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Smart Manufacturing Monitoring System: A Web-Based Platform for Centralized Operational Visibility

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Abstract: ***Manufacturing operations require coordinated visibility into equipment condition, production output, maintenance activities, and inventory availability. When these details are maintained in separate records, operators and supervisors may need to spend additional time collecting information and identifying operational changes. This paper presents the design and current development of a Smart Manufacturing Monitoring System, a web-based application that brings these functions together through a centralized dashboard. The frontend is built with React.js and Vite, the backend uses Node.js and Express.js to expose REST APIs, and MongoDB with Mongoose is used for data persistence. The application includes machine monitoring, production tracking, maintenance work-order management, inventory monitoring, and dashboard-level summaries. A software-based telemetry simulator generates changing machine indicators such as operating status, temperature, vibration, and Overall Equipment Effectiveness (OEE) for demonstration. The project is still under development; telemetry is not sourced from physical factory sensors, and machine-learning-based failure prediction has not yet been implemented or validated. The paper describes the architecture, modules, workflow, and proposed functional testing, and identifies real sensor integration, stronger validation, and predictive maintenance as future work.***

Keywords: Smart manufacturing, industrial monitoring, manufacturing dashboard, machine telemetry, production tracking, maintenance management, inventory monitoring.

I. INTRODUCTION

Manufacturing organizations depend on timely information about equipment availability, production progress, maintenance requirements, and material stock. If these activities are monitored using disconnected applications or manual records, it can be difficult to obtain a consolidated view of current operations. A centralized software platform can make key information easier to access and provide a common interface for reviewing operational status. Research on cyber-physical manufacturing systems and Industry 4.0 highlights the role of connected information systems, monitoring, and performance indicators in modern manufacturing environments [1]–[4].

This paper presents the Smart Manufacturing Monitoring System, a modular web application intended to demonstrate how machine indicators, production information, maintenance work orders, and inventory records can be presented within one interface. The project is being developed as a software-based academic system. To demonstrate dashboard updates without industrial hardware, machine readings are generated by a simulator. The implementation is not presented as a deployed factory solution, and the current version does not provide validated machine-failure predictions.

The main contributions are: (1) a unified dashboard for several manufacturing-support modules; (2) a REST-based communication layer between the user interface and backend; (3) structured persistence of application records in MongoDB; and (4) a modular foundation that can later be extended with physical telemetry sources and predictive analytics.

II. RELATED WORK

Smart manufacturing research describes the integration of physical equipment, computation, and communication as a foundation for connected production systems. Lee, Bagheri, and Kao proposed a cyber-physical systems architecture for Industry 4.0-based manufacturing, emphasizing the relationship between factory processes and digital information systems [1]. Lu reviewed cyber-physical systems for Industry 4.0 and discussed enabling technologies, applications, and integration challenges [2]. These works provide context for developing modular software that organizes manufacturing information.

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Manufacturing performance measurement is also important. Lee et al. reviewed performance metrics for smart manufacturing systems, while Ferrer et al. discussed the implementation and visualization of manufacturing key performance indicators in relation to ISO 22400 [3], [4]. These studies support the need for clear and consistent operational indicators. The present project differs in scope: it is a developing web application demonstrating centralized visualization and record management using simulated machine telemetry, rather than a validated industrial monitoring deployment.

III. PROBLEM STATEMENT AND OBJECTIVES

A. Problem Statement

The project addresses the difficulty of viewing machine condition indicators, production progress, maintenance tasks, and inventory status through a single interface. Fragmented records may increase the effort required to review operational information and coordinate follow-up activities. The project explores a web-based approach for organizing these information categories in a shared application.

B. Objectives

The objectives are to develop a centralized dashboard; display machine status and selected telemetry values; organize production targets and actual output; support maintenance work-order tracking; present inventory details such as stock quantity and thresholds; and provide a backend API with database persistence. Future objectives include connecting real equipment data, implementing alert logic, and evaluating a trained predictive-maintenance model.

IV. PROPOSED SYSTEM

The application follows a three-layer web architecture. The React.js frontend presents the dashboard and module-specific screens. The Node.js and Express.js backend receives frontend requests, applies application logic, and provides REST API endpoints. MongoDB stores application records, with Mongoose used to define and interact with data models. A software telemetry simulator generates changing values for demonstration and makes the machine-monitoring interface testable without physical sensors.

The intended workflow is: (1) a user opens a module from the dashboard; (2) the frontend requests data from the backend API; (3) the backend retrieves or updates relevant MongoDB records; (4) the frontend renders the returned information; and (5) the simulator periodically changes selected machine readings so the dashboard can display changing conditions. Actual refresh behavior and telemetry-history persistence should be confirmed against the final implementation before submission.

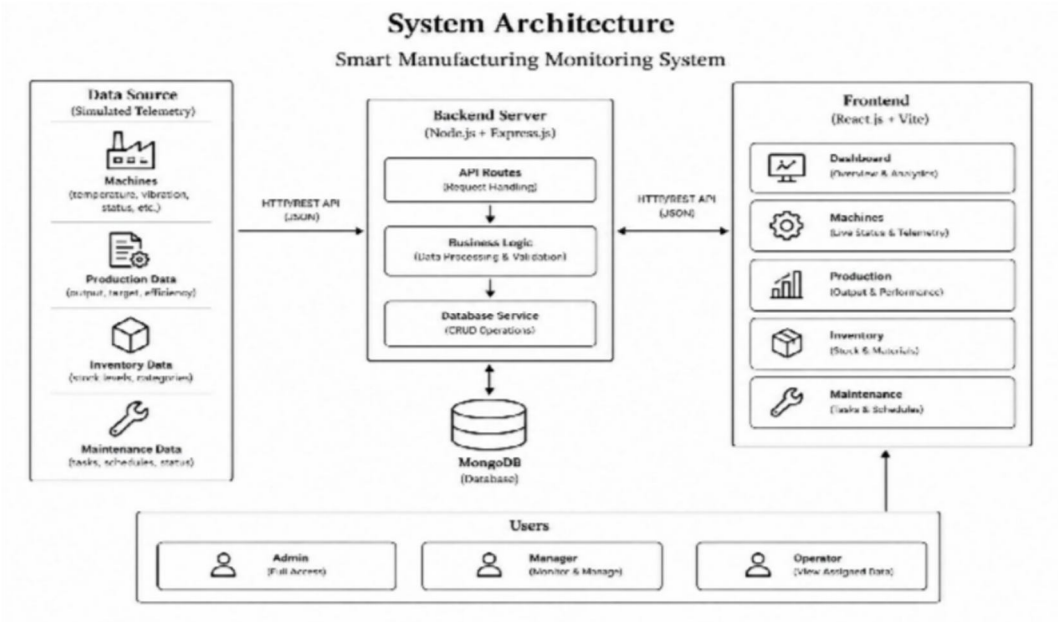


Table I. Main System Components

Fig. 1. Proposed architecture of the Smart Manufacturing Monitoring System.

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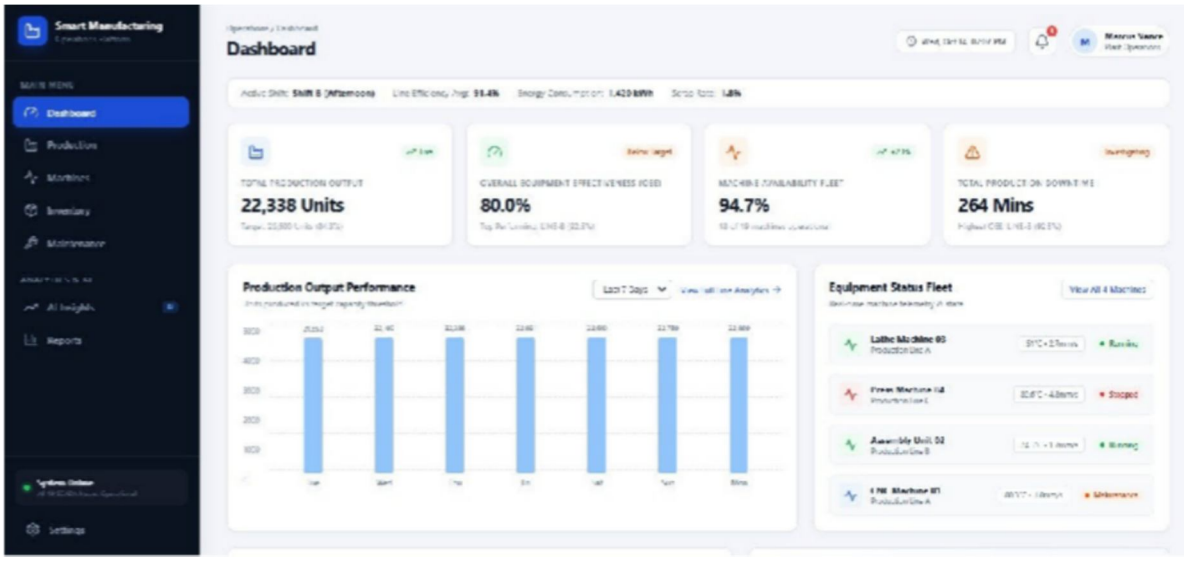


Fig. 2. Main dashboard showing production summary indicators and equipment status. Values shown are application demonstration data.

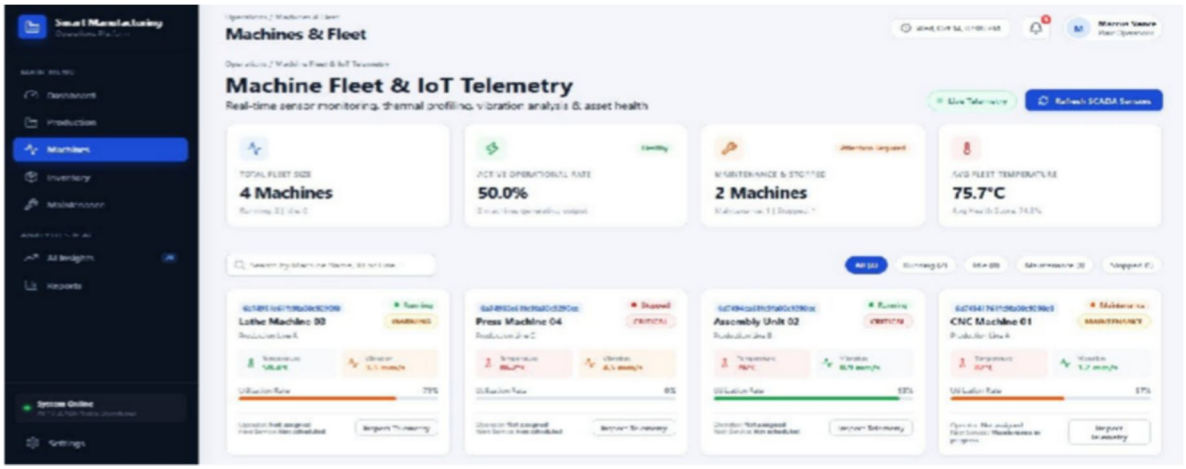


Fig. 3. Machine fleet and simulated telemetry view showing machine status, temperature, vibration, and utilization indicators.

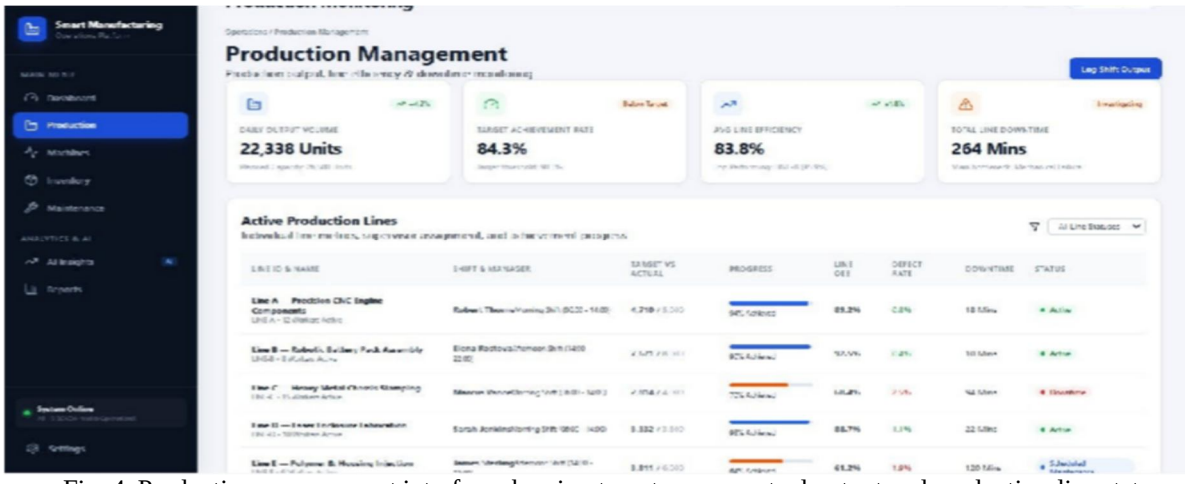


Fig. 4. Production management interface showing target-versus-actual output and production-line status.

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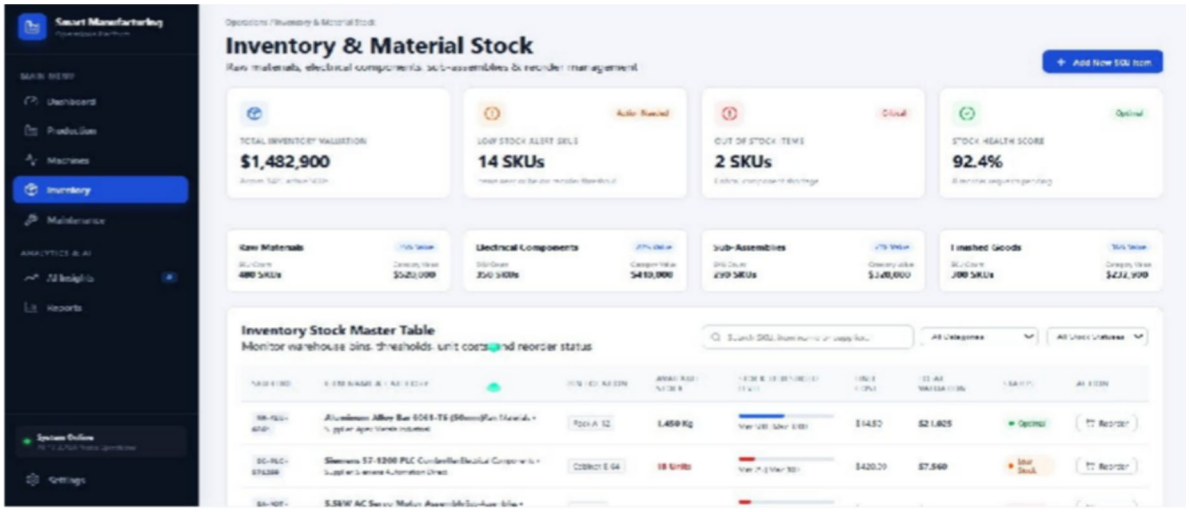


Fig. 5. Inventory and material stock interface showing stock summaries, thresholds, and inventory records.

V. MODULES AND IMPLEMENTATION

A. *Dashboard and Analytics*

The dashboard provides a consolidated view of selected manufacturing information. Summary cards and charts are intended to help users review machine conditions, production indicators, maintenance activity, and inventory status. The dashboard is a presentation layer over information supplied by the backend; displayed values should be interpreted according to their source and update frequency.

B. *Machine Monitoring*

The machine-monitoring module presents machine identifiers, production-line associations, operating states, temperature, vibration, and OEE values. Search or filtering can help users locate a machine. In the current academic implementation, telemetry values are simulated. They demonstrate how a monitoring interface responds to changing readings but do not establish the condition of real industrial equipment.

C. *Production Monitoring*

The production module organizes planned targets and actual output and may present performance trends through charts. Where target and actual quantities are available, production achievement can be represented as Actual Production / Target Production × 100. The formula is meaningful only when the target is non-zero and both values use compatible units and time periods.

D. *Maintenance Management*

The maintenance module organizes work orders associated with machines. Typical fields include machine, maintenance type, description, priority, status, and scheduled date. This supports structured review of planned and pending tasks. The application does not currently claim automated fault diagnosis or predictive maintenance unless such functionality is separately implemented and tested.

E. *Inventory Monitoring*

The inventory module organizes stock records using fields such as SKU, available quantity, threshold, and unit cost. Comparing available quantity with a configured threshold can help highlight records that may require review. The usefulness of this view depends on the accuracy and freshness of stored inventory data.

VI. TESTING APPROACH AND DISCUSSION

Because the project is still under development, this paper reports the system design and a proposed testing approach rather than claiming completed industrial validation. Functional testing should verify that each screen loads, the frontend communicates with the backend, database records can be created or retrieved as intended, and simulated telemetry changes are reflected consistently in the machine view.

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Table II. Suggested Functional Test Checklist

Test area	Expected observation	Evidence to capture
Dashboard	Key summaries and charts render	Screenshot with visible cards/charts
Machine view	Machine records and telemetry fields display	Machine list/detail screenshot
Production	Targets and actual output are shown	Production screen and sample record
Maintenance	Work orders and statuses are visible	Work-order screen
Inventory	Stock quantity and threshold fields display	Inventory screen
API/database	Requests return expected records	API response or application log

The primary intended benefit is consolidation: several categories of manufacturing information can be reviewed through a shared interface. A REST API and database-backed design also create clear boundaries between presentation, application logic, and persistence. However, the simulator limits conclusions about real-time performance. No measured reduction in downtime, cost, or maintenance response time is claimed. Such claims require deployment with representative factory data and a defined evaluation protocol.

VII. LIMITATIONS AND FUTURE WORK

The project remains under development. First, machine telemetry is generated by software rather than physical sensors, PLCs, or industrial gateways. Second, the system has not been validated in a live manufacturing environment. Third, OEE is displayed as an indicator in the project context and should not be described as independently validated unless availability, performance, and quality are calculated from verified source data. Finally, a trained machine-learning model for failure prediction has not yet been implemented or evaluated.

Future work includes connecting equipment through suitable industrial communication interfaces; recording time-stamped telemetry history; implementing threshold-based notifications; improving authentication and role-based access control; validating OEE calculations against defined operational data; and developing a predictive-maintenance model using appropriately labelled historical data. Any future model should be evaluated using a documented train/test procedure and suitable measures such as precision, recall, F1-score, and false-alarm rate before it is used to support maintenance decisions.

VIII. CONCLUSION

This paper presented the design and current development of a Smart Manufacturing Monitoring System that combines machine monitoring, production tracking, maintenance work orders, inventory information, and dashboard summaries within a web-based application. React.js and Vite provide the frontend, Node.js and Express.js expose REST APIs, and MongoDB with Mongoose provides data persistence. A software telemetry simulator supports demonstration of changing machine indicators without physical industrial equipment. The system offers a modular foundation for centralized operational visibility, but its current status and limitations must be considered: it is still under development, uses simulated telemetry, and does not yet provide validated machine-learning-based failure prediction. Further implementation and testing are required before drawing conclusions about industrial impact.

IX. ACKNOWLEDGMENT

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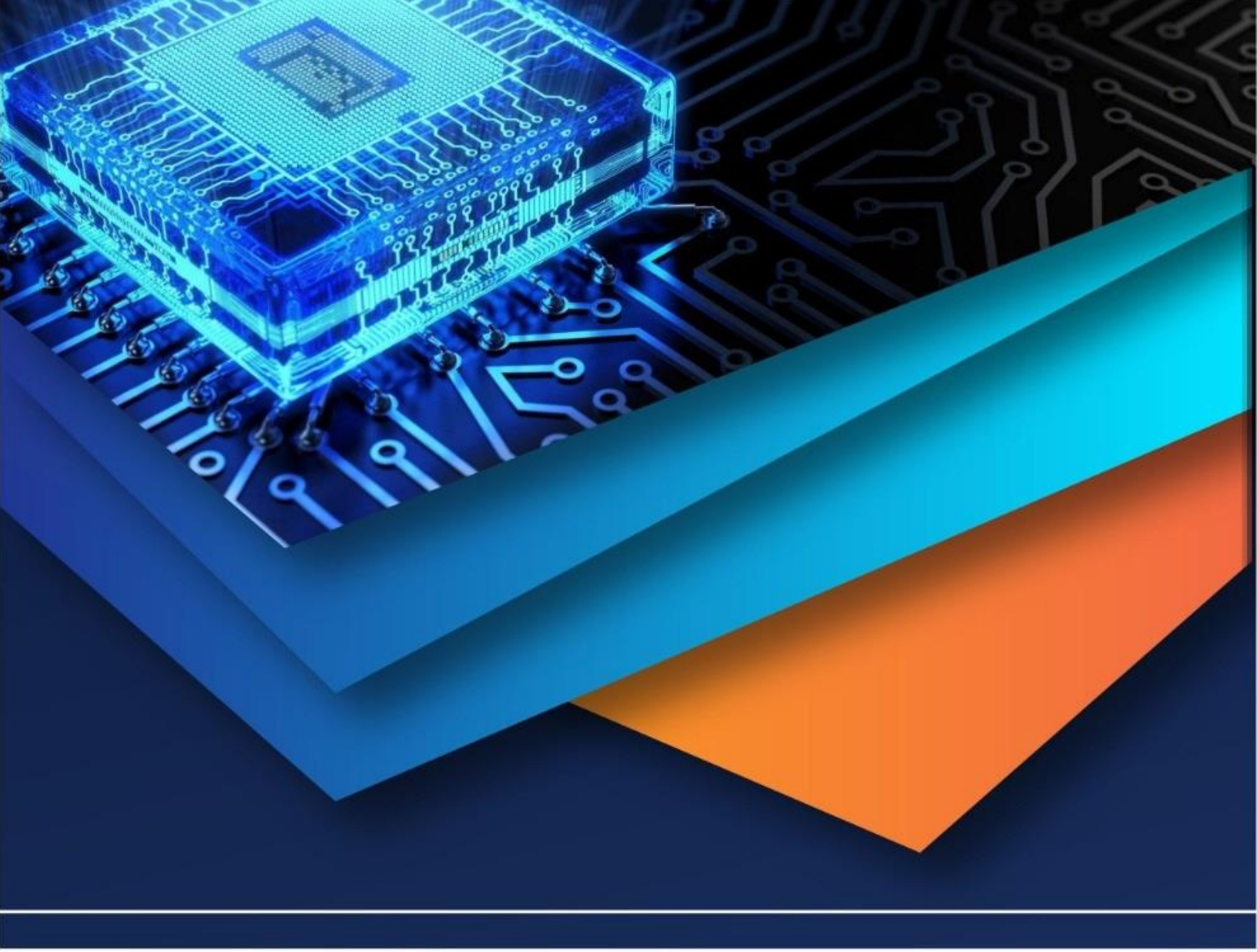
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