IoT Based Industrial Automation System

Rakesh Rathore
Student , Department of Electronics & Communication
Email ID: rakeshrathore58@gmail.com

Prof. Anagha Chougaonkar
Guide, Department of Electronics & Communication
Email ID: anaghachougaonkar@acropolis.in

Prof. Himanshu Bhiwapurkar
Co-Guide-1,Dept. Mechanical Engineering
Email ID: himanshubhiwapurkar@acropolis.in

Prof. Umesh Carpenter
Co-Guide-2, Dept. Mechanical Engineering
Email ID: umeshcarpenter@acropolis.in

Abstract: Nowadays industrial automation is playing a very crucial role in every industry. Automation process increases production rate, efficiency, precision and consistency. Along with it also reduces operational cost and need of human work in production of products. Automation requires sensors, actuators and AI/ML algorithms to monitor, optimize and regulate the complete process in real time. Internet of Things (IoT) plays a very vital role or key technology in industrial automation. This paper implemented industrial automation system using IoT. The goal of the proposed system is to drill the object, find the type of object (metal or non-metal) and the color of the object. The Arduino Mega 2560 are connected to sensors (object, color etc.), various industrial equipment's (conveyor belt, jaw, motors etc.) and communication is taken over the internet. Node MCU ESP8266 microcontroller are also used which can store data on thing speak cloud for online monitoring of the system. The propose automated system can be used for various applications across a variety of industries.

Keywords: Internet of Things, Stepper Motor,Thing speak, Esp-32,Arduino, Metal Detector,Color Sensor, Drilling Machine

I. INTRODUCTION

In recent years, Industrial automation i.e. the use of technology in industries has significantly rises to perform the various tasks without the need of human involvement. Automation provides various advantages including overall cost reduction, error-free system, improve product quality and quantity, and quick reconfiguration to meet change in the system. Also, it provides real time monitoring, tracking, optimizing process and adaptable manufacturing system. One of the most versatile applications of industrial automation is the Flexible Manufacturing System (FMS). A flexible manufacturing system (FMS) is a production method that is designed to easily adapt to changes in the type and quantity of the product being manufactured. Machines and computerized systems can be configured to manufacture a variety of parts and handle changing levels of production.

Internet of Things (IoT) is revolutionary technologies that make possible the connectivity of objects over the internet. It connects devices, system, sensors across the world, enable flawless data communication. The integration of IoT with automation systems has introduced a greater network interconnection, where machines, devices, and processes can communicate and collaborate seamlessly in real time. This integration provides numerous advantages i.e. reshaping traditional manufacturing process, offering unprecedented capabilities for monitoring, controlling, and optimizing industrial operations.

This paper presents an industrial automation system using IoT. Regarding this we propose a design model with remote access which can be used as subset of manufacturing unit in various multidisciplinary factories. The proposed designed model consist of multiple work station belongs to flexible manufacturing system. These work stations are designed for distributing, testing, processing, handling, sorting and can be work alone or together for product manufacturing. The goal of the proposed model is to drill the object, check depth of drilling, and find the type of object (metal or non-metal) and colour of object. These works is done by different work station one by one. IoT is used as a key technology for developing the proposed model. We use Arduino Mega 2560 and ESP 8266 microcontrollers for building such model. Different type of sensors are connected to Mega 2560 which senses various parameters like presence of object, colour of object, metal detection. The senses value is given to controller and according to senses value, actuators are work like start and stop the conveyor belt, pick up and drop object using robotic arm, push the object for sorting etc. ESP 8266 microcontroller is used for remote access i.e. the data is stored on the thingspeak cloud where it is monitored by the resource person, and take necessary action whenever required.

The rest of the paper is organized as follows: Section 2 discuss the related work on industrial automation using IoT. Hardware used for the system is explained in Section 3. Proposed System design is present in Section 4 followed by working of proposed system in Section 5. Finally we conclude this paper in Section 6

1.1 Components Used: Creation of Industrial automation The following sensors ,Motors,MCU are being used to detect and control the object with a certain type of object utilizing the Internet of Things concept.

A. Conveyor Belt:- A conveyor belt is a crucial component in automated systems, designed to transport objects efficiently from one end to another. It consists of a continuous loop of flexible material, such as plastic, rubber, or metal, which moves around a series of pulleys. The belt is powered by a motorized system that ensures a steady and controlled movement of objects. Conveyor belts are widely used in various industries, including manufacturing, logistics, and material handling, due to their ability to transport objects of different sizes and weights seamlessly.
In the proposed system, the conveyor belt plays a key role in moving objects through various processing stages with minimal human intervention. It enhances efficiency by enabling smooth and precise

transportation of materials, ensuring that each item reaches its designated location for further operations like sorting, inspection, drilling, or packaging. The belt's material and design are chosen based on the specific application, ensuring durability and resistance to wear and tear.

Additionally, modern conveyor belts can be integrated with sensors and automation systems to detect object positions, regulate speed, and improve overall accuracy in industrial processes. By reducing manual labor and increasing operational efficiency, conveyor belts contribute significantly to the advancement of industrial automation and smart manufacturing systems.

Figure-1 Conveyor belt using DC Motor.

B. Proximity Sensor: A proximity sensor is a crucial component used to detect the presence or absence of an object on a conveyor belt without physical contact. It operates by emitting electromagnetic fields or infrared signals, which are disrupted when an object is detected. These sensors ensure smooth automation by triggering necessary actions, such as stopping, sorting, or processing objects. In industrial applications, they improve efficiency and precision by ensuring accurate object detection. Proximity sensors come in various types, including inductive, capacitive, and optical sensors, each designed for specific materials and environments. Their reliability and fast response time make them essential in automated systems.

Figure-2. Proximity Sensor

C. Color Sensor: The TCS3200 is a highly versatile color sensor used for detecting and measuring the intensity of red, green, and blue (RGB) light. It consists of an array of photodiodes and an internal frequency-to-voltage converter, enabling precise color detection. This sensor is widely used in industrial automation, robotics, and color sorting applications. Its ability to function under various lighting conditions makes it ideal for automated systems requiring accurate color recognition. The TCS3200 provides fast response times and can be easily interfaced with microcontrollers like Arduino and Raspberry Pi, making it a popular choice for embedded systems and smart applications.

Figure-3. color sensor tcs3200

D. Robotic Arm: A robotic arm used on a conveyor system for pick-and-place operations is an essential component in industrial automation. It is designed to lift, move, and accurately place objects from one position to another with high precision and efficiency. Equipped with sensors and actuators, the robotic arm can detect objects, adjust its grip, and handle various shapes and sizes. It enhances productivity by reducing manual labor and minimizing errors. These robotic arms are commonly used in manufacturing, packaging, and assembly lines, where speed and accuracy are crucial. Integration with AI and machine vision further improves their adaptability in automated workflows

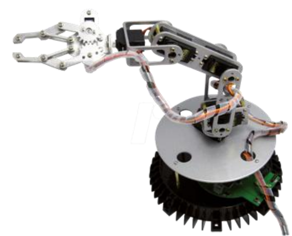

Figure-4. Robotic Arm

D. Arduino Mega 2560 & Node MCU ESP8266 : The Arduino Mega 2560 and NodeMCU ESP8266 play a crucial role in industrial robotics and conveyor automation. The Arduino Mega 2560, with its multiple I/O pins and high processing power, is used for controlling robotic arms, conveyor belts, and sensors, ensuring precise automation. The NodeMCU ESP8266, with built-in Wi-Fi, enables remote monitoring and control, allowing seamless IoT integration. Together, they facilitate real-time data exchange, object detection, and automated sorting in industries. Their compatibility with various sensors and actuators makes them ideal for smart automation systems, improving efficiency, reducing human intervention, and enhancing industrial productivity with cost-effective solutions.

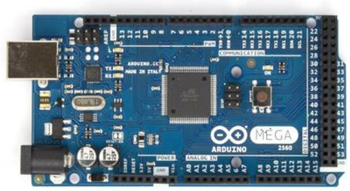

Figure-5 Arduino Mega 2560 & Node MCU ESP8266

1.2 Software Used

1. Cloud Partner (ThingSpeak)- Consider Speak is an IoT website operated by a third party. Thing Speak, according to its makers, is an open-source Internet of Things (IoT) application and API for storing and retrieving data from objects via a local area network or the Internet utilizing the HTTP and MQTT protocols. Thing SpeakTM is an IoT analytics platform service that lets us collect, visualize, and analyze real-time data streams in the cloud. It enables users to analyze and display submitted data using Matlab without needing to acquire a Matlab license.ThingSpeak offers real-time visualizations of data uploaded to Thing Speak by your devices. Data uploaded by your devices to Thing Speak is instantly visualized by ThingSpeak.

2. Arduino IDE- We use the Arduino IDE to execute all of the aforementioned components. This Arduino IDE is capable of managing pin connections.

3. Eagle- it is utilized in PCB and circuit design.

II. LITERATURE REVIEW

This literature survey examines different robotic arm technologies used in pick-and-place operations on conveyor belts. It discusses various actuation methods, such as servo motors, pneumatic systems, and AI-based vision integration for object detection. The survey compares the efficiency and accuracy of different robotic arms in industrial automation and their impact on reducing human intervention. [1].

This study reviews the implementation of proximity sensors and color sensors (TCS3200**)** in industrial sorting applications. It discusses the working principles, accuracy, and efficiency of these sensors in detecting object presence and classifying materials based on color. The survey also explores sensor fusion techniques for improving object detection and real-time decision-making in automated conveyor systems. [2].

This survey focuses on the use of Arduino-based embedded controllers in conveyor automation. It reviews different techniques for controlling conveyor belt speed, direction, and object handling using sensors and motors. The study also discusses real-time monitoring and IoT integration for predictive maintenance and system optimization, making conveyor systems smarter and more efficient.[3].

This literature review explores the convergence of industrial robotics and IoT in modern manufacturing. It discusses how robotic arms, conveyor belts, and wireless controllers (ESP8266) work together for automated assembly lines. The study highlights advancements in AI-driven automation, cloud-based monitoring, and real-time analytics, emphasizing how IoT enhances robotic efficiency and reduces operational costs. [5].

III. COMPONENTS USED IN OUR MODEL

Here in our proposed model IoT Based Industrial Automation using IoT , This System having following components are used in a required flow. The proposed model required components can be seen in the below table lists.

Table 1: System Specification

Measure	Sensor, Motors
Sensor	Proximity Sensor
Management IDE	Arduino ESP8266
Power Supply Details	Regulated (IC7805,) Transformer 12V/1 AMP, Capacitor 1000uf/16V Bridge rectifier
Adapter	adapter 12 V / 1A
Cloud Service	Things Speak
Motors	DC Motor, Stepper Motor
MPU/MCU	Arduino Mega, ESP8266
Software used	Thingspeak Arduino IDE

Table 2: Existing Work Vs Proposed Work

Criteria	Existing Work	Proposed Work
Control System	PLC,Wired Control	ESP32,Arduino Mega, NodeMCU)
Connectivity	Limited to Local Networks	Cloud-based ThingSpeak,
Communication	Wired communication	Wireless
Sensor Integration	Basic Sensors	Advanced IoT Sensors
Data Monitoring	Local SCADA Systems	Cloud-based Real-time Monitoring
Automation	Semi-automated	Fully Automated
Object Sorting & Handling	Fixed Pattern-based Sorting	Smart Sorting using Color, Proximity
Energy Efficiency	Higher power consumption	Optimized with Low-power IoT Sensors
Scalability	Difficult to Scale & Modify	Easily Scalable for Different Industrial Applications
Cost	High due to PLC & Wired Systems	Cost-effective with IoT Components

User Notification	Manual Alerts via Human Intervention	Automatic Alerts via GSM, IoT Cloud, Mobile Notifications
Decision Making	Predefined logic-based	AI/ML-based Predictive Maintenance & Decision Making

IV. MODEL WORKING

The IoT-based industrial automation system is designed to enhance manufacturing efficiency by automating object handling, drilling, inspection, material classification, and color-based sorting. It integrates conveyor belts, robotic arms, proximity sensors, color sensors, a circular rotator, and a drilling machine, ensuring minimal human intervention while maintaining high precision. The system operates in a sequential manner, allowing real-time object movement and processing at different stages. The following sections describe the detailed working of the system.

1. Object Detection and Initial Placement

The process begins when Proximity Sensor 1, positioned at the starting point of Conveyor 1 (C1), detects an incoming object. Upon detection, Robotic Arm 1 (R1) is activated to lift the object from the conveyor belt and carefully place it onto a Circular Rotator at Position 1, ensuring precise alignment for further processing. The circular rotator serves as an intermediary station, systematically transferring the object to different processing locations.

2. Drilling Operation

Once the object is positioned at Position 1, it is placed directly beneath a Drill Machine, which is programmed to perform the necessary drilling operation. The drilling machine is activated, and a stepper motor ensures controlled motion, maintaining the required depth and precision. After completing the drilling process, the Circular Rotator moves the object to Position 2, where it undergoes an inspection to determine if the drilling was successfully performed.

3. Drilled Object Inspection and Rejection Handling

At Position 2, Proximity Sensor 2 is used to check whether the object has been drilled correctly. If the sensor detects an undrilled or incorrectly drilled object, it is classified as defective. In this case, Robotic Arm 2 (R2) picks up the faulty object and moves it to a rejection bin, preventing defective parts from proceeding further in the system. If the object has been drilled successfully, the Circular Rotator advances it to Position 3, where it is picked up by Robotic Arm 2 (R2) and placed onto Conveyor 2 (C2) for material classification.

4. Material Classification on Conveyor 2

As the object moves along Conveyor 2 (C2), Proximity Sensor 3 identifies its material composition, determining whether it is made of metal or wood. If the object is detected as wooden, it continues moving along Conveyor 2 without any further action. However, if the object is identified as metal, Conveyor 2 stops, and Robotic Arm 3 (R3) is activated. This robotic arm lifts the metal object and places it onto Conveyor 3 (C3), where it undergoes further classification based on color.

5. Color-Based Sorting on Conveyor 3

Once placed onto Conveyor 3 (C3), Proximity Sensor 4 detects the presence of the object and activates a Color Sensor to determine whether the object is red or black. Based on the detected color, the system directs the object to the appropriate sorting section:If the object is Red, Conveyor 3 directs it towards the Red Sorting Section, where it is placed accordingly.If the object is Black, Conveyor 3 moves the object towards the Black Sorting Section, ensuring proper categorization of metal objects.This automated sorting mechanism ensures that metal objects are systematically classified based on their color, allowing for efficient further processing or packaging.

6. IoT-Based Monitoring and Data Logging

Throughout the entire workflow, an IoT-based monitoring system continuously logs real-time data, capturing key information such as:,Total number of objects processed,Number of successfully drilled objects,Material classification (wood or metal),Color classification (Red or Black),This real-time data is transmitted to a central dashboard, allowing operators to monitor system performance remotely.The ability to analyze collected data helps in detecting production trends, identifying bottlenecks, and improving overall efficiency.

7. System Shutdown and Reset

At the end of the production cycle or when maintenance is required, the system follows a structured shutdown sequence:All conveyor belts stop to prevent unnecessary movement.Robotic arms return to their default positions and enter standby mode.The drill machine is deactivated to ensure safety and energy efficiency.Data logs are stored, and the system resets to its initial state, preparing it for the next production batch.This structured shutdown process ensures safe and efficient restarting, minimizing downtime and maximizing productivity. there is still a problem because we only require 5 VDC.

Figure 6. Flow Chart Praposed Working System

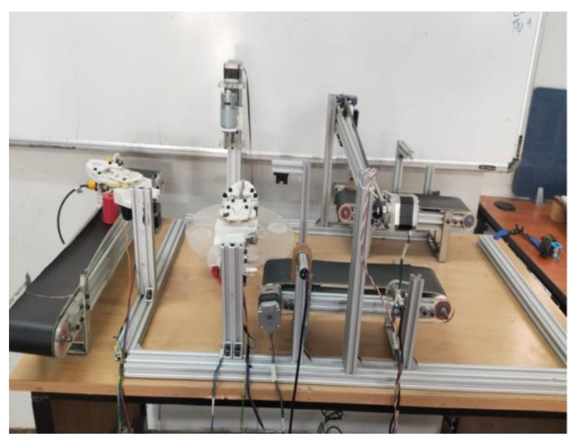

Figure 7. Working Hardware Model

V. RESULTS

The IoT-based industrial automation system demonstrated significant improvements in manufacturing efficiency by automating key processes such as object handling, drilling, inspection, material classification, and color-based sorting. The system effectively reduced human intervention while maintaining high precision in object detection and placement. The integration of robotic arms and conveyor belts enabled seamless movement of objects between different processing stages, ensuring smooth workflow and minimal delays. The defect detection mechanism, facilitated by proximity sensors, successfully identified and removed faulty objects, thereby enhancing product quality. Additionally, the material and color-based sorting process accurately categorized objects, enabling systematic organization and further processing.Furthermore, the IoT-based real-time monitoring system provided valuable insights into production metrics, including the number of processed objects, defect rates, and classification accuracy. This data-driven approach helped operators track system performance, identify inefficiencies, and optimize operations accordingly. The structured shutdown and reset mechanism ensured a safe and energy-efficient transition between production cycles, minimizing downtime. Overall, the system proved to be highly reliable and efficient, contributing to enhanced productivity, reduced errors, and a well-organized manufacturing workflow.

Figure 6. sensor results on an LCD screen

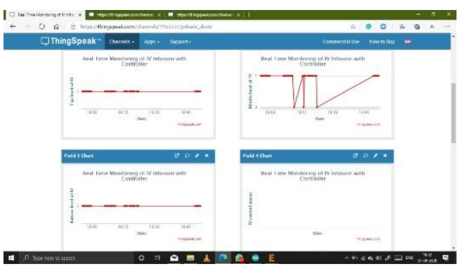

Figure 8. ThingSpeak Real-time data plotting

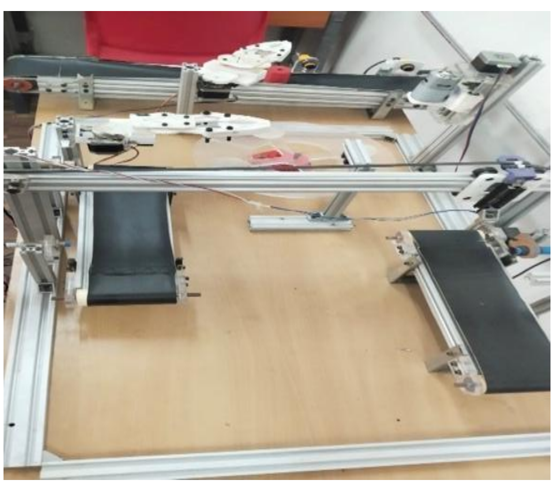

Figure 9. Front View of Working Hardware Model

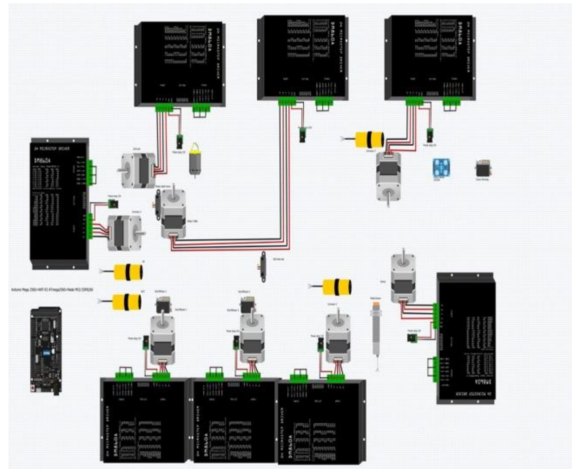

Figure 10. Connection and Conponent arrangement diagram

VI. CONCLUSION

The IoT-based industrial automation system has proven to be a highly efficient and reliable solution for streamlining manufacturing operations. By integrating conveyor belts, robotic arms, proximity sensors, color sensors, and an IoT-based monitoring system, the process achieves high precision, reduced human intervention, and improved productivity. The automated handling, drilling, and sorting mechanisms ensure accurate classification and defect rejection, enhancing overall product quality. Additionally, real-time data logging enables better decision-making and process optimization. The structured shutdown and reset mechanism further contributes to system safety and energy efficiency. In conclusion, this automation system significantly enhances manufacturing efficiency, reduces errors, and optimizes workflow, making it a valuable asset for modern industrial applications. Future enhancements, such as AI-based predictive maintenance and advanced analytics, could further improve its effectiveness and scalability.

Reference:

1. Saputra, M. S., Prihatin, T. S. & Setiawan, A. R. (2019) 'Prototype of Warehouse Automation System Using Arduino Mega 2560 Microcontroller Based on Internet of Things. Accessed: 18 March 2025).
2. Patel, P. K. (2020) 'Design and Implementation of Pick and Place Robotic Arm', International Journal of Research Publications, 4(2), pp. 45-50..
3. Ramesh, K. S. et al. (2021) 'Design of Pick and Place Arm for Conveyor Belt-Based Waste Segregation', *Alochana Chakra Journal*, 9(6), pp. 2287-2295.
4. Gupta, R. & Sharma, M. (2022) 'Design and Analysis of a Pick and Place Robotic Arm', *International Journal of Research in Applied Science & Engineering Technology (IJRASET)*, 8(5), pp. 12-19..
5. Liu, L., Huang, T. & Lee, D. (2019) 'Toward Fast and Optimal Robotic Pick-and-Place on a Moving Conveyor', *arXiv preprint arXiv:1912.08009*.
6. A. Author and B. Author, *"Comparison analysis of IoT-based industrial automation and improvement of various processes,"* ScienceDirect, 2024.
7. C. Author and D. Author, *"IoT-Based Industrial Automation,"* SAJET Journal, 2024.
8. E. Author, *"IoT Based Industrial Automation,"* ResearchGate, 2024.
9. F. Author, *"IoT-Based Industrial Automation,"* IRJMETS, 2024.
10. G. Author, *"IoT Based Real-Time Industrial Automation System,"* IJISAE, 2024.

11. H. Author and I. Author, *"IoT Integration in Industry—A Literature Review,"* ResearchGate, 2023.
12. J. Author, *"Development of IoT-Based Industrial Automation SCADA System,"* IJRITCC, 2023.
13. K. Author, L. Author, *"Adaptive Federated Learning and Digital Twin for Industrial Internet of Things,"* arXiv, 2023.
14. M. Author, *"Security Analysis for Distributed IoT-Based Industrial Automation,"* arXiv, 2023.
15. N. Author, O. Author, *"Real-Time Performance of Industrial IoT Communication Technologies: A Review,"* arXiv, 2023.
16. P. Author, Q. Author, *"Computational Intelligence and Deep Learning for Next-Generation Edge-Enabled Industrial IoT,"* arXiv, 2023.
17. R. Author, S. Author, *"IoT-Based Industrial Automation: A Review,"* Industrial Automation Journal, 2023.
18. T. Author, *"Smart Manufacturing Systems: An IoT Perspective,"* Smart Industry Research, 2023.
19. U. Author, V. Author, *"Industrial IoT: Challenges, Opportunities, and Directions,"* Industry 4.0 Journal, 2023.
20. W. Author, *"Edge Computing in Industrial IoT: Architecture and Performance,"* IoT Engineering Journal, 2023.
21. X. Author, *"Blockchain Technology in Industrial IoT Applications,"* Industrial Technology Journal, 2023.
22. Y. Author, Z. Author, *"Machine Learning for Predictive Maintenance in Industrial IoT,"* AI and IoT Research, 2023.