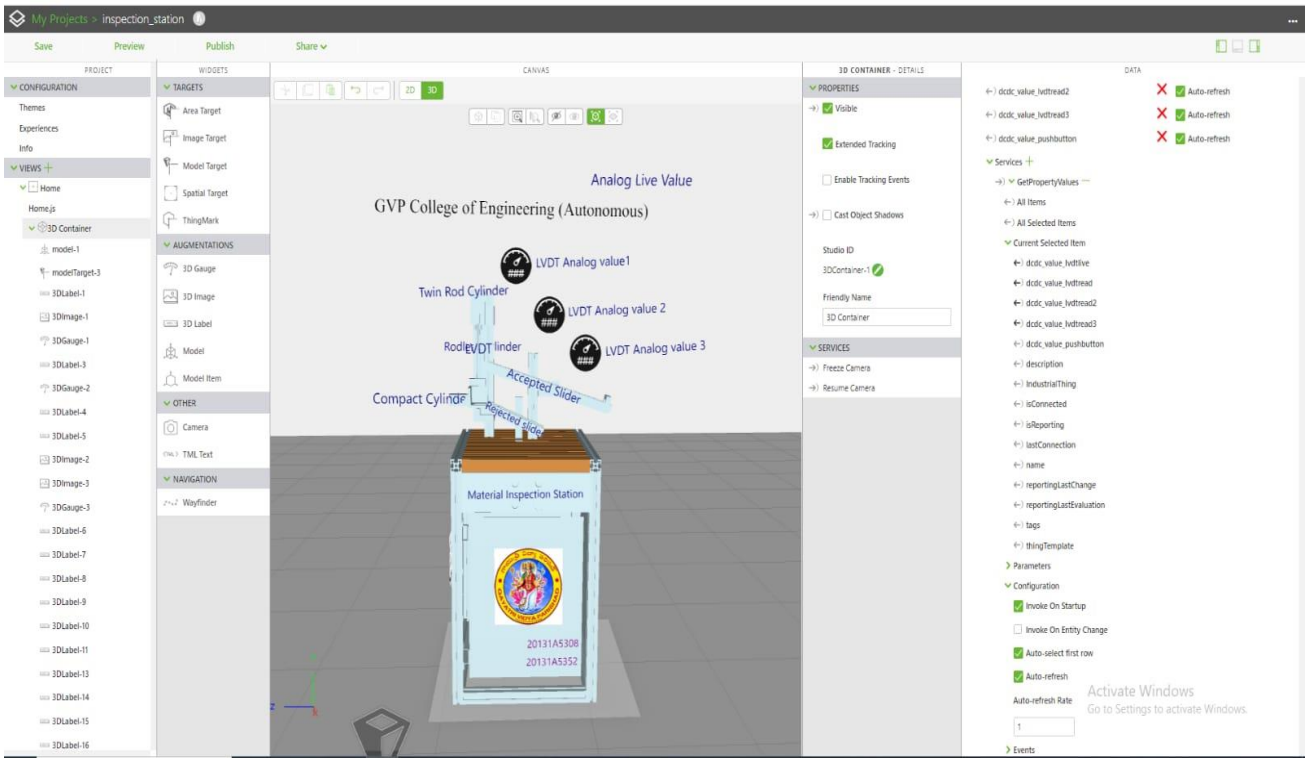

FIG:3.8 AR Screen of Material Inspection Station where we can automate the entire Inspection and Quality control process and identify parts, classify the object's state, and automatically learn from pass/fail decisions. This virtual screen is been designed in Vuforia Studio Software

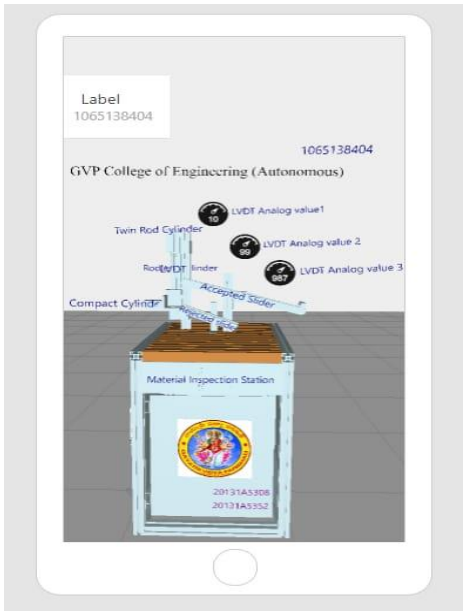

FIG:3.9 Mobile Preview of Inspection Station

FIG:4.0 Material Inspection Station

AUGMENTED REALITY:

- Augmented Reality(AR) is an interactive experience that combines the real world and computer-generated virtual content.
- The ultimate goal of AR is to create a system such that a user cannot tell the difference between the real world and the virtual content.

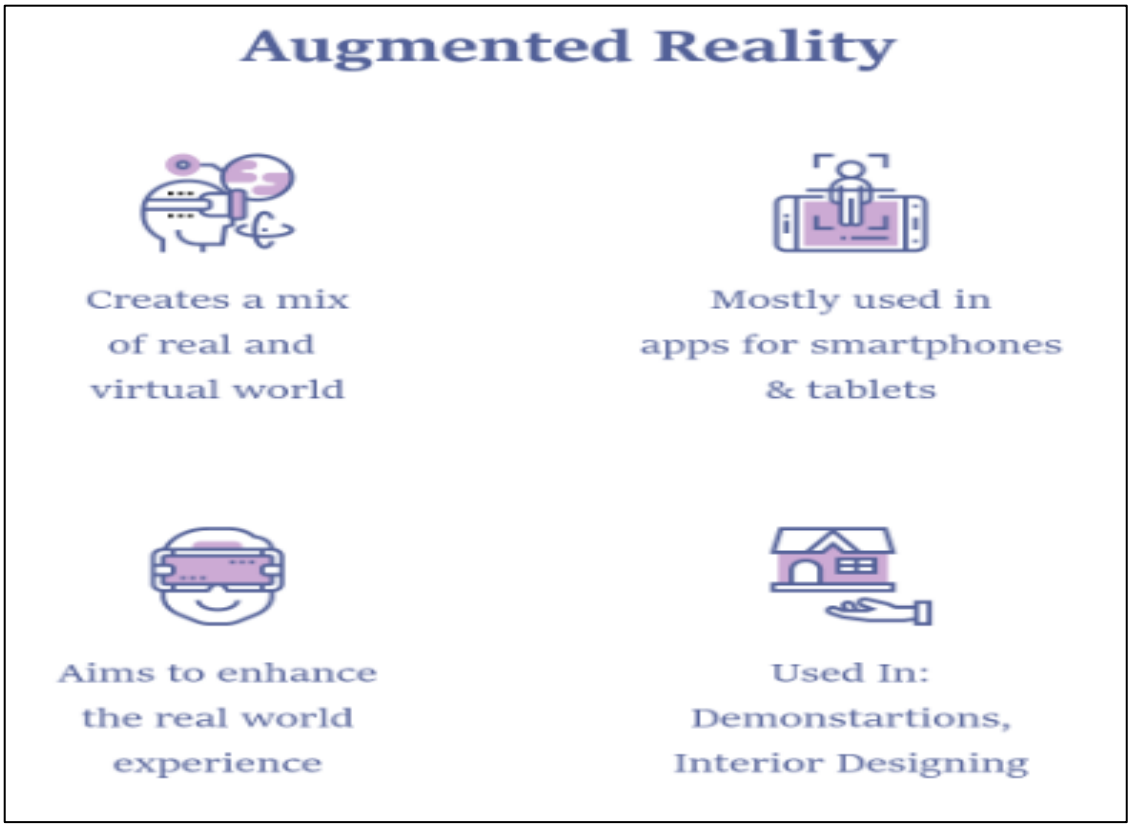

FIG:4.0

Hardware Used:

- Hardware components for augmented reality are: a processor, display, sensors and input devices.

Software Used:

- Vuforia View: Vuforia Engine is a Software Development Kit (SDK) for creating for creating Augmented Reality apps.

CONCLUSION:

Inspection is a critical part in the quality control process in manufacturing. Quality inspection ensures that product quality and work steps performed meet the defined standards. Raw materials and components are often checked prior to the assembly process; products can also be inspected during and post production. Frontline workers measure, examine, and test whether work steps were carried out correctly, and that products and their components were assembled or maintained according to specifications. AI-enhanced visual inspection detects false parts, and with AR, guides workers to improve quality control. Step Check helps frontline workers to perform end-of-line inspection cycles faster, with higher accuracy and less risk of errors. Step Check uses AR and AI to identify parts, classify the object's state, and automatically learn from pass/fail decisions.